ECB FORUM ON CENTRAL BANKING

27–29 June 2022

Challenges for monetary policy in a rapidly changing world

Conference proceedings

EUROPEAN CENTRAL BANK
EUROSYSTEM

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18:30	Reception and dinner hosted by the Banco de Portugal

Challenges for monetary policy in a rapidly changing world - takeaways from the ECB's Sintra Forum

By Philipp Hartmann and Ivan Jaccard[1]

Abstract

The 2022 ECB Forum on Central Banking was designed to analyse a series of disruptions that affected the euro area and the world economy during the recovery from the COVID pandemic, including notably Russia's invasion into Ukraine, and a number of parallel structural changes. Participants discussed implications for inflation, monetary policy and financial stability. In this article, two of the organisers summarise some main points from the papers and discussions, including how supply bottlenecks drive inflation, how oil price shocks affect the macroeconomy and how Europe is restructuring its energy supply, how globalisation turns from goods to services, how inflation expectations should be used in the conduct of monetary policy, what house price booms imply for monetary and macroprudential policies, which financial stability challenges have recently emerged and how a Central Bank Digital Currency should be designed and what it would imply.

1 Introduction

Just as societies seemed to be getting the coronavirus (COVID-19) pandemic and its economic implications under control, armed conflict materialised in Europe's east. While the Russian invasion of Ukraine was clouding the post-pandemic recovery, it also doubled down on the pandemic legacy of an inflation wave driven by energy prices and supply bottlenecks. The military aggression sharply raised uncertainty and also posed serious questions about the future international economic order. The 2022 ECB Forum on Central Banking analysed selected aspects of this new environment. It looked at the implications for the euro area economy in the global context, including previous trends and structural changes that the pandemic seemed to have reinforced, and at lessons for monetary policy, inflation and financial stability.

In this chapter we summarise some of the main issues discussed at the Forum and group them in eight themes: the role of supply disruptions for euro area and US inflation; how oil price shocks affect the macroeconomy and the role that gas plays in the restructuring of European energy sources; key features of the new services

[1] Philipp Hartmann is the Deputy Director General for Research and Ivan Jaccard is a Senior Economist in the European Central Bank's Directorate General Research. Any views expressed in this chapter are summarised to the best of the authors' understanding from the various participants' Forum contributions and should not be interpreted as the views of the ECB or the Eurosystem.

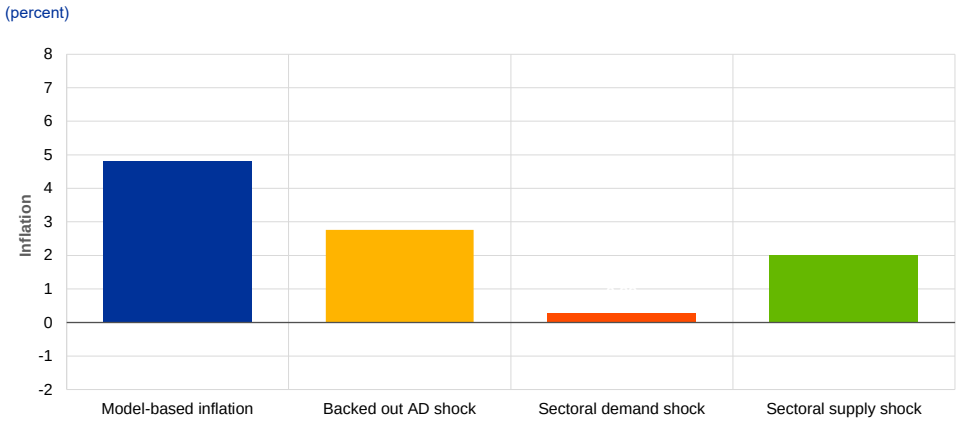
globalisation and how its implications differ from the previous goods-driven globalisation; how inflation expectations should be used in the conduct of monetary policy; what implications real-estate boom-bust cycles have for monetary and macroprudential policies; which financial instabilities have been observed in the context of rising monetary policy rates; and the motivation for, the design and implications of Central Bank Digital Currencies. The papers, presentations and video recordings of all sessions can be found at the ECB website.

2 Supply disruptions and inflation

Sebnem Kalemli-Özcan discussed the sources of inflation in the euro area and the United States during the recovery from the COVID pandemic but before Russia's invasion into Ukraine (di Giovanni, Kalemli-Özcan, Silva and Yildirim 2023). Starting from data showing that in both economies inflation recovered in line with indicators of global supply chain pressures, inflation began to increase before employment, durable goods recovered faster than services and the euro area experienced a larger collapse in imports than the US, she made the point that inflation was likely the result of a combination of supply disruptions in domestic and global production networks, the rotation of demand from services to goods and macroeconomic stabilisation policies stimulating aggregate demand.

Chart 1

Model-predicted inflation and components in the euro area between 2019Q4 and 2021Q4



Source: Giovanni et al. 2023, Chart 14.
Notes: The blue bar shows the cumulated inflation predicted over the reporting period by a simplified Baqaee and Farhi (2022) model calibrated to the euro area for three sectors, considering all shocks (demand and supply). The yellow bar shows the inflation component that is due to the aggregate demand (AD) shock alone, the orange bar the component only related to sectoral demand shocks and the green bar the component only related to sectoral supply shocks.

To quantify the role of supply disruptions in inflation in the euro area and the US, Kalemli-Özcan then went through three steps. She first calibrated a closed economy multi-sector macro network model with limited factor substitutability based on Baqaee and Farhi (2022), using data on input-output linkages for a large number of sectors. In this setup the COVID-induced rotation from services to (durable) goods consumption would create inflationary sectoral labour shortages. Chart 1 displays the overall euro

area inflation predicted by the model for the early COVID recovery (up to Q4 2021) and its decomposition in the components from three types of shocks. Sectoral demand and supply shocks are identified with data for sectoral consumption and hours worked. For the euro area calibration, it turns out that labour supply constraints account for close to half of the predicted inflation. For the US they only contribute about on third (di Giovanni et al. 2023, Charts 15 and 16).

Second, to quantify the role of global supply disruptions Kalemli-Özcan built on previous work extending the Baqaee and Farhi (2022) model to a multi-country setting (Cakmakli et al. 2021 and 2022). Combining the domestic production network with a rich set of input-output linkages among 65 countries, she finds that external shocks explain almost two thirds of euro area inflation (Chart 19 in di Giovanni et al. 2023). Last, she argued that the relatively quick rebound in international trade during the pandemic, relative to the financial crisis of 2008-2009, led to the erroneous belief about well-functioning global supply chains. Instead, the authors estimate significantly reduced elasticities of trade to GDP, which illustrate the persistency of global supply chain bottlenecks (Table 4 in di Giovanni et al. 2023).

The discussant, Gabriel Felbermayr, reckoned that the effects of supply constraints on inflation are probably even higher than estimated by the authors. First, the model neither captures shipment costs and protectionism nor includes the reduction in competition from firms exiting the market due to supply shocks. Regarding the persistence of global supply bottlenecks, Felbermayr detected mixed signals. While ocean delivery times somewhat declined during the months before the Forum, idle containership capacity re-increased due to traffic jams around Shanghai and in the North Sea.

The paper and the discussion rhymed well with the introductory speech by President Lagarde (2023), which had highlighted global supply chain disruptions coupled with surging global demand as one of the key factors driving the observed high inflation rates. Moreover, the speech pointed to broad-based labour shortages across sectors and an only gradual resolution of global supply chain disruptions as factors influencing the persistency of inflation.

Gabriel Felbermayr expressed particular concern about the rise in protectionism that explains “slowbalisation” already since shortly before the global financial crisis. It implies upward pressure on prices and reduces the capacity of the global trade system to adjust to shocks. He presented recent research suggesting that the welfare costs of removing global value chains (“decoupling”) significantly exceed the benefits in terms of “insulation” from foreign shocks (Eppinger, Felbermayr, Krebs and Kukharsky 2021).

The subsequent general discussion revolved very much around measurement issues and the role of demand policies. Ricardo Reis pointed out that the inflation effects of labour shortages could be overestimated, as different labour market policies in Europe and the US may explain cross-Atlantic differences in hours worked. For example, the widespread use of furloughs in Europe reduced measured employment fluctuations relative to the US, potentially leading to an upward bias in the estimated euro area elasticity of inflation to employment.

Harald Uhlig recalled that inflation should ultimately be a monetary phenomenon. He wondered whether supply constraints should not result in relative price changes rather than general inflation and which goods prices would decline in the approach presented. Jim Bullard argued that the right way to look at the results is – for given monetary and fiscal policies – what are the additional effects of supply constraints on inflation. Gabriel Felbermayr suggested to bring in models with optimal monetary policy in the presence of nominal frictions. Sebnem Kalemli-Özcan suggested that the recent paper by La'O and Tahbaz-Salehi (2022) does precisely that with a production network approach. The paper finds that central banks should target a price index in which goods with relatively rigid prices would receive a high weight and goods with relatively flexible prices a low weight. Simply speaking, monetary policy should focus more on services and less on energy prices.

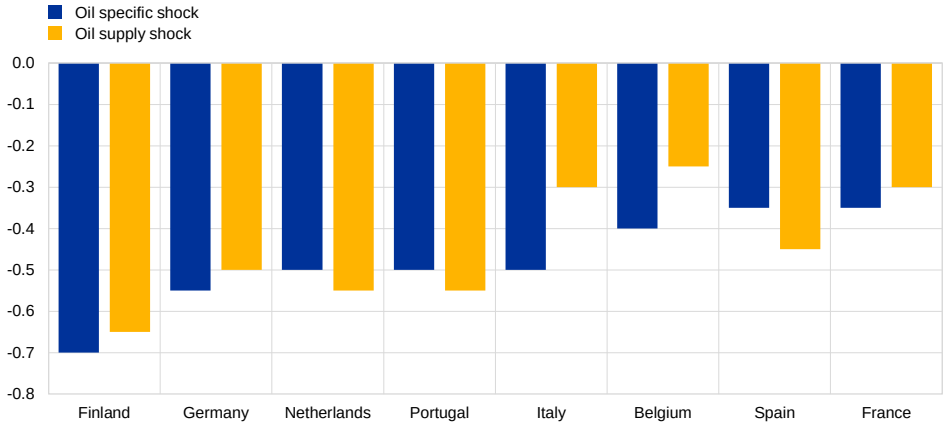
3 Oil prices, gas supply, the macroeconomy and the restructuring of European energy sources

Jim Hamilton's seminal paper (Hamilton 1983) found that all but one recession in the United States since World War II has been preceded by a dramatic increase in the price of crude oil. The negative relationship between oil prices and economic growth can be explained with a cost channel in that the higher production costs and associated inflation make households and firms reduce their aggregate demand. But there is disagreement about whether monetary policy has been exacerbating or dampening the relationship. Hilde Bjørnland reviewed the recent literature on the relationship and drew lessons for the situation in Europe following the COVID pandemic and the start of the war in Ukraine (Bjørnland 2023).

Taking into account the endogeneity of oil prices to global demand and supply, oil price increases of 10 to 15 percent tend to decrease GDP in major economies by 0.3 to 0.5 percent. Europe is hit particularly hard by oil-specific supply shocks due to its energy intensity, openness and high investment share, except exporters of North Sea oil that benefit. Chart 2 shows how diverse the growth effects of large oil price shocks across the euro area are. The GDP decline in an energy-intensive economy like Finland is about twice as large as for France. The shale revolution makes also the US benefit and renders oil supply more price-elastic, while not necessarily stabilising oil prices immediately but likely in the longer run. Some measures of inflation expectations are sensitive to oil price shocks, as e.g. gasoline prices are very salient in households' consumption baskets (see also the section on inflation expectations and monetary policy). But the strength of the indirect expectations channel on inflation will depend on the nature, combination and persistence of shocks. For example, updating the analyses in Aastveit, Bjørnland and Cross (2023), Bjørnland concluded that in the year before the Forum the increase in oil prices due to demand shocks contributed to the rise of 1-year ahead consumer inflation expectations in the US but it did not explain a major part of it.

Chart 2

Simulated effects of different oil price shocks on GDP in various euro area countries



Source: Bjornland (2023), Chart 5, based on Aastveit, Bjørnland and Thorsrud (2015).
Note: The bars show median effects on the level of GDP at the 2-year horizon. The oil supply shock is normalised to decrease oil production by 1% (which eventually increases the oil price by 10 percent). The oil-specific demand shock is normalised to increase the real oil price by 10% on impact.

Hilde Bjørnland concluded that rising inflation and short-term inflation expectations require swift monetary policy actions now, so that long-term inflation expectations remain anchored and a wage-inflation spiral is prevented. Going forward, policy should become more balanced for the increased recession risk. At the same time, however, some of her past research (Bjørnland, Larsen and Maih 2018) suggests that it is more difficult for central banks to limit the effect of oil price shocks on inflation when oil price volatility is high – like in the period before the Forum. And while the shocks are smaller in size than the 1970s oil shocks, they are more broad-based (covering a wider range of energy sources and food prices). Therefore, the growth effects may be severe and the probability of a recession in Europe had increased in Bjørnland's view.

The discussant, Christian Zinglersen, complemented Hilde Bjørnland's presentation with six points (Zinglersen and Vereecke 2023). First, the current energy shock is particularly gas-driven for Europe, which accounts for 20 percent of power generation in the EU. It led to large increases in electricity prices for households and firms. While physical gas scarcity did not emerge until recently, reaching the desirable 80 to 85 percent storage levels for the winter may require that about 20 percent of Russian gas continues to flow. Still, some gas could be saved without inducing electricity scarcity. Second, gas currently accounts for almost a quarter of Europe's energy mix (behind oil with about a third) and it will remain important for many years to come. The main reason is that no other energy source is as flexible to accommodate seasonal demand fluctuations, including potentially high peak demands in the future. But the current east-to-west pipeline infrastructure would have to be changed towards Liquified Natural Gas (LNG) terminals and new pipelines from other locations, which will take time. Third, the global LNG market is likely to stay tight and prices will not return to their pre-conflict levels. The key fundamental of LNG availability may not increase very much until 2025/26, as only Middle Eastern state-owned companies invest above pre-COVID levels, the parallel green transition creates uncertainties for and shareholder pressure on investors. At the same time, the RePowerEU plan implies

additional European LNG demand in the order of 10 percent of global trade and Russian gas supplies cannot be quickly redirected to Asia and the implied LNG capacity releases not quickly evacuated.

Fourth, the diversification of Europe's energy sources requires an acceleration of the green transition both on the demand and the supply side. On both fronts price signals are not enough. On the demand side, improving the energy efficiency of buildings (which account for 40 percent of energy consumption, with 75 percent of the stock being energy inefficient) requires targeted measures to overcome strong behavioural and institutional barriers. On the supply side, a stronger increase of renewable energy requires accelerating permits and improving infrastructures and grids across the EU. Fifth, in terms of "early lessons" Zinglersen called for a balanced approach between demand and supply measures. Too much focus on supply risks price increases and inflationary pressures. The current organisation of European gas and electricity markets has economic advantages. Rather than reforming the markets in the light of high prices, Zinglersen prefers a focus on sound redistribution measures that protect the most vulnerable. Finally, he pointed out that the next three to four years also provide an opportunity for the EU to move towards true energy resource sharing. This would have enormous investment implications and require changed rules and governance. National political representatives would have to be comfortable with some countries becoming structural exporters and other structural importers of energy.

During the Q&A session, Daniel Gros wondered why shale oil production has not yet adjusted, given the rise in oil prices, and whether producers could be uncertain about the persistence of the increases. Hilde Bjornland explained that research suggests that shale gas production typically reacts to forward prices. The fact that it has not done so recently may be related to the high levels of uncertainty and interfering factors such as the green transition and related shareholder pressures – a point that also Christian Zinglersen made in his discussion. Gros also enquired whether gas demand has declined in proportion to the very large price increases. Zinglersen answered that a 9 percent demand reduction in Q1 2022 and slightly less subsequently is less than what would be needed (for both gas and oil). Europe is also facing a "perfect storm", as there are very significant nuclear outages in France. Beat Siegenthaler wished further assessment of the European storage levels and Zinglersen added that if Russian gas delivers would stop entirely, then it would become difficult to reach the necessary levels for the winter and policymakers would have to consider moving from pricing measures to rationing. Xavier Vives wondered whether there is an investment gap in fossil transition technologies, e.g. for gas. Zinglersen responded that current investment is about 20 percent lower than before the pandemic, but it is not clear whether this is too low. It would depend on future demand reductions and the uptake for alternative clean energy supply.

Beatrice Weder di Mauro and Claire Jones asked the speakers about their views on price caps for Russian gas and oil. Zinglersen answered that capping some of the rents makes intuitive sense but it is difficult to implement in practice. If they are targeted to only Russia, some extreme reactions could be the consequence. Moreover, one would have to distinguish between LNG and pipeline deliveries. The

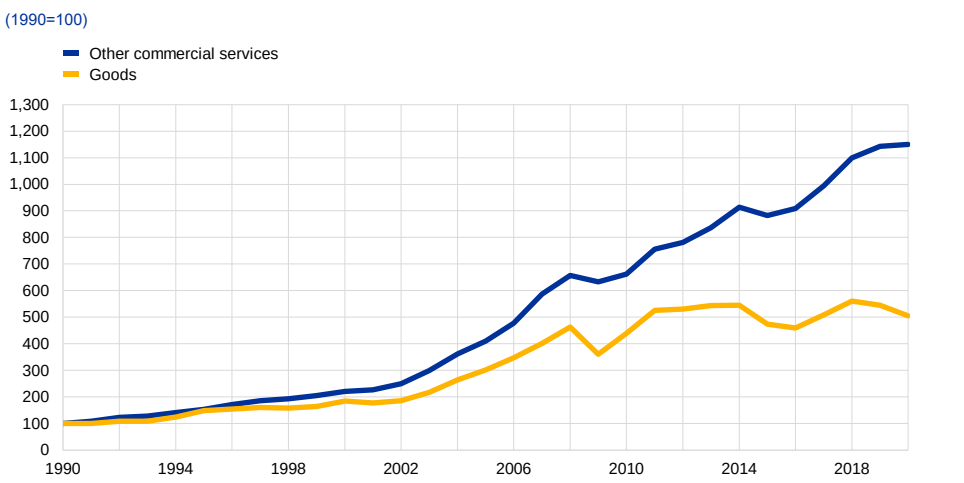
former is traded in a global competitive market and the flexible cargoes would go to where the higher prices are paid. The question for pipeline suppliers is what is their further goodwill in times when other concessions are needed, such as urgent maintenance.

4 Services globalisation, inflation and labour markets

Richard Baldwin discussed how the next era of globalisation would focus on services trade, driven by advances in digital communication tools (Baldwin 2023). In contrast to goods, global services trade has not peaked but rather accelerated very much since the 1990s (see Chart 3). The share of "other commercial services" (all services without transportation, tourism and travel) in total global trade in goods and services has risen from about 9 per cent to about 20 per cent in the three decades preceding the COVID pandemic (Baldwin 2023, Chart 4, right panel), with very similar numbers for the euro area. The reason for this third phase of globalisation is the significant reduction of "face-to-face costs" through new telecommunication technologies, which enable strong growth in the cross-border provision of labour services (Baldwin 2019).

Chart 3

Trends in world trade in goods versus world trade in services



Source: Baldwin 2023, Chart 4, left panel.
Notes: The chart is in levels and stops in 2020 since the COVID pandemic had severe and historically unprecedented effects on services trade. Data are downloaded from stats.wto.org.

Baldwin displayed a number of facts about services globalisation and discussed in which regard services are different from (manufacturing) goods, which drove globalisation before. First, services are a larger share of advanced economies than manufacturing, for example in the euro area they constitute three quarters of employment and two thirds of GDP. Second, barriers to services trade tend to be much higher than barriers to goods trade, but most barriers to intermediate services are technology-linked and digital technology advances are eroding them at a very fast pace. Third, services intermediates as a share of total output tend to be three times as important as manufacturing intermediates and the former are on the rise. In other words, the potential demand for intermediate services in high-income countries and

the potential labour capacity in emerging economies are both very large. Hence, intermediate service trade growth is already two to three times faster than goods trade growth since the mid-2000s and this is likely to continue. Fifth, service automation is different from manufacturing automation as it affects jobs with higher skill levels, creating “white collar robots” so to speak. The coding of regular manufacturing robots is slow relative to machine learning, which is very prominent in services automation. Sixth, services globalisation and automation – combined denoted by Baldwin as “globotics” – happen at the job or task level, whereas manufacturing automation and globalisation happened at the product level. Seventh, whereas “globotics” in manufacturing was relatively uniform across sectors, the automatability and/or the teleworkability of different service occupations are rather diverse (Baldwin 2023, Chart 12).

In what concerns central banks’ core business, the weight of services in the euro area Harmonised Index of Consumer Price (HICP) is 44 percent and services inflation tends to be (structurally) faster and less volatile than goods inflation. The cumulative excessive inflation of services in the euro area amounted to 17.5 percent over the last 20 years. Prices of the most important services sub-sectors (housing, recreation, transport and miscellaneous) tend to grow in tandem, while the communications sector is an outlier in experiencing price declines over the last 20 years. Complementing Baldwin’s structural perspectives, Lagarde (2023) noted that in the post-COVID recovery spending rotated back from goods to services, driving the May 2022 services inflation rate up to 3.5 percent. Moreover, the sticky nature of services inflation may have implications for the persistence of the current inflation wave in the euro area.

One key conclusion from Baldwin’s paper was that current statistics do not allow to calculate the effect of services globalisation on euro area prices and inflation, which is likely to be reductionary. First, there are missing import prices, as services do not have custom declarations like goods. Second, services trade categories cannot be properly mapped into domestic sectors and occupations. Therefore, Baldwin suggests a research programme to overcome these problems.

The discussant, Barbara Petrongolo, considered to which extent the observed effects of goods globalisation on inflation, employment and inequality could also emerge in services globalisation (Petrongolo 2023). A recent study by Jaravel and Sager (2019) using a large number of product categories spanning both goods and services found that a 1 percent increase in import penetration from China implied a more than 2 percent decline in inflation and a 1.8 percent decline in employment. Most of the rather large inflation effect comes from locally produced (rather than imported) goods for which foreign competition increased productivity and, particularly, reduced firm markups.

In what concerns distributional effects, services globalisation could be different from goods-driven globalisation. The share of women in services is much higher than in goods production, so that women would not be shielded any longer. This could potentially undo the increase of women’s labour market participation facilitated by domestic services sector growth. Moreover, she expected the employment effects of services globalisation to be more uniform across geographical regions because

services are less regionally concentrated than manufacturing. She confirmed Baldwin's point that, all in all, services globalisation would affect better educated workers more than the case for goods globalisation. She nevertheless reported results of a recent study on the effects of the European Union's posting policy (Muñoz 2022). Workers from one EU country posted by foreign EU firms to another EU country (without properly migrating and being employed by local companies in the traditional way) would typically fulfil tasks requiring less education, such as in construction, cleaning, truck driving etc. The study – based on French data – suggests that workers posting significantly reduces domestic employment at the firms receiving the services but not local employees' wages. Most of the welfare gains, however, accrue to the sending countries that experience rising productivity of and wages at the sending firms.

Philip Lane opened the discussion with the observation that Baldwin's numbers could even underestimate services trade growth, as they do not capture the cross-border provision of services within multinational enterprises. Volker Wieland wondered whether political obstacles to services globalisation could still arise, as geostrategic conflicts are on the rise, cyber attacks are a particular threat and governments could also benefit from technical progress. Based on his 2019 book, Baldwin acknowledged that this could happen, but it is way harder than for manufacturing. For example, for taxing intermediate services it is difficult to know where they are produced and how to value them. Governments would have to control all internet traffic to detect undeclared cross-border service provision. Or, alternatively, they would have to regulate domestic firms very strictly, as it is the case in some constituencies for outsourcing medical or financial services.

Kristin Forbes pointed out that the global component in services inflation is way smaller than for overall consumer price inflation, which does not rhyme well with very dynamic services globalisation. Richard Baldwin first explained that in what concerns the euro area the HICP does not cover precisely the tradable services whose trade grows particularly dynamically. The exception is that it covers communication services, whose prices declined during the last two decades, in line with global competition. Moreover, as technology is still developing, most of the effects are still to come. Last, he agreed with Forbes that the strong trend in services inflation could have been taken out by monetary policy and therefore not visible.

Helene Rey expected that two factors should remove the Balassa-Samuelson effect over time, which implies that low-productivity services would have higher price growth than high-productivity goods in industrial countries. These are strong services globalisation – as a source of competition – and technical progress in services, both highlighted in the globotics phenomenon.

5 Inflation expectations and monetary policy

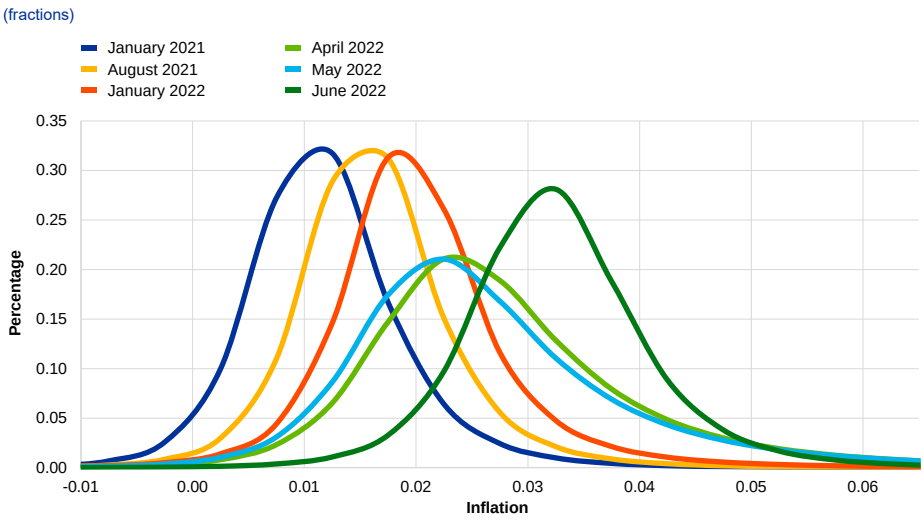
In her introductory speech to the Forum, President Lagarde (2023) explained a key role for inflation expectations in the ECB's current approach to incorporate the principles of gradualism and optionality in determining the appropriate monetary policy

stance. Gradualism allows policymakers to assess the impact of their moves on the inflation outlook as they go, which can be a prudent strategy in times of uncertainty. Optionality ensures that policy can react nimbly to the incoming data on the economy and inflation expectations. For example, if inflation threatens to de-anchor inflation expectations, the ECB would need to withdraw accommodation more promptly to stamp out the risk of a self-fulling spiral.

A panel session on “the role of inflation expectations in monetary policymaking” followed also up from a discussion at the 2021 Sintra Forum in which Charles Goodhart and Ricardo Reis had expressed contrasting views about the usefulness of inflation expectations (see the summary in Hartmann and Schepens 2021 or their contributions in ECB 2021). In the 2022 Forum Reis first reviewed the different measures of inflation expectations and their relative strengths and weaknesses: surveys of regular households and firms; surveys of professional forecasters; and inflation expectations extracted from financial market prices (Reis 2023). With both short (1-year ahead) and medium-term expectations (5-years ahead) he illustrated that in 2021 and 2022 household expectations reacted ahead of market prices, whereas professional forecasters were not signalling inflation risks early.

Chart 4

Euro area longer term inflation expectations: estimated probability densities 10 years ahead



Sources: Reis (2023) Chart 6, based on Bloomberg data.
Notes: Probability densities are derived from swaption prices, reflecting the average expected inflation rate over 10 years following the dates indicated in the legend. See Hilscher, Raviv, and Reis (2022) for methodological details.

His previous research (Reis 2020) suggests that all three types of measures should be combined and their common component be extracted after using statistical methods to correct for their respective imperfections. The new measure of “fundamental” medium-term inflation expectations shows marked increases for the euro area around the third quarter of 2021 and another jump in early 2022. Something similar can be seen from a measure extracting longer term inflation expectations (10-years ahead) from option prices (Hilscher, Raviv and Reis 2022). Chart 4 suggests that during the months before the Forum the mean of this measure had reached around 2.5 to 3

percent, which is somewhat above the ECB's inflation goal of 2 percent. Moreover, the extracted tail risk of a "high-inflation disaster" of average inflation above 4 or 5 percent over the next 10 years since the end of 2021 also increased from negligible levels to around 5 or 10 percent probabilities, respectively (Reis 2023, Chart 7).

To discuss whether policymakers should care about these developments, Reis looked at the lessons from standard New Keynesian macroeconomic models. Monetary policy should react with tightening if consumers act through higher wage demands and greater spending on the inflation expectations. It should act stronger, when consumers overreact with their spending decisions and wage demands to supply shocks. If consumers start to doubt about the long-run credibility of the central bank to keep inflation at target, monetary policy should tighten immediately and very aggressively. Only if fluctuations in inflation expectations are just noise to which consumers do not react a monetary policy tightening is not justified.

Loretta Mester went through the theory and the practice of using inflation expectations, concluding on an approach how to take them into account from the perspective of a US policymaker (Mester 2023). She recalled that inflation expectations are a central feature of models of inflation dynamics since the 1960s and 1970s. They influence wage demands and offers as well as firms' price-setting. Recent research by the Federal Reserve Bank of Cleveland (Tallman and Zaman 2020) also suggests that incorporating survey-based longer-term expectations improves macroeconomic forecast accuracy. In addition, inflation expectations provide a signal about the credibility of central banks' inflation commitment.

While the theory is very compelling, in practice inflation expectations are not directly observable. The extent literature so far gives only limited guidance to conflicting messages between the many available measures, the diversity of expectations across different people and goods and the direction of causality between inflation and expectations about it.

In the present context of high inflation and rising longer-term inflation expectations Mester called for a risk management approach. Simulations with the Federal Reserve Board's FRB/US model suggest that assuming that inflation expectations are anchored when they are not will be more costly than assuming that inflation expectations are on the way of unanchoring when they are not (De Pooter et al. 2016). So, policymakers need to be very resolute in bringing inflation down to target again. The current situation belies the view that monetary policy should always look through supply shocks.

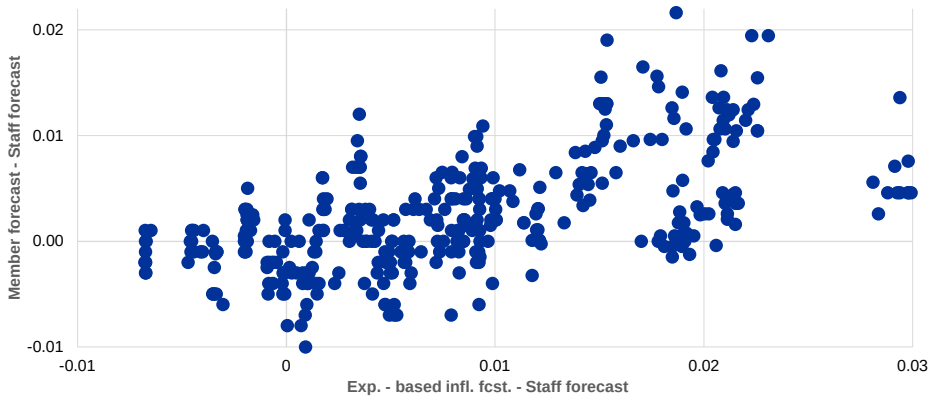
Ulrike Malmendier discussed what a period of high inflation such as the present one does to inflation expectations of households, firms and policymakers and ultimately their decision-making, considering insights from neuroscience and neuro-economics (Malmendier 2023). For households she reported the results of research with the University of Michigan survey of consumer expectations, suggesting that when forming inflation expectations households put a high weight on inflation experiences that they personally made over their lifetimes relative to other available historical information (Malmendier and Nagel 2016). This is different from standard adaptive learning models. In what concerns firms, a survey of managers in New Zealand found

that the top four answers on the question “How do you typically form your inflation expectations?” included experiences with the prices of competitors and suppliers, own shopping experiences and discussions with co-workers and family members (Kumar, Afrouzi, Coibion and Gorodnichenko 2015). Chart 5 shows similar evidence for US central bankers. Inflation forecasts of the members of the Federal Open Market Committee (FOMC; vertical axis) are positively related to simple inflation forecasts enhanced with their personal life-time inflation experiences (horizontal axis).

Chart 5

US FOMC members’ inflation experiences and forecasts

(Horizontal axis shows experience-based inflation forecasts for FOMC members, vertical axis shows FOMC members’ inflation forecasts, both normalised by subtracting the corresponding staff forecasts; fractions)



Sources: Malmendier 2023, Chart 2, and Malmendier (2021).
Notes: Forecasts of members of the Federal Open Market Committee (FOMC) are from the semi-annual Monetary Policy Report to Congress, 1992 - 2007. Staff forecasts are Greenbook forecasts from the same period. Experience-based forecast are AR(1) model forecasts estimated based on weighted life-time inflation data for each FOMC member.

The neuro-science explanation is that each time a new experience is made the brain builds a connection between two neurons, a synapse. The strength of this memory is influenced by the frequency, the duration and emotional associations with the experience, such as fear, larger or smaller traumata. Malmendier explained that this research suggests a different perspective on the anchoring of inflation expectations. Rather than to abstract credibility, it points to agents effectively experiencing that the central bank “fights the inflation reality”.

Erik Nielsen (2023) provided a perspective from a financial market practitioner and corporate banker. While he acknowledged the importance of long-term inflation expectations for central bank credibility, he felt that during 2022 the frequent references to inflation expectation indicators in relation to specific monetary policy steps (but not the general policy direction) was excessive and sometimes led to confusion in financial markets and volatility.

Survey and market-based measures of inflation expectations are volatile, opaque and prone to revisions. For example, markets’ pricing of “inflation compensation” can move significantly above the central bank’s inflation target and then come down to it again in a few weeks. It is also hard to interpret due to the embedded time-varying liquidity and inflation risk premiums. Once adjusted for these premiums, market-based inflation expectations become little more than an average of private-sector professional forecasts. Recently, Nielsen had to spend a lot of time with financial market

participants and clients about what the right interpretation of small changes in household inflation expectation measures and their implications for the size of interest rate increases to be expected from central banks are. But these surveys contain a lot of noise, as it is not clear which prices people have in mind when they fill the surveys and the dispersion across respondents can become very large.

Moreover, at the time of the Forum Nielsen saw little evidence that measured inflation expectations drive unions' wage demands in Europe. They seem rather intended to compensate for past inflation. So, he remained confident that the risk of a self-fulfilling wage-price spiral in the euro area was limited. Central banks should only worry about a loss of credibility and use measures of inflation expectations to inform the direction and speed of monetary policy when a collection of longer-term expectation measures deviate measurably (e.g. by 50 basis points or more) and over an extended period of time (e.g. six months) from target.

In the subsequent discussion there was general agreement with Nielsen that monetary policy should not directly react to new readings of specific inflation expectation measures. Mester explained that the Fed does not use them in that way when making interest rate decisions. This is not what data dependence means. They are rather looked at in the context of trends in all data and what they contribute to the understanding of how the overall economy evolves. Isabel Schnabel remarked that fluctuations in risk premiums in market-based measures are not just noise but may sometimes also contain useful information about the uncertainty in inflation going forward. Reis suggested to downplay them when they are out of sync with risk premiums of other assets, such as the equity risk premium. He also explained that his measure of "fundamental" inflation expectations takes some of the volatility and biases out. Such measures should receive more attention at turning points when many of them move in the same direction.

Vítor Constâncio challenged that measures of inflation expectations generally improve inflation forecasts. Using a wide range of time series models, a recent ECB working paper finds that neither household or firm surveys nor market-based measures improve forecasts (Bańbura, Leiva-Leon and Menz 2021). Only the expectations from the ECB survey of professional forecasters and from Consensus Economics do, but not to a large extent. Ricardo Reis found these results consistent with professional forecasters being somewhat useful in normal times but not at turning points like the present change from low to high inflation. Constâncio also argued that with the much lower unionisation nowadays a wage-price spiral was less likely.

In response to a question by Markus Brunnermeier who wondered whether different euro area countries' past inflation experiences can be seen in today's inflation expectations, Ulrike Malmendier referred to research suggesting that cross-country differences in inflation experiences still impact inflation expectations today. Moreover, they also affect peoples' choices in the housing market, such as buying houses or choosing fixed-rate mortgages as hedges to inflation risks. Jim Bullard asked whether the low inflation readings from before the COVID pandemic are now discounted and whether this implies dangers going forward. Loretta Mester reported that current forecasting models give less weight to the recent past and more weight to the future,

and therefore – also in line with the neuro-economic research – the present situation has a higher risk of destabilising inflation expectations.

Silvia Ardagna asked whether some of the research presented would help understand the European Commission's recent household surveys. They show expectations of price increases over the next 12 months, but no increase in consumption and lower expectations about future consumption. Ulrike Malmendier felt that the disappointing consumption pattern is what neuro-scientific research about the long-lasting effects of past experiences would predict. Ricardo Reis reasoned that the pattern was in line with what standard models would suggest about supply shocks: high inflation expectations and less spending in the future.

6 Implications of house price booms for monetary and macroprudential policies

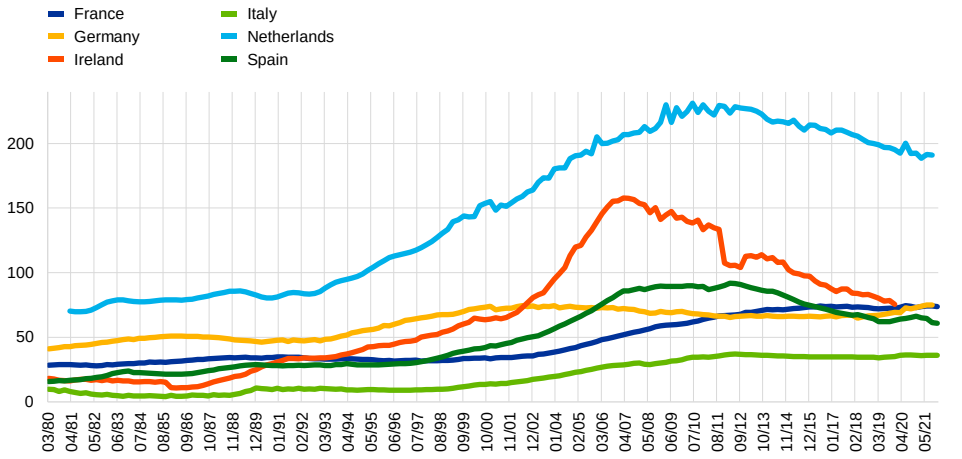
Against the background that real-estate prices had increased significantly in the euro area during the decade preceding the Forum, John Muellbauer discussed their role in the financial accelerator and drew lessons for the models used in central banks, for monetary and macroprudential policies (Muellbauer 2023). Focusing on the build-up to and unravelling of financial crises and on the five largest euro area countries plus Ireland, he particularly emphasised the value of estimating mortgage credit conditions, i.e. indicators of lending standards, as input into central bank modelling and decision-making. Real-estate boom-bust cycles typically start with lax lending standards that lead to overvalued property prices, more construction and growth, which ultimately reverse when defaults and foreclosures set in. Also on the way down the financial sector amplifies the adjustment, as banks become fragile, contagion and panic emerges and lending standards tighten significantly, ultimately depressing consumption and growth (e.g. Duca, Muellbauer and Murphy 2021).

According to research Muellbauer undertook with Valerie Chauvin (2018) on France, the housing accelerator from lending standards to aggregate demand works through six channels: 1) short-term monetary policy rates and longer term mortgage rates; 2) house prices; 3) residential investment; 4) consumer spending; 5) mortgage debt; and 6) non-performing loans. A latent-variable approach identifies lending standards as the common component in the equations for 2), 4) and 5). Moreover, the latent lending standard indicator derived from the model has strong predictive power for non-performing loans. Therefore, Muellbauer argued that such aggregate lending standards would be useful indicators to add for most euro area countries to the risk dashboard of the European Systemic Risk Board (ESRB and ECB 2022), as they would summarise the information from multiple other indicators and reconcile their potentially contradictory signals. Good news was, however, that the relatively high real estate valuations in the six euro area countries at the time of the Forum did not seem to be driven by particularly lax lending standards. Moreover, contrary to the Great Financial Crisis, mortgage debt-to-income ratios were at relatively moderate levels in the most recent data (see Chart 6). While the described variables and mechanisms are systematically considered in the work of central banks' financial stability wings, Muellbauer criticised that the macroeconomic models typically used in most central

banks for supporting monetary policy hardly featured them. In fact, the paper by one of the ten finalists for the Sintra Young Economist Prize shows how different the transmission of monetary policy can work across countries when they feature diverse shares of variable relative to fixed-rate mortgages (Pica 2022).

Chart 6

Mortgage debt-to-income ratios in the five largest euro area countries and Ireland



Source: Muellbauer 2023, Chart 11, based on data from National Central Banks.
Notes: Pre-1999 data for Italy and pre-1994 data for Spain are spliced to total household debt, respectively. Housing loan data may not always be fully comparable, e.g., in the treatment of securitised debt, which is sometimes deregistered from bank balance sheets.

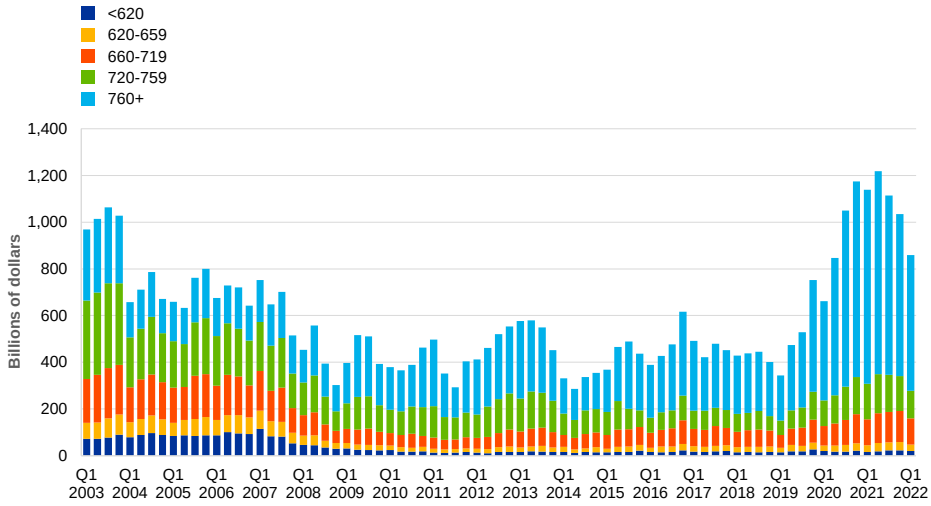
Concluding on monetary policy, Muellbauer suggested that the effects of previous monetary easings on household demand was less than intended, as for example the housing wealth effect is weak in some countries (e.g. Germany) and as high debt levels as well as negative affordability effects of high house prices mute consumer spending. Moreover, they may have had negative side effects on productive investment and on some dimensions of inequality. There was remarkable progress with macroprudential policy and the new setup in the EU has worked reasonably well. The macroprudential tightening in the previous years has now been "validated" by the economic crisis, which otherwise would not have been far from a "perfect storm". One success factor in the euro area was that cross-country differences in real-estate markets have been taken into account by the competent national and EU authorities. This heterogeneity is also a challenge for monetary policy that would try to "lean against the wind". It would be better if governments took out housing market distortions, for example by cutting mortgage interest tax relief and by relating property taxes to market prices. Going forward, Muellbauer urged to limit leverage in commercial real estate and in buy-to-let residential real estate, as the perceived inflation hedge and negative real interest rates could encourage debt-financed housing investments.

The discussant, Giovanni Dell'Ariccia (2023), agreed with most of the points made by Muellbauer and reinforced or complemented some of them from the literature, with his own or with other research done at the International Monetary Fund. He particularly stressed that there is a lot of empirical evidence that the main financial stability problems emerge when house price increases go along with rising debt and leverage. For example, the relationship between house price growth and mortgage delinquency

rates during the US subprime crisis disappears, if one controls for mortgage credit (Dell'Ariccia, Igan, Laeven and Tong 2016). But not all credit booms end with financial crises, some are of a "good" type. One useful indicator for distinguishing "bad" from "good" credit booms is construction, which typically also booms in credit booms that end with crises (Dell'Ariccia, Ebrahimy, Igan and Puy 2020). In this regard, one less reassuring development in the recent past is that building permits were trending up in 37 countries after the COVID pandemic. In contrast, a good news is that in a sample of 40 countries the correlation between house price growth and housing debt measures is lower than for the Great Financial Crises, even though this fact is more pronounced in the US than in Europe. Another good news for the situation at the time of the Forum is that mortgage originations in the preceding years were particularly driven by borrowers with relatively high credit scores (see Chart 7). By contrast, before the Great Financial Crisis, a large share of mortgages was originated with low-quality borrowers.

Chart 7

Mortgage originations in the United States by credit score



Source: Dell'Ariccia 2023, Chart 4, based on data are from the Federal Reserve Bank of New York.
Notes: A higher credit score indicates a lower default risk.

Dell'Ariccia also supported Muellbauer's and Pica's points about the great importance of cross-country and cross-regional heterogeneity for differential transmission of monetary policy or financial instabilities. Aspects that account for such differences include not only fixed versus variable rate mortgages but also differences in household indebtedness and mortgage leverage ratios, portability of mortgages, bank capitalisation, non-performing loans, securitisation, land scarcity and building regulations. While rising monetary policy rates tend to reduce house price growth and the riskiness of loans in general, the strength of monetary transmission through housing variables is diverse in the euro area, with Luxembourg and the Netherlands at one end of the spectrum (strong transmission via house prices, debt-to-income ratios, mortgage market participation or variable-rate mortgage shares) and Italy at the other (relatively weak transmission). An issue is also whether the COVID pandemic has triggered structural changes in real-estate markets, for example whether the higher house prices at greater distance from city centres would revert – like rents did – or not.

Regarding the leaning-against-the-wind debate, dell'Ariccia argued that there may be better instruments than monetary policy – notably macroprudential policy instruments – to lean against credit-fuelled housing bubbles. But they might be less effective when monetary policy is not aligned but moves in the opposite direction.

During the discussion with the floor, Lars Svensson pointed out that the recent ECB paper by Kockerols and Kok (2021) took the leaning-against-the-wind debate to the euro area data and found again that the costs of leaning with monetary policy exceeds the benefits. The paper also finds that there are net benefits of using macroprudential policy.

Kristin Forbes wanted to know which of the different macroprudential policy instruments (loan-to-value ratios (LTVs), debt-to-income (DTIs)/debt-service-to-income ratios (DSTIs) etc.) should be used. Or whether the problem of leakage raised by Giovanni Dell'Ariccia would argue in favour of broader instruments, such as the countercyclical capital buffer for banks. John Muellbauer responded that the case of France illustrates that a wider spectrum of macroprudential measures is called for. The narrow regulatory focus on the DSTI ratio allows a lot of lending when interest rates are low. At the same time, there is a host of measurement problems, which make the assessment of the effectiveness of different macroprudential policy instruments difficult. Still, cross-country data suggest that they are effective. Giovianni dell'Ariccia agreed that a wide range or all macroprudential instruments should be used, notably to avoid leakage. Much like for capital controls, market participants typically find after some time ways to circumvent macroprudential measures. This is also why they should only be introduced for limited periods of time. On the specific instrument choice, he recalled that borrower-based measures (like LTVs, DTIs etc.) tend to have more direct effects, whereas intermediaries can adjust their balance sheets more easily and it is not clear that intermediary-based measures would stop a boom. Last, there are strong political economy obstacles for introducing borrower-based measures. They are politically unpopular, as they typically hit young and poor people the most. Interestingly, interest rate increases tend to be less resented, as their effects are less direct and more uniform across people.

Hélène Rey asked John Muellbauer about the interpretation of his latent variable as a measure of lending standards. She wondered to which extent it would be influenced by factors like monetary policy, prudential regulation, competition between intermediaries and other structural incentives for intermediaries influencing their risk-taking. Muellbauer clarified that the latent variable is focused on the outcomes for aggregate house prices and captures many different micro factors that are hard to understand in their complexity. For its interpretability as lending standards, control variables are crucial. For example, in France the nominal interest rate is particularly important. In the model a 1 percentage point decline in it induces a 17 percent long-run appreciation of house prices just by itself. The chairman, Luis de Guindos, enquired about the effects of the increased construction costs and the associated prices and shortages of materials. Muellbauer responded that supply shocks of this nature reduce construction volumes, which are part of the downside risks to growth.

7 Financial stability, crypto assets and cyber risks

Richard Portes and Hélène Rey had a dinner conversation on “Threats to financial stability” moderated by Isabel Schnabel. Portes saw three factors playing a role in the recent financial market volatility. First, three types of events were “not conducive” to market stability: first, the continuing COVID pandemic in China; second, Russia’s war against Ukraine, which triggered major disturbances in commodity markets; and, third, elections in France and Germany, as well as the upcoming one in the US. Second, financial markets shifted to a risk-off mode with both equity and bond markets sharply down. Third, there is enough informal market evidence that some structural factors have reduced liquidity in financial markets, although hard evidence of this phenomenon was still missing. While Portes did not see yet acute financial instability like in 2008 or 2020, he warned that central banks could still be called upon to act again as market makers of last resort. First, stress could come from money market funds for which the regulatory improvements are not yet finalised. Second, Central Clearing Counterparties (CCPs) still have procyclical margins for commodity derivatives and a CCP could also become distressed.

In what concerns euro area fragmentation, Hélène Rey observed that despite the monetary tightening sovereign yields are still relatively low. In times of rising interest rates and the withdrawal of central bank liquidity, there can be normal and more dangerous differentiation in asset markets. Given that countries have different credit risks, some price discrimination leading to spreads is normal, as can also be observed in assets of emerging market economies and in high-yield corporate bond markets. More problematic is when sovereign spreads “take a life of themselves”, with self-fulfilling unstable dynamics. While there is a “grey area” between the two situations and typically observers’ convictions come into play, they can be distinguished when spreads move disconnected from economic fundamentals and/or particularly fast. The peculiarity of the euro area as an advanced economy composed of a set of independent states without much fiscal integration is that fragmentation can happen more easily than in mature nation states. This would be different with more fiscal integration, a Capital Markets Union involving a euro area safe asset and a completed Banking Union. While there was “no reason to panic” at the time of the Forum – e.g. some debt-to-GDP ratios were going down due to nominal growth –, developments need to be watched and instruments should be available to deal with emerging fragmentation. The dilemma of European Monetary and Economic Union has been for a long time how to be able to share risk and at the same time preserve market discipline.

President Lagarde (2023) further covered this topic in her introductory speech. In Europe’s incomplete monetary union the transmission of the ECB’s monetary policy could be impeded if spreads in some countries respond in a rapid and disorderly way to underlying changes in risk-free rates, over and above what would be justified by economic fundamentals. In such a situation, a change in the monetary policy stance can be followed by an asymmetric response of financing conditions, regardless of the credit risk of individual borrowers. The ECB is acting in two ways to prevent such unwarranted fragmentation from emerging. First, it will use flexibility in reinvesting redemptions coming due under the Pandemic Emergency Purchase Programme

(PEPP). Second, it has tasked the relevant Eurosystem committees and ECB services to accelerate the completion of the design of a new instrument for consideration by the Governing Council. This would allow to use separate instruments for targeting inflation, on one hand, and for preserving the monetary policy transmission mechanism, on the other hand.

When Isabel Schnabel turned in the dinner conversation to the dramatic reduction in the market capitalisation of crypto asset markets that had taken place in the months before the Forum Richard Portes said that it was a kind of natural implication of the switch from risk-on to risk-off mode. There has been an “embarrassing hype” around those assets. For example, the most important “so-called stable coin” Tether broke its peg to the US dollar and one third of its falling assets are in commercial paper with residual maturity of 44 days. Celsius, a major crypto lender, had to gate deposit withdrawals. And it has now become worthless, much like Terraluna. Some crypto exchanges, such as Binance, could reach leverage above 100, which Portes compared to Deutsche Bank’s leverage in 2008 of 65 – regarded by many at the time as a real problem. The financial stability risks from the shake-out were, however, limited at the present time, as crypto markets were overall still relatively small. But their growth had been very, very rapid before and they could have soon reached a more dangerous dimension. The problem with them is that they do what other markets do, but they do not have the regulations, backstops and fiduciaries that had developed for other markets “painfully” over decades.

Portes regarded “at least as dangerous” as those assets so-called smart contracts that are often associated with them. They give automatic execution without recourse. This was “not smart”. Contract law and commercial courts exist for a good economic reason: it is not possible to write all possible contingencies properly in a contract. Not even a “fat finger mistake” could be called back with such smart contracts.

Hélène Rey ended with similar conclusions as Portes. Crypto currencies have nothing to do with money. For example, Bitcoin is a very bad medium of exchange – due to high transaction costs –, unit of account and store of value. For other crypto assets, such as stable coins, it is still to be shown what their business model is other than avoiding regulation, avoiding fiscal dues or gaining seigniorage. An advantage of crypto assets could be technological advances, such as their programmability. But this is not about the object itself and could be developed separately. For example, similar technologies could be used for a Central Bank Digital Currency (see the section on CBDCs below), which would not have the same inconveniences as private crypto assets, and a CBDC has the potential to improve financial inclusion and cross-border payments.

Next, Schnabel oriented the discussion to cyber risks. Rey said that this area is plagued by lack of data, as the parties affected by incidents have incentives for underreporting for example. Therefore, one needs to become creative in finding ways to measure the associated financial stability risks. One such way is to study what analysts report about companies. From this data cyber attacks seem to have increased over time, in particular since 2016. While being initially more concentrated in the US, they now seem to have migrated more to the rest of the world, for example Europe and Asia, and to more sectors, such as insurance. A little bit of the risk can

now also be seen in asset prices, such as stocks and options. For example, there are some indications of contagion across companies from cyber attacks. Other channels through which cyber risks could easily become systemic are through attacks on systemic intermediaries, parallel attacks on multiple institutions or attacks on companies that provide IT systems or data to many other companies. But it remains important that the data situation is improved.

The dinner conversation concluded with risks for emerging market economies. Richard Portes recalled that two major emerging market debt crises – the Latin American crisis of 1982 and the Mexican crisis of 1994/95 – emerged when US interest rates went up. Both required action from the US and the International Monetary Fund. When rates and the dollar rise there are increasing risks of debt defaults, bank failures and exchange rate crises, which can be strongly interconnected. Looking at the current situation in emerging markets, for example Turkey did not look good in Portes' view, although it is not clear that the country is systemically important at the global level. For example, the Argentinean crisis in the early 2000s hardly "ruffled any feathers" at the global level. Moreover, the data so far showed only mild capital outflows from emerging markets.

8 Central bank digital currencies: rationale, design, monetary policy and cross-border implications

Fabio Panetta opened the panel on "Central bank digital currencies and the digital euro project" by describing how the increasing preference for digital tools in society is also reflected in finance and payments. Central banks have to embrace the evolving preferences of citizens as well. According to the Bank for International Settlements, 105 central banks, representing 95 percent of world GDP are exploring a Central Bank Digital Currency (CBDC). At the same time, however, recent crashes and failures in the private crypto asset world illustrate how technology hypes can also give rise to speculation, bubbles and abuses (see also the previous section on financial stability, crypto assets and cyber risks). This is why central banks need to make sure that alongside the general digitalisation process central bank money, a public monetary anchor and a numéraire for payments remain available for everybody at all times. The following discussion revolved around five main topics.

The first topic addressed how CBDCs should be designed so that they become sufficiently attractive but without crowding-out other market-based alternatives. Cecilia Skingsley described this balance as finding the "goldilock version" of CBDCs. She distinguished between CBDCs' role as money and as tool for payment services because they imply different crowding-out challenges. CBDC as money, notably as store of value, competes with bank deposits. Skingsley pointed out that central banks can use caps on the amount of CBDC that users can hold and interest rates paid on these amounts to ensure that private money does not disappear. Also, a recent report by seven major central banks concluded that they have the tools they need to make CBDC attractive but not too attractive in this regard (BIS 2021).

Ulrich Bindseil added that the quantity limits are the simplest solution to potentially excessive disintermediation of commercial bank deposits emerging from the high liquidity and risk-free nature of CBDC. All CBDC currently considered seem to have them. More complicated is to set their size neither too high nor too low. For example, too restrictive limits could unduly limit the elasticity of supply. Regarding remuneration Bindseil referred to the “anomaly” of cash that has always and everywhere an interest rate of zero, irrespective of where the short-term interest rate stands. A CBDC could in theory relax this constraint, for example with a tiered schedule that would reach a negative rate for very large holdings. But it could also be agreed that a CBDC is remunerated at zero to emphasise that it is “digital cash”.

Calibrating the attractiveness of CBDC as a payment service is a bit more difficult, Skingsley continued. Platform design choices and the rule book determine how easy it will be to convert CBDC in other forms of money. Moreover, governments need to enact clear legislative frameworks, including whether the CBDC is legal tender and in a binding way. If the resulting network effects turn out very strong, then private payment services could be crowded out. Most central banks analysing a CBDC consider models with private intermediaries providing the payment services, which raises the issue how design choices and innovation interact. On one hand, design choices could limit private innovation. On the other hand, private innovation could constrain central banks’ ability to steer attractiveness. But as progress will be gradual, Cecilia Skingsley expressed confidence that the right choices can be made.

Markus Brunnermeier pointed out that a certain level of privacy is needed for people to accept CBDC. For cash transactions nothing is recorded, but behind digital transactions is always a ledger. Hence, governments have to intervene to create a governance structure that ensures the right level of privacy. But this needs to take trade-offs between privacy and illicit criminal activities into account. Moreover, to exploit all the benefits of CBDCs they need to be interoperable with other ledgers, such as supply chains or smart contracts. Interoperability would be easier with a unified meta ledger between the different systems, but privacy would require the meta ledger to be compartmentalised. Last, private information may also have a social value (think about the DNA and cancer research). In sum, there are many complex problems still to be resolved.

The second topic covered which other policy objectives a CBDC could help achieving, in addition to the overarching aim of preserving a public monetary anchor formulated by Fabio Panetta in the introduction. Ulrich Bindseil referred to objectives that follow from the European Union treaties. The digital euro could contribute to competition, innovation and inclusion in the payment markets. While innovation has been impressive over the last decades, competition not necessarily, as payments are a network industry, leading to concentration and exertion of power by the main providers. Therefore, a CBDC that is cost-free for citizens and benefits from significant scale economies could increase efficiency by taking away some market share from dominant players. Moreover, it should be designed to contribute to a competitive ecosystem that fosters innovation through openness and multiple providers, rather than central banks operating them in isolation. For example, Neha Narula added that she expects a variety of different intermediaries to take on a wide range of roles in

conjunction with the core platform operated by or for the central bank. Inclusiveness will become particularly important once the use of banknotes declines significantly in the euro area, Bindseil continued. For that moment in the future central banks should plan and have adequate devices and customer support ready.

The third topic discussed dealt with the central role of technology for the design of CBDCs (see also the section on financial stability, crypto assets and cyber risks). Neha Narula suggested that the ideal order would be that policymakers first determine the objectives of a CBDC, then the design choices following from these objectives would be formulated and last the best technology for the design features chosen. But as there is value in a "policy-technology loop" about what is feasible, experimentation with different technologies should start already in parallel with the first step.

Narula further clarified that a CBDC does not require a blockchain or distributed ledger technology (DLT), which are decentralised. As a central bank would be issuing the CBDC, there is a central governing body and the usual distributed agreement in decentralised DLT is not needed. But CBDCs should have offline capability as a design feature, in her view. It is necessary for robustness in case of natural disasters and for inclusion in low connectivity areas. Much like regular cash, an advanced mobile device, signing up to an account or signing up to terms of use should not be necessary.

The digital nature of the technology raises the issue of cyber risk (see also the section on financial stability, crypto assets and cyber risks). Neha Narula represented the view that the best approach to contain them is to not offer an attractive target. In particular, showing and storing as little data as possible goes a long way in reducing cyber risk, as it makes the CBDC much less attractive for an attack and also implies less damage should nevertheless one occur. Moreover, privacy and cyber security can go hand in hand, enhancing one improves the other. In addition to that, it is important to use well understood and hardened technology, i.e. well-known cryptographic primitives and best practices from system design, rather than the latest innovation from the crypto asset world. Third, technology can also provide tools to reduce risk, e.g. by removing third parties that may fail or by ensuring cryptographic auditability.

The fourth topic discussed the implications of a CBDC for monetary policy. Markus Brunnermeier gave several examples about how it could enhance the uniformity and effectiveness of monetary policy. First, by creating a uniform monetary anchor in the digital space it would prevent certain forms of fragmentation that could affect monetary transmission in the euro area. Such fragmentation had been observed with competing moneys in economic history or recently in the area of crypto assets. (His recent report for the European Parliament – Brunnermeier and Landau 2022 – argued that the digital euro would create a euro area safe asset.) Second, if the CBDC is remunerated, interest rate changes by the central bank would be transmitted more directly and faster to the economy. For example, if the CBDC rate moves with the monetary policy rate, then commercial banks would be less in a position to delay deposit rate increases in a tightening cycle. Third, although probably very unpopular, the possibility of setting a negative rate on CBDC holdings could in principle provide ways to avoid the constraints for monetary policy associated with the effective lower bound of interest rates and the so-called reversal rate (Abadi, Brunnermeier and Koby

2018). But where there are a lot of opportunities, there are also risks of abuse, Brunnermeier argued. For example, such a CBDC would also be more effective in creating financial repression and imposing an inflation tax on households that own a lot of nominal assets. So, one has to think about safeguards against potential abuses in order to preserve trust in CBDCs.

The fifth topic tackled cross-border implications of CBDCs and international payment issues. Markus Brunnermeier took the perspective of monetary sovereignty. If CBDCs would foster a “digital dollarisation” of the world, then it would limit the ability of affected countries to stabilise their economies with monetary policy. If a large number of transactions in a country is paid in a foreign currency, then the central bank’s changes of interest rates in domestic currency would be less effective in stimulating or slowing down the local economy and inflation. Brunnermeier perceived particular concerns in smaller emerging countries, which are therefore at the forefront of developing their own digital currencies to prevent that foreign CBDCs of large countries take over.

While he observed Europe to be more inward-looking and consumer-oriented, Brunnermeier saw two scenarios in which currencies from large countries could expand their international roles. In the United States he saw a trend towards multiple private stable coins whose tokens would, for example, finance supply chains. Instead of the development of a central-bank driven CBDC, he rather expected a public regulatory framework for stable coins to emerge. This rather well integrated system could make the dollar over time even more prominent in the world than the case today. The second scenario would be driven by large Chinese technology companies, if the government does not constrain them too much. They offer payment services like Alipay and WeChat Pay, which have already become dominant in the Chinese economy and could be increasingly used by citizens of foreign constituencies. Both scenarios could redraw the map of currency areas, shifting the boundaries from geographical states to virtual systems.

Cecilia Skingsley, who chaired at the time of the Forum the BIS Committee on Payments and Market Infrastructures (CPMI) Future of Payments Working Group, focused on the many challenges in cross-border payments today and how CBDCs could help. Today, such payments have high funding costs for providers, are expensive and opaque for clients, tend to be slow, subject to complex compliance procedures and are hindered by mismatches in operating hours. The fact that so many countries are now looking at CBDCs creates a historical opportunity to improve and make progress also in other areas towards 24/7 straight-through processing.

While Skingsley sees no “silver bullet”, CBDCs could help through their interoperability and access options (CPMI 2022). It would be most efficient if foreign payment system providers (PSPs) received direct access to CBDCs, but when countries regard this as too risky sponsored models could be considered where a foreign PSP receives indirect access through a domestic PSP. Another issue is whether foreign individuals, such as tourists, could have access to CBDCs and at which amounts. Where the diplomatic relationships between countries prevent the interoperability of their CBDCs, lower-level compatibility and interlinking could be considered. Most likely, a patchwork of different arrangements will emerge. Technical solutions, although key, will take the

international community only part of the way. The real difference is made by the governance arrangements: standards; regulations; supervisory committees etc.

In the floor discussion several remarks were made about the rationale for and objectives of CBDCs. Harald Uhlig thought that the CBDC movement was triggered by the threat of private digital currencies, notably the Libra project later renamed Diem. Then resistance of commercial banks emerged, as they could be disintermediated if a CBDC would be remunerated. All in all, he wondered whether a digital euro could not experience the fate of the Susan Anthony dollar in the US at the turn from the 1980s to the 1990s, which certain groups really wanted but which did not become generally attractive. Xavier Vives also considered whether CBDCs are a rather defensive move against private stable coins or foreign currency substitution. Perhaps all the goals mentioned were too many and it was not clear which market failures they would address. A recent IESE Business School/CEPR report (Duffie, Foucault, Veldkamp and Vives 2022) found that the main problem in the payment sector is competition and CBDCs may not be the best way to address it. Moreover, the report suggested not to rush into a retail CBDC until its economics and the necessary technology are compelling.

Cecilia Skingley and Ulrich Bindseil disagreed that the rationale for CBDCs was not convincing. Following up from Fabio Panetta's introduction, Skingsley explained that they are a reaction to societal changes and can be regarded as an investment in protecting the integrity of the fiat money systems. Central banks had already started discussing them before the Libra proposal. Bindseil added that since their beginnings central banks had evolved with regard to how they offer access to their liabilities and how transfers are settled. Ledger entries were the quasi-unique form of central bank money for almost two centuries before Banknotes appeared in the middle of the 17th century. There is no reason why central banks should stick uniquely with 17th century technology when societies change. Central bank money should be offered in a way that continues to meet the expectations of citizens and so that it continues to be used. The two-layer monetary system of central bank money and private credit served societies well and should be preserved in a digitalised world. But Markus Brunnermeier contributed that in principle there is an alternative to a public monetary anchor at par. In theory, the combination of banking regulation, lender-of-last-resort facilities and deposit insurance could ensure similar results. The issue is whether advanced economies would want to experiment with such a new system.

Vítor Constâncio asked for estimates of the demand for CBDCs. Cecilia Skingsley explained that they are very dependent on assumptions and designs, but some estimates by the Riksbank in Sweden found that the demand could be around 7 to 10 percent of GDP. Xavier Vives pointed out that disintermediation and currency substitution would become more acute in times of financial stress. He wondered how central banks could ensure that in such situations enough CBDC is supplied and parity between it and other money or accounts be preserved without inducing effectively unlimited supply in all states of the world. Bindseil answered that despite potential individual limits an aggregate limit for a CBDC is not possible. The individual limits, however, do not endanger parity as there cannot be a secondary market for CBDC. Brunnermeier made some scenarios for potential bank runs. They can already happen

today and only the way they happen would change with a CBDC. If there is a run on a single bank, the CBDC balance would just go to another bank, but the central bank would have much more and quicker information. So, the central bank can simply transfer the money back, provided the run bank is solvent. If there is a run on the whole banking system, then the money would stay in the CBDC (the “currency area”) rather than flowing abroad and, again, the central bank could transfer money back to solvent institutions.

Harald Uhlig observed that there is a lot of demand for wholesale digital currency by the industry, with smart contracts allowing decentralised finance applications and the like, and a lot of infrastructure for that is already built on top of the Ethereum blockchain. Would it be an alternative to a separate public infrastructure with a centralised ledger to build a CBDC also on top of the Ethereum blockchain? Neha Narula responded that the main obstacle to building a public stable coin on top of the Ethereum blockchain is governance. With this approach, the central bank would depend on the globally distributed set of anonymous validators for how contracts are executed, whether transactions are recorded and which fees are paid, for example. It is not clear why central banks would give up this level of control. At the same time, Narula hopes that central banks would incorporate some modicum of programmability in their CBDCs. Quite a bit of functionality can be put in additional layers rather than fully featured contracting and programming languages being directly embedded, as the case for many crypto assets. Brunnermeier added a political economy argument against such ideas about Ethereum interoperability. Technology companies are earning a lot of seigniorage with issuing private stable coins and the owners become very rich. It is not clear that it is in the public interest that such systems would afterwards be validated as public money.

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Price stability and policy transmission in the euro area

By Christine Lagarde[1]

Inflation in the euro area is undesirably high and it is projected to stay that way for some time to come. This is a great challenge for our monetary policy.

In response to the changing inflation outlook, we have consistently followed the path of policy normalisation since December last year, sequentially adjusting our policy stance.

Net asset purchases under our various programmes will come to an end this week. In July we intend to raise our policy rates for the first time in 11 years. And we have provided some guidance for our September policy meeting and the rate path we envisage taking thereafter.

We will continue along this normalisation path – and we will go as far as necessary to ensure that inflation stabilises at our 2% target over the medium term.

As Victor Hugo is said to have remarked, perseverance is the “secret of all triumphs”.

At the same time, the euro area differs from some other major economies for two key reasons and the path of normalisation has to be managed accordingly.

First, inflation in the euro area today is being driven by a complex mix of factors that reflect, in part, our economic structures and strategic dependencies. This creates uncertainty about how quickly inflation will return to our medium-term target.

In this setting, we need to act in a determined and sustained manner, incorporating our principles of gradualism and optionality. This means moving gradually if there is uncertainty about the outlook, but with the option to act decisively on any deterioration in medium-term inflation, especially if there are signs of a de-anchoring of inflation expectations.

Second, the euro area has a unique institutional set-up, built around 19 not yet fully integrated national financial markets and 19 national fiscal policies, with limited coordination. This presents the risk of our monetary policy stance being unevenly transmitted across the union.

And this is why we have emphasised all along that flexibility is integral to the process of normalising our monetary policy. It is essential to allow us to deliver the necessary policy stance and protect price stability in an environment where inflation is too high.

Today, I would like to outline how a combination of shocks is currently hitting the euro area economy; how our monetary policy stance should react to the challenges these

[1] President of the European Central bank.

shocks create; and how we can preserve the transmission of this stance throughout the euro area.

1 The shocks hitting the euro area economy

Broadly speaking, inflation in the euro area is being driven by two different types of shock.

First, the original source of inflation is an extraordinary series of external shocks.

Global supply chain disruptions coupled with surging global demand have pushed up prices sharply for industrial goods along the pricing chain.[2] Mismatches between supply and demand in global energy markets have led to rising energy prices for the euro area. And the Russia-Ukraine war has amplified both of these factors while also driving up global food prices.

Given its energy dependence, the euro area is experiencing these shocks acutely.[3] The current levels of food and industrial goods inflation have not been seen since the mid-1980s.[4] And the increase in the relative price of energy in recent months is much higher than the individual spikes that occurred in the 1970s.

Together, energy, food and industrial goods account for around 80% of the overall inflation rate seen since the start of this year.

The second factor driving up inflation – and one which has intensified in recent months – is the recovery in internal demand as the economy has reopened after the pandemic.

Spending is rotating from goods back to services as restrictions are being lifted, while pent-up demand for tourism and leisure activities is proving unexpectedly strong. This rebound in spending has seen services inflation rise to 3.5% in May – the highest rate since the mid-1990s – with the highest price increases in contact-intensive sectors.

These shocks, in particular the surge in energy prices, are driving up short-term inflation to very high levels. They are also leading to significant upward revisions to our medium-term inflation forecasts. The June Eurosystem staff projections saw inflation above 2% for the whole projection horizon, converging back to slightly above our medium-term target in 2024.

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2 Kalemli-Özcan, S., di Giovanni, J., Silva, A., Yıldırım, M. (2022), “Global supply chain pressures, international trade and inflation”, paper presented at the ECB Forum on Central Banking, Sintra, 27-29 June 2022.

3 Bjørnland, H. (2022), “The effect of rising energy prices amid geopolitical developments and supply disruptions”, paper presented at the ECB Forum on Central Banking, Sintra, 27-29 June 2022.

4 Based on historical Consumer Price Index data series for euro area countries.

2 The persistence of inflation

But the size and complexity of these shocks are also creating uncertainty about how persistent this inflation is likely to be.

We are not facing a straightforward situation of generalised excess demand or economic overheating, in which case the trajectory of medium-term inflation would have been clearer. Despite the bounceback in services, private consumption in the euro area is still more than 2% below its pre-pandemic level. And investment remains subdued.

Although there have been some signs of above-target revisions in recent months, longer-term inflation expectations currently stand at around 2% across a range of measures. This supports our baseline projection for inflation to converge back towards our medium-term inflation target.

At the same time, inflation pressures are intensifying and broadening through the domestic economy. Almost four-fifths of items in the consumption basket had annual price increases above 2% in April, and this is not only a reflection of high import prices. A new ECB indicator of domestic inflation – which removes items with a high import content – currently stands above 3%.[5]

In this environment, it is important to understand how persistent domestic price pressures are likely to become. There are several factors worth considering here.

First, inflation is starting to take root in the services sector, which is the "stickiest" component of inflation and has a higher weight than goods.[6]

Second, unemployment in the euro area is at a record low[7], labour shortages are broad-based across sectors and indicators of labour demand remain strong. This tightening of the labour market, together with the catch-up effect triggered by the high inflation environment, suggests that wage growth will pick up. Our latest forecasts see wage growth[8] above 4% in 2022 and 2023 and at 3.7% in 2024 – almost double the historical average before the pandemic.

Third, these factors combined have led us to project core inflation at 2.3% in 2024 – and, in the euro area, core inflation tends to be an indicator of headline inflation over the medium term.

We are also seeing signs that the supply shocks hitting the economy could linger for longer. While it is reasonable to assume that global supply chain disruptions will gradually be resolved, the outlook for energy and commodities remains clouded.

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5 Fröhling, A., O'Brien, D. and Schaefer, S. (2022), "A new indicator of domestic inflation for the euro area", Economic Bulletin, Issue 4, ECB.

6 For the increasing importance of services in the Harmonised Index of Consumer Prices, see Baldwin, R. (2022), "Globotics and macroeconomics: Globalisation and automation of the service sector", paper presented at the ECB Forum on Central Banking, Sintra, 27-29 June 2022.

7 However, 1.1% of workers are still enrolled in job retention schemes.

8 Compensation per employee.

There is not yet an end in sight to the Russia-Ukraine war, and we still face the risk of cuts to supply that could keep energy prices high. That could contribute to inflation directly – if it leads to further rises in energy costs – or indirectly, if a higher level of energy prices makes some production uneconomic and leads to a durable loss of economic capacity.

The war is also likely to accelerate Europe's green transition as a way to enhance our energy security. In the long term, this should lead to lower energy costs in Europe. But in the meantime, it could lead to price increases for rare minerals and metals,[9] higher costs for the investment needed in clean technologies, and an expansion of carbon-pricing schemes.[10]

3 Uncertainty about growth

That said, these shocks also have implications for growth and, as such, they can weigh on the medium-term inflation outlook. So what are we seeing in this regard?

The external supply shocks hitting the euro area are affecting spending. Rising import prices represent a terms of trade "tax" which reduces the total income of the economy.

Households are seeing their real income being squeezed. Real wage growth has been negative for two consecutive quarters. And consumer surveys suggest that households are expecting their real income and consumption to decline further over the next year.

Firms are trying to protect their margins by raising prices, but this uncertain environment is also leading them to delay investment decisions. And sales growth now appears to be decelerating. The latest Purchasing Managers' Indices point to no further growth in new business, and business expectations in a year's time have reached their lowest level since October 2020.

At the same time, spending is being supported by the boost to demand from the full reopening of the services sector. And consumption is being buffered by the large stock of household savings built up during the pandemic, fiscal support measures and the continued strength of the labour market, which is helping to sustain labour income overall.

But if supply shocks drag on and inflation continues to exceed wage growth by a wide margin, losses in real income could intensify and the excess savings buffer could be eroded. The resulting hit to demand could test the resilience of the labour market and possibly temper the expected rise in labour income.

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9 International Energy Agency (2022), "The Role of Critical Minerals in Clean Energy Transitions", revised version, March.

10 Kuik, F., Morris, R. and Sun, Y. (2022), "The impact of climate change on activity and prices – insights from a survey of leading firms", Economic Bulletin, Issue 4, ECB; Bua, G., Kapp, D., Kuik, F. and Lis, E. (2021), "EU emissions allowance prices in the context of the ECB's climate change action plan", Economic Bulletin, Issue 6, ECB.

In this setting, we have markedly revised down our forecasts for growth in the next two years. But we are still expecting positive growth rates due to the domestic buffers against the loss of growth momentum.

4 The path ahead for rate normalisation

Based on the overall outlook, the process of normalising our monetary policy will continue in a determined and sustained manner. But given the uncertainty we still face, the pace of interest rate normalisation cannot be defined ex ante.

As I laid out in a recent blog post[11], the appropriate monetary policy stance has to incorporate our principles of gradualism and optionality.

Gradualism allows policymakers to assess the impact of their moves on the inflation outlook as they go, which can be a prudent strategy in times of uncertainty. Optionality ensures that policy can react nimbly to the incoming data on the economy and inflation expectations and, if uncertainty decreases, re-optimise the policy path as necessary. Indeed, there are clearly conditions in which gradualism would not be appropriate. If, for example, we were to see higher inflation threatening to de-anchor inflation expectations, or signs of a more permanent loss of economic potential that limits resource availability, we would need to withdraw accommodation more promptly to stamp out the risk of a self-fulfilling spiral.

These two elements of the monetary policy stance underlie the Governing Council's decisions at our meeting on 9 June.

Consistent with moving gradually, we announced that we will end net asset purchases under our asset purchase programme on 1 July and intend to raise our three key interest rates by 25 basis points at our next meeting on 21 July.

But we also announced that we expect to raise the key interest rates again in September, and "if the medium-term inflation outlook persists or deteriorates, a larger increment will be appropriate at the September meeting."

This reflects the optionality principle. If the inflation outlook does not improve, we will have sufficient information to move faster. This commitment is, however, data dependent.

This conditional approach to the pace of interest rate adjustment should not be confused with delaying normalisation. As our policy stance rests on a clear reaction function, interest-rate expectations and risk-free rates can adjust in advance.

Our policy adjustment is already working its way through the euro area economy. The €STR forward rate ten years out is around 240 basis points above its pre-pandemic level, without policy rates having yet moved. One-year forward real rates, one-year ahead and five-year forward real rates, five-years ahead are around 100 and 140 basis points higher, respectively.

[11] Lagarde, C. (2022), "Monetary policy normalisation in the euro area", The ECB Blog, 23 May.

Beyond September, the Governing Council has agreed that a “gradual but sustained” path of further rate increases will be appropriate. The starting point at each meeting will be an assessment of the evolution of the shocks, their implications for the outlook and the degree of confidence we have in inflation converging to our medium-term target.

5 Transmitting the policy stance

For these changes in our monetary policy stance to be effective, we need to preserve the orderly transmission of our stance throughout the euro area.

The ECB is conducting monetary policy in an incomplete monetary union, in which its policy has to be transmitted through 19 different financial and sovereign bond markets. The yields on those sovereign bonds provide the benchmark for pricing all other private sector assets in the 19 Member States – and ultimately also for ensuring that our monetary policy impulse reaches individual firms and households.

If spreads in some countries respond in a rapid and disorderly way to an underlying change in risk-free rates, over and above what would be justified by economic fundamentals, our capacity to deliver a single monetary policy is impeded. In this situation, a change in the policy stance can be followed by an asymmetric response of financing conditions, regardless of the credit risk of individual borrowers.

In such conditions – when we have what we describe as unwarranted fragmentation – preserving policy transmission is a precondition for returning inflation to our target.

The normalisation of our monetary policy will naturally lead to rising risk-free rates and sovereign yields. And, as euro area sovereigns are starting from different fiscal positions, it can also lead to a rise in spreads.

But in order to preserve the orderly transmission of our policy stance throughout the euro area, we need to ensure that this repricing is not exacerbated and distorted by destabilising market dynamics, leading to a fragmentation of our original policy impulse. That risk of fragmentation is also affected by the pandemic, which has left lasting vulnerabilities in the euro area economy. These vulnerabilities are now contributing to the uneven transmission of the normalisation of our policy across jurisdictions.

The Governing Council is therefore acting in two ways.

First, we will use flexibility in reinvesting redemptions coming due under the pandemic emergency purchase programme (PEPP) to preserve the functioning of the monetary policy transmission mechanism. In other words, those redemptions can, as appropriate, be invested within the Eurosystem in bond markets of jurisdictions where orderly transmission is at risk. We have decided to apply this flexibility in reinvesting redemptions coming due in the PEPP portfolio as of 1 July.

Second, we have decided to mandate the relevant Eurosystem committees, together with the ECB services, to accelerate the completion of the design of a new instrument

for consideration by the Governing Council. The new instrument will have to be effective, while being proportionate and containing sufficient safeguards to preserve the impetus of Member States towards a sound fiscal policy.

This decision lies squarely within the ECB's tradition. In the past, the ECB has made use of separate instruments to target inflation and to preserve the functioning of the monetary policy transmission mechanism. Measures to preserve transmission could be used at any level of interest rates – so long as they were designed not to interfere with the monetary policy stance.

At times when inflation fell too low, it made sense to shift from "separation" to "combination" so that all tools reinforced the required policy easing. That is why, for example, we linked asset purchases tightly to forward guidance on rates. But with high inflation now being the main challenge, there are merits in separating policy tools again.

Preserving policy transmission throughout the euro area will allow rates to rise as far as necessary. In this sense, there is no trade-off between launching this new tool and adopting the necessary policy stance to stabilise inflation at our target. In fact, one enables the other.

6 Conclusion

Let me conclude.

The euro area is facing a complex mix of shocks which are reducing growth and pushing up inflation. In this environment, it is imperative for policymakers, within their respective mandates, to address the risks to the economic outlook.

Fiscal policymakers have to play their part in reducing these risks by providing targeted and temporary support while, over the medium term, following a rules-based framework that underpins both debt sustainability and macroeconomic stabilisation.

We are unwavering in our commitment to ensure that inflation returns to 2% over the medium term. We have designed a strategy to normalise our policy that allows us to respond nimbly to the high inflation environment.

And we will ensure that the orderly transmission of our policy stance throughout the euro area is preserved. As Leonardo da Vinci said, "every obstacle yields to stern resolve". We will address every obstacle that may pose a threat to our price stability mandate.

Globotics and macroeconomics: Globalisation and automation of the service sector

By Richard Baldwin[1]

Abstract

Globalisation affects the functioning of the euro area macroeconomy. The macroeconomy's functioning, in turn, conditions the conduct and impact of monetary policy. This is why globalisation matters for central banks. It is also why central bankers should pay attention to the evolution of globalisation. And evolve it has. This paper argues that the future of trade is in services – especially trade in intermediate services. Barriers are radically higher and falling radically faster for services versus goods, and, unlike farm and factory goods, there is no capacity constraint when it comes to the export of intermediate services from emerging markets. Undertaking the analysis for services trade that was done in the 2000s for goods trade, however, will require a substantial upgrading of the data available.

1 Introduction

This paper argues that our economies are at the start of a third great transformation that will have macro implications for euro area economies and ECB policymaking. Having gotten your attention, I hasten to add that there is nothing revolutionary here. The argument splices together trends that have been in evidence for years into a string of logic that leads to novel implications. Even those may not be so new.

In a nutshell, digital technology (digitech) is rapidly exposing services that were previously non-tradeable to the opportunities and challenges of globalisation. One name for this new form of globalisation is "telemigration", which refers to workers who sit in one nation but regularly work in offices and remote teams in another nation. Simultaneously, digitech is introducing automation to services that were previously non-automatable. "White-collar robots" is one name for the automating algorithms – things like Robotic Process Automation (RPA), virtual assistants, chatbots, and sophisticated AI packages like IBM's Watson. These robots are automating service-sector tasks at digitech's eruptive pace – driven by machine-learning on one hand, and, on the other hand, by the falling cost of gathering, transmitting, storing, and processing the massive datasets needed to train the algorithms.

[1] Graduate Institute, Geneva.

To stress that both the globalisation and robotisation of service jobs are happening at the same time – and are driven by the same technologies – I created the ugly, but hopefully memorable word 'globotics' in my 2019 book on the subject. In my view, globotics will improve lives in the long run but the transition could be rough. That is why the word 'upheaval' follows globotics in my book's title.

Firms that are embracing white-collar robots and telemigrants today, and those who will do so in the future, are seeking to save money by replacing high-wage office and professional workers with cheaper alternatives. The mismatch in speeds of digitech (displacing jobs) and human ingenuity (creating jobs) may produce ructions in euro area labour markets in the medium term. As was true for the manufacturing sector over the past quarter century, automation and globalisation in services will create new opportunities for European firms and citizens who are globally competitive but more competition for those who are not. The effect is likely to be akin to the China Shock's impact on goods-producing sectors, but potentially much larger since services account for a much larger share of euro area employment and GDP.

What does any of this have to do with running a central bank?

1.1 Globotics and central banking

Policy choices depend critically upon how the macroeconomy works – especially the economic mechanisms that determine prices, wages, employment, and growth. Globotics will create and displace jobs, will raise productivity and quality, will lower costs, and is likely to quicken growth-enhancing innovation. Globotics will buffer the links between local labour market conditions and wage formation by creating better substitutes for local labour. These changes may affect the equilibrium rate of unemployment. Or they may create a new form of unemployment as steady jobs are replaced by precarious work arrangements rather than overt joblessness. It could further flatten and globalise the Philip's Curve. It could depress inflation by slowing wage growth and boosting import competition in the service sector. In this exploratory paper, I concentrate on the impact of globotics on the HICP.

Plainly, there is little novelty in these assertions. Former ECB President Jean-Claude Trichet pointed out much of this in his 2008 speech in Barcelona (Trichet 2008), and ECB researchers have elaborated many of the themes in the 2021 ECB Strategy Review.[2] The conversation we need is about speeds and magnitudes, and the fact that the future automation and globalisation of services sector will not be identical to automation and globalisation of goods sectors in the past.

I believe a whole new research work programme is needed to think ahead on how this looming service-sector transformation will impact the functioning of euro area macroeconomies. Indeed, one way to read my paper is as a sales pitch for such a work programme. To kick off the sales pitch, I frame my conjectures about globalisation's future as a response to the classic question that journalists frequently pose to international economists across the planet.

[2] See ECB (2020) and ECB (201a, b, c).

2 Has globalisation peaked?

The answer to this question is twofold: for trade in goods and the phase of globalisation that has driven it since 1990, the answer is probably yes; for trade in services the answer is surely no.

2.1 False peaks in trade in goods

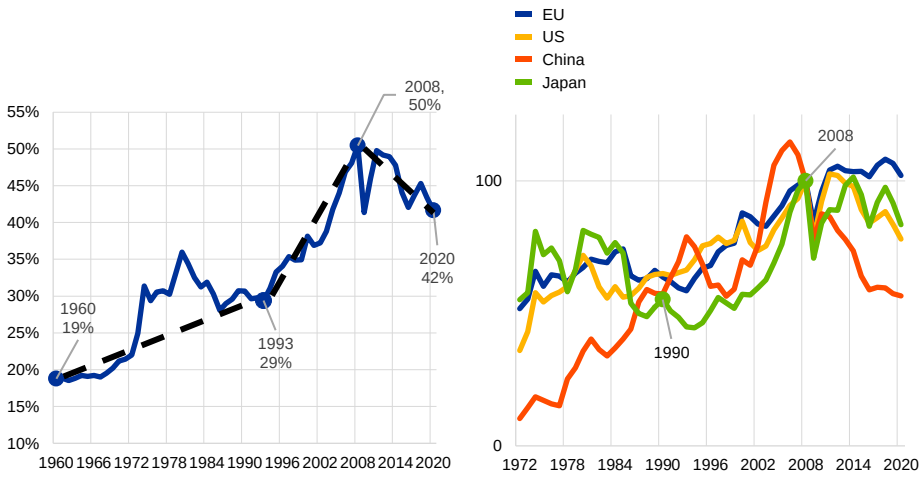
Chart 1 shows the standard case for 'peak globalisation.' The left panel shows the ratio of world trade in goods to world GDP from 1960 to 2020. The 'lazy narrative' asserts that trade in goods was globalising gradually until the ICT revolution launched an acceleration around 1990 that was fatally wounded by the 2008 Global Financial Crisis and attendant Great Trade Collapse.

Chart 1

Peak globalisation in goods– the 'lazy narrative'

Lazy narrative: The ICT revolution launched globalisation's offshoring-expansion phase in 1993; the Global Financial Crisis fatally wounded globalisation in 2008

(% of GDP in left panel, right panel shows % of GDP indexed to 2008 = 100)



Sources: Author's calculations based on WTO trade data, downloaded from stats.wto.org, and World Development indicators GDP data, downloaded from wdi.worldbank.org.
Notes: Trade in goods (imports plus exports), and GDP figures measured in current price US dollars.

I call this the lazy narrative since the 2008 world peak is false. As the right panel shows, the world's largest exporter, China, peaked well before (in 2006), and the world's second and fourth largest, the US and Japan, peaked after 2008 (in 2011 and 2014 respectively). Taken together, the EU has not really peaked so much as stagnated. In other words, the peak in the left panel is false – a happenstance of adding together disparate trends. This is definitely not a situation where one explanation fits all (hence the 'lazy' moniker).

The falsity of the single peak does not change the fact that the globalisation of markets for goods is no longer rising as it had been rising between the 1990s and the mid-2000s. 'Slobalisation' is the term used by some to describe this. Particularly

striking is the shift in China's trade to GDP figures (right panel of Chart 1). For deeper analysis and empirical investigation, see Antras (2021) and Lund (2021).

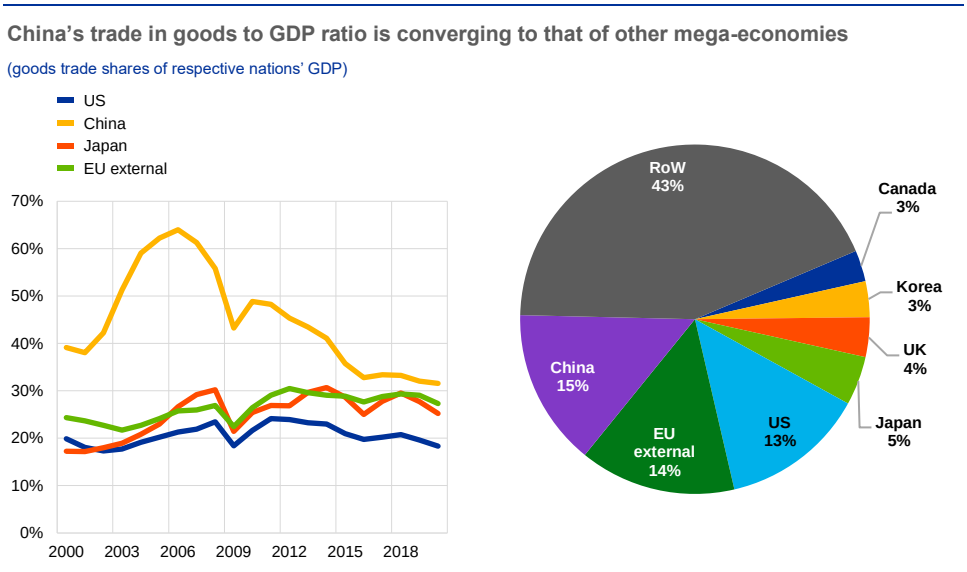
The complexity behind the global peak matters since attempts to associate the changes in globalisation with the trauma of Global Financial Crisis of 2008 and Great Trade Collapse of 2008-2009 are misguided. While the intensity of global trade in goods is undoubtedly declining, there is no overarching explanation. It is not true that nations worldwide are retreating from globalisation since 2008. What Chart 1 tells us is that we need explanations that vary from nation to nation. As the world's largest trader (Chart 2 right panel), China deserves special attention.

2.1.1 What's going on with China?

China's rapid industrialisation, which started with globalisation's offshoring-expansion phase in the early 1990s, was unusually fast by historical standards. Before the 1990s, many nations – including all the G7 nations apart from the UK – industrialised the old-fashioned way. They built up their industrial base behind high tariff walls. China, and a handful of other emerging economies, industrialised in a radically different way. They did it by lowering tariffs, welcoming offshored stages of production, and importing many of the intermediate inputs that they could not yet produce. The industrialisation was so rapid due, in part, to the massive inflows of manufacturing knowhow that offshoring G7 firms sent to China along with the stages of production.

Chart 2

China's openness ratio, 2000-2020



Sources: Author's calculations based on WTO trade data, downloaded from stats.wto.org, and World Development indicators GDP All data, downloaded from wdi.worldbank.org. All data behind the shares and ratios are in millions of current USD.
Notes: Trade in goods include imports and exports. Trade and GDP figures measured in current price US dollars; 'EU external includes only goods trade with non-EU nations.

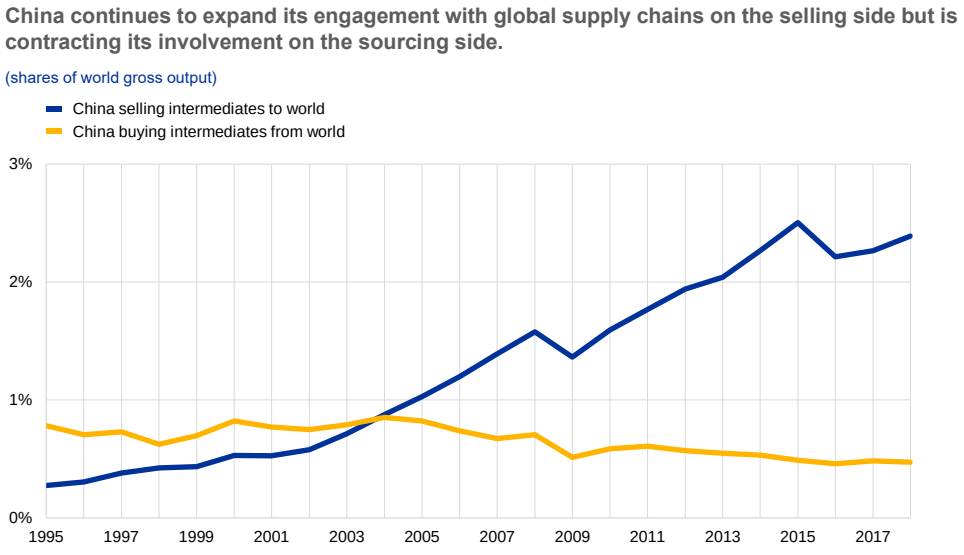
The offshoring produced a great deal of new Chinese trade in intermediates and thus a rapid rise in its trade-to-GDP ratio, as Chart 2 (left panel) illustrates. By the 2000s, however, the easy fruits of offshoring had been harvested, so the pace of new

offshoring slowed, and, more importantly, the Chinese industrial base achieved 'escape velocity.' Further growth was accompanied by what might look like de-globalisation because China was substituting locally made inputs for imported ones.

Chart 3 shows how the drop in Chinese trade in goods is due to an asymmetric decline in its purchases of imported inputs but a continued expansion of its sales of intermediates to nations around the world.

Chart 3

China's asymmetric engagement with global supply chains, 1995 - 2018.



Sources: Calculations undertaken by Rebecca Freeman and Angelos Theodorakopoulos using concepts developed in Baldwin, Freeman and Theodorakopoulos (2022), based on OECD's TiVA database.
Note: The gross trade concept is used in both measures so as to match the gross world output which forms the denominator of both measures.

2.2 No peak in trade in services

While trade in goods has peaked, trade in services has continued to boom. Chart 4, which shows the value of trade (not trade to GDP ratios as in Charts 1 and 2) illustrates the point, but understanding the figures requires a bit of background.

First, data on trade in services is not really fit for the purpose of tracking its impact on the global economy. The data are of a much lower level of quality and detail than is available for trade in goods. Second, trade is services is an amalgamation of several things that are driven by very different economic mechanism. At the most aggregate level, trade in services is broken down into three bins. The first two – travel (which includes tourism) and transportation – are well measured and easily interpreted. The third category, which accounts for about 60% of world trade in services is a grab-bag of services called 'Other Commercial Services' (the 'commercial' is added to indicate the service providers are private as opposed to public entities). Other Commercial Services (OCS) include a very wide range of commercial activities. It includes, for instance, the famous Indian IT outsourcing providers and call centres in the

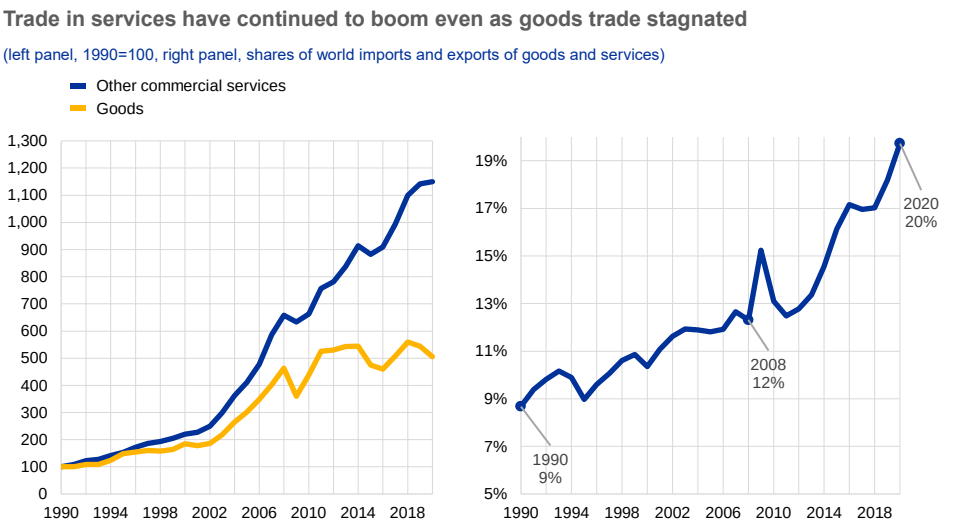
Philippines as well as payments made to Apple's App Store. See Box 1 for more detail on the composition of OCS.

Here I focus on OCS since international transportation services are closely associated with trade in goods. The 'travel' category is closely associated with people crossing borders. While transport and travel services are important in their own right, they are not the future of globalisation since they are not profoundly affected by the explosive advance of digital technology. By contrast, OCS mostly takes place electronically and so is profoundly affected by digital technology.

Chart 4 (top left panel) displays data on worldwide OCS flows and goods flows. To emphasize the long-term growth divergence, the services are indexed to 100 in 1990. The main takeaway is that OCS has grown faster than trade in goods for decades (left panel). Since recovery from the Great Trade Collapse of 2008-2009, the paths of the two types of trade became more pronounced. The level of the series in 2020 reveals the cumulative growth over the last three decades. Between 1990 and 2020, goods expanded about five times while OCS multiplied by eleven times.

Chart 4

Trends in world trade in goods versus world trade in services since 1990



Sources: Data downloaded from stats.wto.org.
Notes: These flows are not normalised by world GDP. The charts stop in 2020 since the pandemic had severe and historically unprecedented effects on services trade (see Box 1).

The right panel shows how the different growth rates have greatly boosted the relative importance of services in overall international commerce. In 1990, OCS accounted for only 9% of all trade in goods and services, but by 2020, that figure had tripled. The ratio's rise shows no sign of abating. The same pattern holds for the euro area economy (not shown in the chart).

Work in the most recent World Development Report leads to the same conclusion using a purpose-built categorisation of services trade (World Bank 2021). The publication points out that what they call 'data-driven services' have increased from about one-quarter to almost half of total service exports.

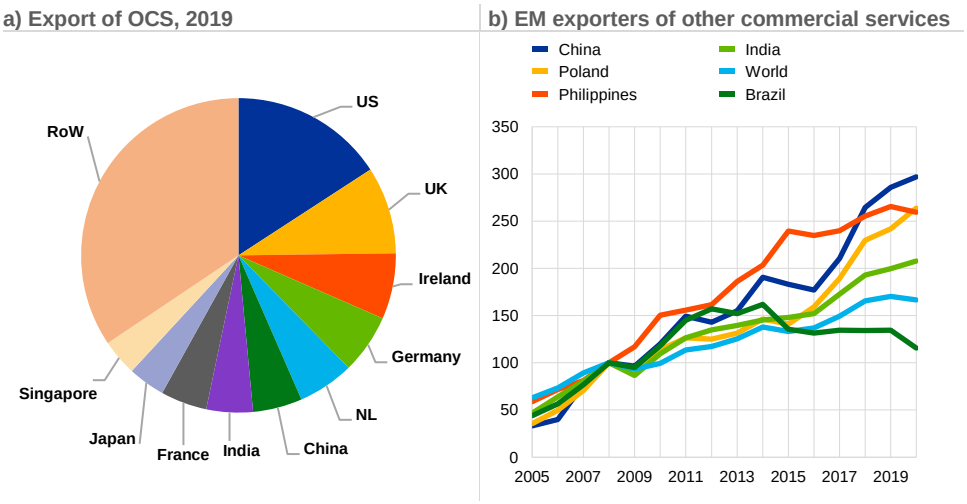
2.2.1 Who are the big players in the services trade?

The global shares of the largest OCS exporters are shown in Chart 5 (left panel). The top ten exporting nations account for about two-thirds of all service exports. The US, UK, Ireland, Germany, and the Netherlands alone account for about 40% of world exports. Adding in India and China brings the total to over half. The right panel shows that most of the large emerging economies are seeing faster than average growth in their service exports. Brazil is an exception. This matters since the wages for their office and professional workers are far lower than they are in the euro area (Baldwin and Dingel, 2022). As digitech makes remote workers less remote and easier to weave into workflows in high-wage nations, emerging markets are likely to offer a large reservoir of attractively priced service sector workers (more on this below).

Chart 5

Top ten exporters of services and emerging market exporter trends

(left panel, shares; right panel, 2008=100,



Sources: Stats.wto.org.
Notes: The series presented are a splice of the old BOP5 series and the recent BOP6 series for Other commercial services.

While advanced economies still account for the bulk of service exports worldwide, the role of emerging economies is fast gaining pace. The biggest emerging market exporters of services are China, India (with 5% of the world total each), Korea, Poland, the Philippines, and Brazil. The world export of OCS has risen by 1.7 times since 2005, but the OCS exports from China and India, for instance, have almost tripled.

The growing importance of emerging economies in global services trade has been widely remarked in the world of development economics. The International Labour Organisation's flagship report in 2021, for instance, noted that: "The role of digital labour platforms is transforming the world of work." It goes on to point out that: "a trend has developed towards outsourcing work, both low-skilled and high-skilled, especially as traditional businesses look to digital labour platforms and digital tools to meet their needs for human resources. These platforms host workers from around the world, enabling businesses to complete their tasks at a faster pace and lower price than if the tasks were performed on site. In many instances, the work is outsourced on these

platforms by businesses in the global North and performed by workers in the global South."

Box 1
Primer on (the sad state of) trade in services statistics

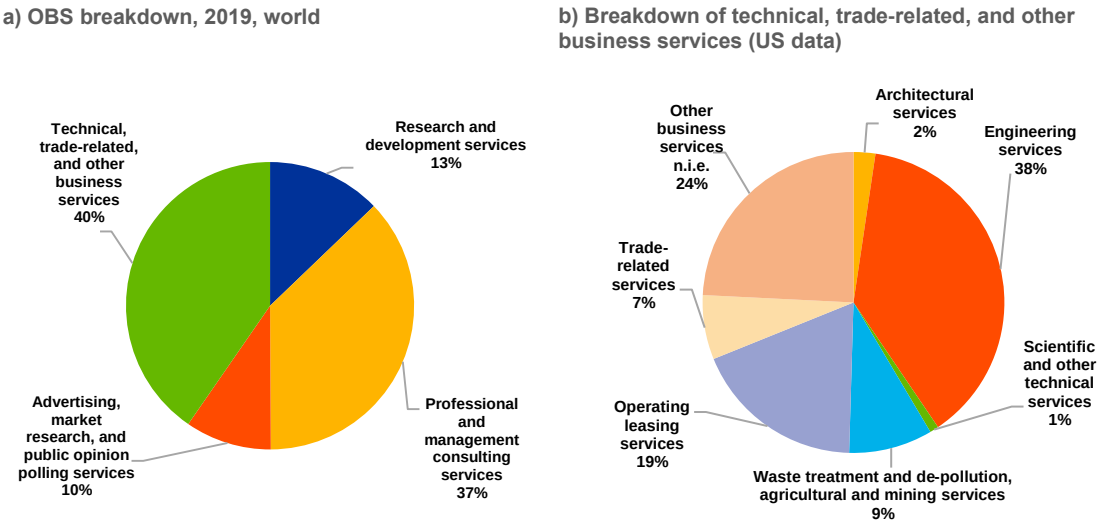
The services trade data are gathered either from balance of payment statistics, or large enterprise surveys. Both sources provide statistical agencies with the value of imports and exports of services but little more. The categories for reporting the services trade were last updated in 2010 which, as Chart 4 showed, was just when the role of OCS started to take off sharply. This box focuses on 2019 which was the last year before Covid-19 massively distorted services trade (see below). As mentioned in the text, the three highest level aggregates are transportation (about 17% of total services trade) and travel (24% of total services trade). The rest is OCS.

The OCS category consists of a few big items and many small items. Some are easily recognisable. Among the bigger categories are Financial Services (9%), and payments for intellectual property rights. The category Telecommunications, Computer, and Information Services accounts for 11% of the total; much of this is made up of computer services related to software, but a large share is tossed into the category 'Other computer services other than cloud computing' (this is typical of the lack of precision in services trade statistics).

Chart A
Breakdown of components of other business services (OBS), 2019, World

OBS, which is 23% of OCS, includes many of the classic service offshoring activities

(shares of world trade by category, left panel; shares of US services imports, right panel)



Sources: Data downloaded from stats.wto.org.
Note: services measured in current US dollars.

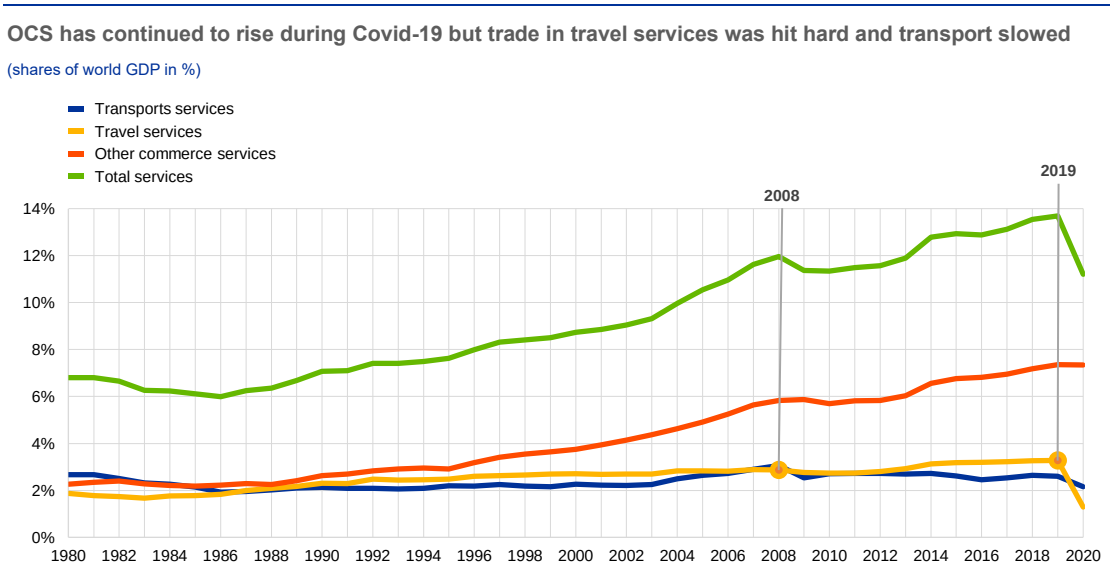
The largest sub-category of OCS is 'Other Business Services' (23%). Peeling off another layer of the onion, Chart A shows the components of OBS. The largest categories are: Professional and management consulting services (37% of OBS), and Technical, trade-related, and other business

services not elsewhere included. Disaggregate figures for the 'Technical, trade-related, and other business services not elsewhere' included (TTOBS) category are not available for the whole world, but some nations – like the US – provide more detail. The right pie chart in the figure shows these. It indicates that the big items are: Engineering services (38% of TTOBS), Leasing services (19% of TTOBS), Other business services, not included elsewhere (24% of TTOBS).

As Chart B shows, the pandemic had a peculiar impact on services trade stemming from the 'great lockdown.' In 2020 and 2021, travel and transport services plummeted, but other types of services trade continued to expand at their usual pace. The reason is that travel is mostly made up of international tourism and business travel – much of which was directly shutdown by Covid-linked restrictions and indirectly by consumer hesitancy. The impact on travel was so severe that it sharply pulled down the total service figure.

Chart B

Impact of pandemic and lockdowns on components of world services trade



Sources: Author's calculations based on WTO trade data, downloaded from stats.wto.org, and World Development indicators GDP data, downloaded from wdi.worldbank.org.
Note: services and GDP are measured in current US dollars.

3 Why did globalisation change?

The charts in Section 2 showed that the boom in goods trade that started around 1990 slowed around the mid-2000s, but the boom in services trade powered ahead throughout the whole period. Moreover, the change in 2008 was just the latest transformation in globalisation over the past couple of centuries. How can we make sense of these changes and differences?

This section provides a simple bit of intellectual infrastructure to organise thinking about how and why globalisation changed in the past, and, more importantly, to lay the foundations for thinking about future globalisation. The intellectual infrastructure is based on the 'globalisation as arbitrage' approach that derives from my early thinking on globalisation (Baldwin 2006) and refinement in my 2016 book, The Great Convergence: Information Technology and the New Globalisation (Baldwin 2016).

3.1 Arbitrage and globalisation's great unbundlings

Arbitrage drives globalisation. Putting capital flows aside, globalisation can be defined as all the things that happen when goods, services, investment, expertise, and knowhow cross international borders.

Arbitrage is what drives these cross-border flows. When things are relatively scarce (and thus relatively dear) in one place and relatively abundant (and thus relatively cheap) in another, firms arbitrage the differences by making them in the later and selling them in the former.

As David Ricardo taught us at the dawn of modern globalisation, there is always a counter arbitrage to be done since the dissimilarities concern relative differences. Because the differences are relative, the things that are relatively scarce in one nation are, by the definition of relative, relatively abundant in the other. This is the heart and soul of international commerce. This is exactly what Ricardo's comparative advantage is all about.

Such arbitrage is constrained by three main types of separation costs: trade costs (which constrains arbitrage in goods), communication costs (which constrains arbitrage in knowhow), and face-to-face costs (which constrains arbitrage in labour services). When the separation costs are high, arbitrage is difficult, so things remain 'bundled' together within economies. For example, before the 19th century transportation revolution, most production and consumption were bundled together inside nations, so trade was rare (Federico and Tena, 2016). Autarky is the jargon word for the extreme version of the bundling of production and consumption.

The history of globalisation is best regarded, in my view, as the sequential relaxing of the three arbitrage constraints. During the first great transformation (farms to factories), steam power lowered separation costs for goods trade and thus allowed the international unbundling of production and consumption. During the second great transformation (factories to offices), ICT allows the unbundling and offshoring of stages of manufacturing that were previously all bundled in factories in high-wage nations.

To test the approach's utility, we use it to structure a quick trot through two centuries of globalisation.

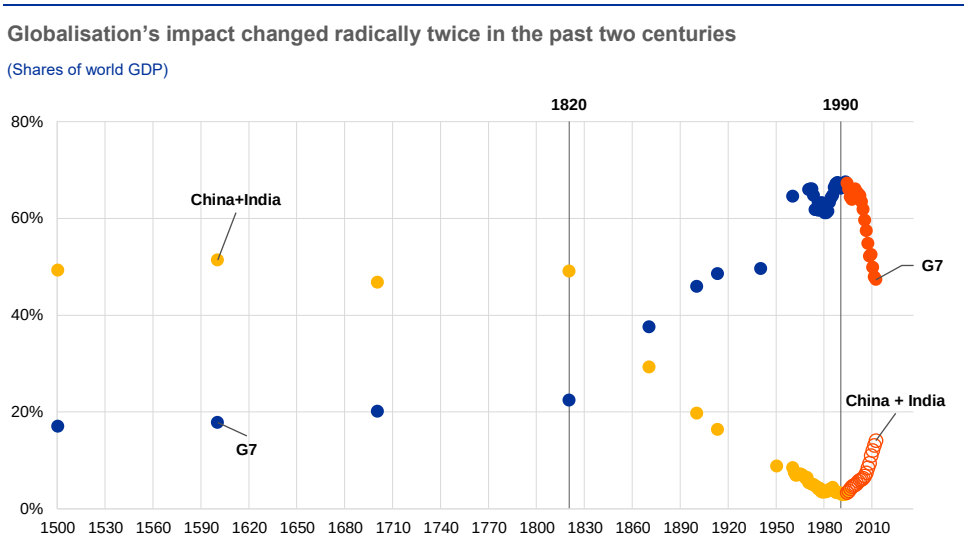
3.1.1 Globalisation's two historical unbundlings

Globalisation's 'first unbundling' happened when steam power and Pax Britanica radically lowered the cost of moving goods but lowered the other separation costs much less. Goods trade boomed (Findlay and O'Rourke 2007). The trade boom reshaped the world. It set off self-enforcing cycles of agglomeration and innovation that spurred growth in the small club of economies that used to be called the industrialised countries. The rest of the world grew more slowly for 170 years. The result was the 'Great Divergence' (Chart 6) that saw the G7's share of global GDP rise from a fifth to two-thirds while China's and India's share plunged.

Globalisation again changed dramatically around 1990 when it entered its offshoring-expansion phase, or what I have called the 'second unbundling' (Baldwin 2006). This unbundling was triggered by the ICT revolution which relaxed the second separation cost – communication and coordination costs. ICT made it feasible for G7 firms to unbundle highly complex industrial processes into production stages, and then offshore them to low-wage nations. This can also be called globalisation's offshore expansion phase. The impacts on global GDP shares from 1990 were spectacular (Chart 6). The G7's share tumbled. The China plus India share soared. This is the Great Convergence. In a sense, this offshoring-expansion phase is what put the 'emerging' into the 'emerging economy' label.

Chart 6

World GDP shares, G7 and China+India, 1500-2012



Sources: Author's calculations based on data downloaded from Maddison and WDI.
Notes: GDP measured in current price dollars.

But how could a few offshored factories reverse the course of globalisation? The answer is that the offshoring G7 firms sent their manufacturing knowhow along with the production stages because the offshored process had to continue to operate as if it were still bundled. GM factories in Mexico, for example, are using GM technology, not Mexican technology. In this phase of globalisation, we have factories crossing borders, not just goods. As a result, China, India, Thailand, and a handful of other emerging economies started to produce and export manufactured goods that they could never have produced with their own technology. The second unbundling was really about arbitraging differences in the knowhow per worker. The ratio was high in G7 nations and low in emerging economies.

In a nutshell, the Great Divergence flipped over into the Great Convergence because globalisation now involved massive movements of manufacturing knowhow from a handful of high-wage to a handful of low-wage nations. The booming trade to GDP ratio was one symptom of the switch over. That is, as factories now straddled international borders, parts and components passed through custom posts multiple times, for instance first as intermediate goods on their own and then again once they

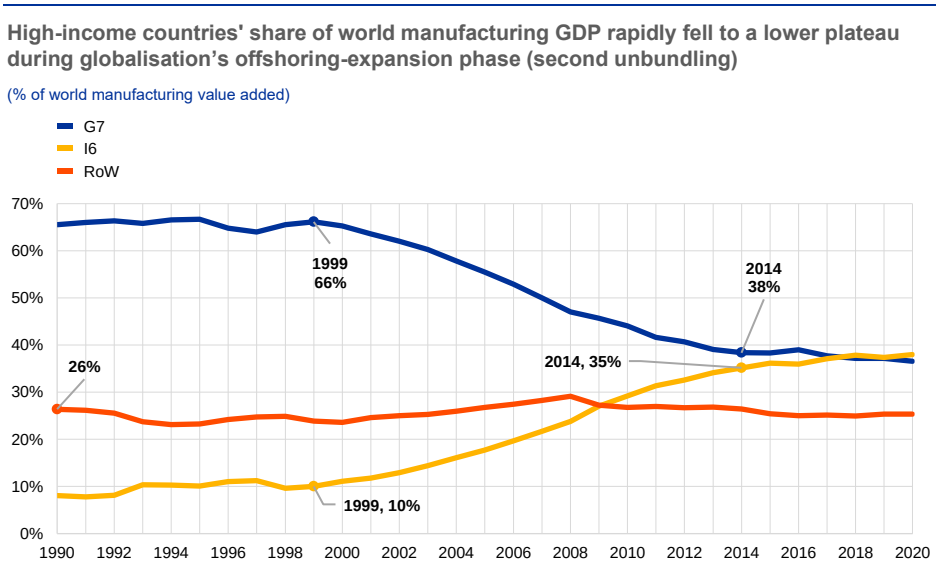
were embedded in exported final goods. The world trade-to-GDP ratio naturally took a step up while offshoring was in its expansion phase (as Chart 1 showed).

The second-unbundling arbitrage created a new way to make industrial goods. Before, G7 firms' competitiveness was founded on high-wages and high-tech. Developing nations' competitiveness was based on low-wage and low-tech. The second unbundling allowed a new combination – high-tech and low-wages (more on this in the next sub-section). The expansion phase eventually slowed once the lowest-hanging profits from offshoring were harvested.

Is there any evidence behind this narrative? From 1990 or so, the new possibility of making things with high-tech and low-wages fostered a rapid shift of manufacturing away from high-wage nations and towards a handful of low-wage developing nations. Chart 7 exhibits the impact on world manufacturing shares. The share of high-wage nations (proxied by the G7) started out at a high and stable level of about two-thirds. As the offshore-expansion phase dialled up, the G7 share declined rapidly up to the mid-2010s – dropping from 66% to 38%. Since then, the share seems to have plateaued, or at least the drop has slowed substantially. This is one indication that the offshoring-expansion phase has ended.

Chart 7

Shifting shares: World manufacturing value added shares, 1990-2020



Source: Author's calculations based on UNIDO data, Manufacturing Value Added, current USD.
https://stat.unido.org/database/National%20Accounts%20Database.
Notes: I6 is China, India, Korea, Indonesia, Thailand, and Brazil; the G7 is France, Italy, Germany, UK, Japan, US, and Canada.

Where did the G7's loss of world share reappear? The chart also displays the share for six rapidly industrialising emerging economies. The six were selected since they are the only economies whose global manufacturing shares rose at least one half of one percentage point between 1990 and 2020. They are, with the percentage-points gain in parentheses, China (+16.2), India (+1.5), Korea (+1.5), Indonesia (1.0), Thailand (0.5), and Brazil (0.5). The share of the Industrialising six (I6) is plotted in the chart along with the share of the rest of the world (RoW).

The behaviour of the G7 and I6 shares are almost mirror images of each other. This is consistent with the idea that the second unbundling triggered a process that shifted manufacturing knowhow, and thus comparative advantage, from the G7 to the I6. The G7's loss of 38 percentage points between 1990 and 2014 is almost fully matched by the I6's gain of 35 percent points. The balance was spread across the hundreds of nations in the RoW aggregate.

The offshoring and attendant technology flows had growth effects and trade effects. The growth gradient reversed. After 1990, many poor nations grew faster than the rich ones. This produced a rapid reversal of global GDP shares from about 1990 (Chart 6). The slowing of offshoring-expansion phase, and thus Global Value Chain (GVC) trade, is part of the explanation for why the intensity of goods trade peaked in the 2000s (Chart 1). Moreover, multiple-border-crossing trade is unwinding since industrial automation is reducing the labour cost-share of manufacturing and with it the profitability of offshoring stages to low-wage nations. Reshoring, in other words, is driven by secular technological changes in addition to any medium-term rise in trade costs and risks (Baldwin and Freeman 2021).

3.1.2 Comparative advantage was partly de-nationalised

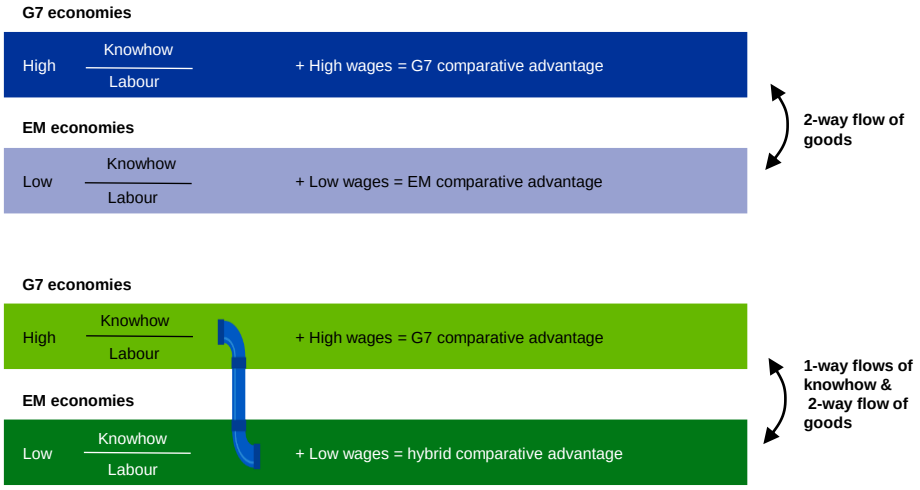
A point that is not sufficiently recognised is how different the economics driving the second unbundling was from that of the first. From 1820 to 1990, the arbitrage driving the first unbundling could be thought of as following Ricardo's law of comparative advantage. Rich nations had higher knowhow-to-labour ratios (and thus higher wages) but in some sectors their high-tech more than offset their high wage and so they were price competitive. In other sectors, the opposite held and nations with low-tech-low-wage combination were price competitive. Two-way trade resulted.

The second unbundling was driven by arbitrage in manufacturing knowhow, which worked on very non-Ricardian principles. Manufacturing firms in rich nations owned lots of technical, managerial, and marketing knowhow but high communication costs restricted them to applying it only to rich-nation workers. ICT opened previously non-existence arbitrage opportunities that led to a one-way flow of knowhow out of G7 nations and to a handful of emerging economies. Since the knowhow was the basis of the rich nations' Ricardian comparative advantage, we slipped into a world where the sources of comparative advantage were crossing borders, not just the goods that were the fruits of the comparative advantage.

A schematic diagram helps nail this down (Figure 1). The top two bars show the traditional determinants of Ricardian comparative advantage during the pre-1990 globalisation. Nations that had high knowhow to labour ratios (take the G7 nations to be concrete) had high wages. G7 nations had a comparative advantage in sectors where their high productivity more than outweighed their high wages. The second bar shows the situation of Emerging Markets (EMs) whose low knowhow/labour ratios produced low wages that were, in their comparative advantage sectors, low enough to offset their low productivity.

Figure 1

How and why comparative advantage changed around 1990



Sources: Author's elaboration of ideas in Baldwin (2016).

The second set of bars shows how the second unbundling changed comparative advantage. ICT opened a pipeline (i.e., relaxed the second constraint on arbitrage) that allowed G7 firms to combine their high technology with low wage workers abroad. This created a hybrid comparative advantage. For example, when Ford makes auto parts in Mexico, it is using American knowhow and Mexican labour, not Mexican technology and Mexican labour. Before ICT, this was not practical. Now, comparative advantage is defined at the level of companies' internationalised manufacturing processes, not national boundaries as was the case in the first unbundling.

This brings us back to the original question: Why did services trade behave so differently?

3.2 The future: globalisation's third unbundling

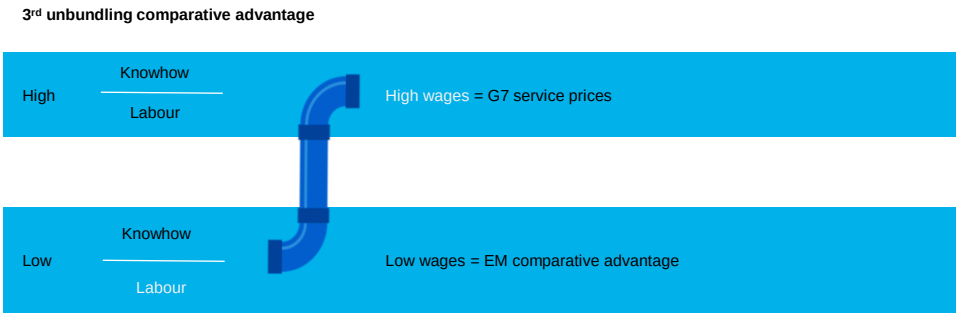
Digital technology is refashioning the future of trade. Today we are seeing a third unbundling. It is driven by the modern version of ICT – namely digital technology. But rather than enable arbitrage in manufacturing knowhow via GVCs, it is enabling the arbitrage of labour service sector via international remote work, or 'telemigration.' This third unbundling concerns the spatial unbundling of labour services and the labourers.

Figure 2 schematically illustrates some differences between the third unbundling and the first two. The first unbundling was arbitrage in goods, with knowhow locked inside nations. The second unbundling allowed the source of Ricardian comparative advantage (knowhow) to be arbitraged internationally. The economics of the third unbundling is much more like that of the first.

The third-unbundling arbitrage is between the low service-sector wages in emerging economies and the high service-sector wages in G7 nations with digitech opening the pipeline that allows this export of office work without the office workers migrating.

Since the job is not always won by the cheapest, the export of labour services will be two-way.

Figure 2
Why services trade did not peak in the mid-2000s



Sources: Author's elaboration of ideas in Baldwin (2016).

3.2.1 The third unbundling as service-sector wage arbitrage

Note that the arbitrage here is direct, international wage competition among service sector workers, and wage differences are probably the largest unexploited arbitrage left in today's world. Taking Colombia as an example of a middle-income emerging market, a recent study matched the US's occupation classifications with those of Colombia to compare wage rates (Baldwin, Cardenaz, and Fernandez 2021). Focusing only on the occupations that Dingel and Neiman (2020) have classified as teleworkable in the US, the study found that the wages in the US were on average 1500% higher in the US than in Colombia. Plainly low wages are not the only source of competitiveness in services but with wage gaps being that large, it is likely that the digitech-driven globalisation of the service sector will have an impact on prices and wages in advanced economies.

Some of the arbitrage is done via online freelancing platforms like Upwork, Freelancer, and Zhubajie (these are like eBay but for services). Wage comparisons based on worker-level data scrapped from such online freelancing platforms confirm the presence of enormous wage gaps, although the size varies greatly according to the data selection criteria. Data from a number of the largest freelance platforms reported in ILO (2021) indicate that average hourly earnings paid in a typical week for those engaged in online work is US$4.9, with the majority of workers (66%) earning less than the average. While $4.90 an hour seems like a low wage in Europe, it corresponds to full-time equivalent salary of about $10,000 per year – a salary which is considered comfortably middle-class in most countries.

An important difference between goods and services barriers arises from the nature of some services. While most goods can be put in a box and shipped, some services require real face-to-face contact. This need will shield some rich-nation service workers from direct wage competition.

As with the first two, the third unbundling will, in my view, affect the macroeconomy by strengthening the connection between domestic and international prices while weakening the connection between domestic labour supply and demand conditions and the wage formation process. There will be some big differences that are explored in Section 4, but first consider the argument that the future of globalisation lies in services trade.

3.3 The future of globalisation is trade in intermediate services

“The future is already here – it's just not evenly distributed,” is one of the more famous quotes ascribed to the science fiction writer William Gibson. The quote seems to be purpose-built for the future of trade in intermediate services. As Chart 4 showed, OCS services are already 20% of all international commerce and rising fast. This section presents the argument that this trend will continue for the foreseeable future and may well accelerate.

The argument boils down to a few facts and a deduction. First, barriers to trade in most services are now two or three orders of magnitude higher than the barriers to trade in goods (Benz and Jaax 2022), but many of today’s service barriers are technological rather than fiscal or regulatory.

Services are hard to tax at the border, so most barriers to service imports arise from domestic regulation (OECD 2020). Much of this regulation, however, concerns final services, not intermediate services. Regulations, restrictions, and controls typically apply only to transactions between the final service seller and the final service buyer. The service tasks that are inputs to these final services are – by contrast – much less regulated. For example, while there are strict rules for selling accounting services in the US, there are few rules concerning the qualifications of the service workers that do the paperwork behind the provision of such accounting services. A US accountant can employ pretty much anybody to tally up a client’s travel expenses and collate them with expense receipts. The quality control burden falls on the sellers of the final service, not government regulators.

In short, since it is hard to tax imported services, the main source of protection is regulation, but since most of the regulation only applies to final services, the main barriers to international arbitrage in intermediate services are the technical and social difficulties of coordinating work teams that include faraway workers.

What are intermediate services? They are the tasks done by occupations like bookkeepers, forensic accountants, CV screeners, administrative assistants, online client help staff, graphic designers, copyeditors, personal assistants, corporate travel agents, software engineers, lawyers who can check contracts, financial analysts who can write reports, etc. The key identifier is that the service tasks are done for a company, not a final customer.

The second fact is that digitech is rapidly lowering the technological barriers to trade in intermediate services and pandemic-linked changes accelerated the reduction in separation costs (MGI 2021). These two facts mean that services-trade barriers are

falling radically faster than goods-trade barriers and likely to continue doing so for the foreseeable future.

The third fact is that export capacity in emerging markets is not as great a limiting factor in services as it is in goods since every nation has a workforce that is producing intermediate-service tasks. All emerging market economies have workers who are already providing intermediate services to domestic companies. There is no need to develop whole new sectors, build factories, or develop farms or mines. This fact, by the way, is the basis of a broad re-evaluation of development pathways for emerging markets – as has been noted by several recent, high-profile reports stressing the role of services trade in development (WTO, 2019; Nayyar, Hallward-Driemeier, and Davies, 2021; ILO, 2021; ADB, 2022).

The fourth fact is that the demand for imported intermediate services is not as great a limiting factor as it was for trade in goods. Businesses in G7 nations spend a great deal on services (more on this below). Many services, say housing services, are nontraded, but many are potentially tradable. Roughly speaking, if the service could be provided by someone working remotely during the pandemic, then it is a candidate for competition from imported services – although there are many caveats (Baldwin and Dingel 2022). Moreover, tradeable intermediate services are inputs into many nontraded final services. For instance, a company that manages rental properties might be able to cut costs and thus rents by offshoring some back-office services to a low-wage nation.

The deduction is simplicity itself. Barriers are radically higher and falling radically faster for services versus goods, and, unlike farm and factory goods, there is no capacity constraint when it comes to intermediate services. Ergo, the future of trade lies in intermediate services. The specific conjecture is that the share of OCS in international commerce will continue to rise as it has for decades (Chart 4).

3.3.1 How important are imported intermediate services to the euro area?

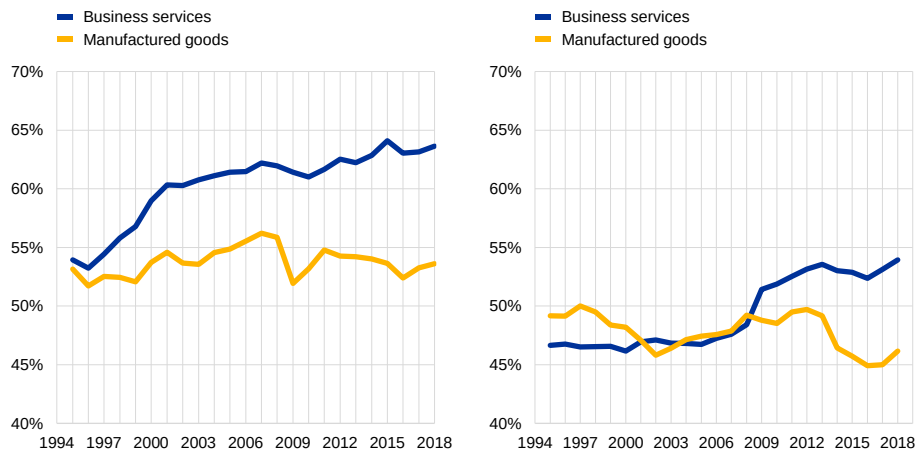
While official trade data does not distinguish between final and intermediate services, the OECD's TiVA database has, via estimation rather than observation, collected the bilateral flows in intermediate services. The TiVA database covers only the advanced economies and a few large emerging markets, and it covers only 1995 to 2018, but its focus on intermediate inputs of goods and services is ideal for the purpose at hand. Or almost ideal. The TiVA database categories of services do not line up with standard international services trade categories, like OCS, so I use 'business services' which encompass all non-governmental services.

The left panel of Chart 8 shows, for the euro area, the importance of imported intermediate services in EA19 overall imports of business services. Starting with the familiar, note that the share in intermediates in imports of manufactured goods is about half. This indicates that EA19 manufacturing sectors are highly dependent upon imported intermediate goods. The trend is rising to the mid-2000s but declining gently since 2008. This confirms the trends documented in Section 2.

The trend and level are quite distinct for the share of intermediate services in total EA19 imports of business services. The level starts out a bit higher for services than goods, but the trend is steadily upwards achieving an astounding two-thirds by 2018. To be clear, this shows that trade in intermediate services is not an issue for the future. Intermediate services already dominate trade in services in the euro area. The right panel, which presents UK data for comparison, shows that the facts are similar when it comes to trends, even if the levels are somewhat lower.

Chart 8

Intermediates as share of imported services and manufactures, EA19 and UK, 1995-2018



Sources: Author's calculations based on OECD TiVa data, downloaded from stats.oecd.org.
Notes: TiVA data are only available for the 1995-2018 period. Imports in the charts are measured on the usual 'gross' basis (not value added basis). Business services encompass all non-governmental services (the TiVA database categories of services do not line up with standard trade in services categories, like OCS). It includes travel and transport but since the series ends in 2018, the 2019-2020 disruption is absent.

The main conclusion is that trade in intermediate services is not a matter for the distant future. Euro area imports of services are already dominated by intermediate services.

4 Services are important and different

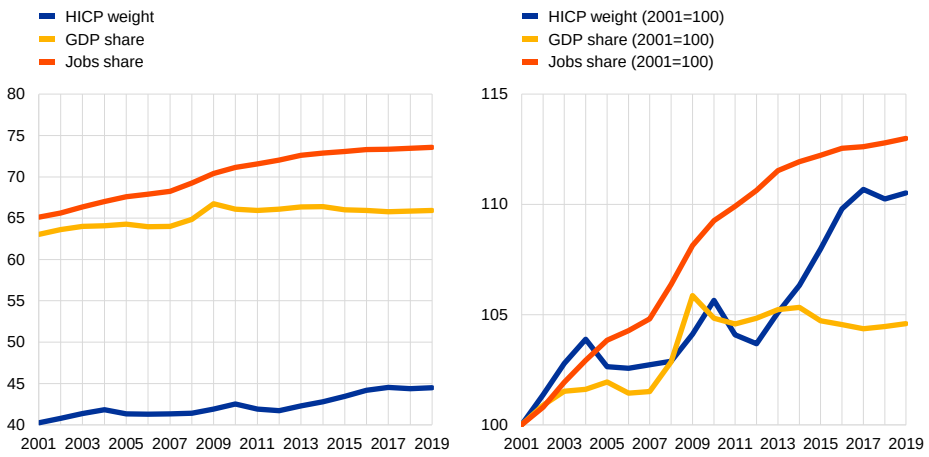
Services are an enormously important part of the euro area economy and getting more important, as Chart 9 shows. Service jobs accounted for about two-thirds of all jobs in 2001. This rose to three-quarters by 2019 (last year before the pandemic disruptions). Over the same period, the service sector's GDP share rose from 63% to 66% but has stagnated since the Global Crisis. The divergence between the share of service jobs and service share of GDP is due to the well-known fact that labour productivity is, on average, lower in services than it is in other sectors. The divergence in the trends show that the productivity gap has been widening. The bottom line in the left panel shows the weight of services in the HICP index. This is a proxy for the importance of services in EA19 final consumption. As we see, people devote a large fraction of their expenditure to services, about 40% in 2001 with the figure rising to about 45% in 2019.

This is an important part of the evolution of the role of services in the EA economy. It shows that there is an upward trend in the demand for services from consumers.

The right panel focuses on trends for the same variables by indexing the left-panel series to equal 100 at the start of the period in 2001. This illuminates the fact that the importance of services in employment has been rising quite fast. The rise in expenditure shares is almost as fast, but the behaviour of the GDP share is quite different. It rises quickly up to 2008 but stagnates after that.

Chart 9

'Servicification' of EA19 economy – jobs, GDP, and expenditure shares, 2001-2019



Sources: Authors elaboration of data from World Bank's World Development Indicators database (jobs and GDP shares) and Eurostat data (HICP services weight).
Notes: The right panel shows the left-panel variables indexed to 2001 = 100 to illustrate the cumulative growth. The service jobs share is employment in services, % of total employment (modelled ILO estimates), and GDP share is value added as % of GDP., service expenditure share is proxied by the HICP expenditure weight on all services.

A remarkable feature of these charts is the substantial difference between services' weight in consumer expenditure and their weight in the general economy. Since the EA's net export of services is a small share of GDP (around 1%), the difference must lie in the fact that many services are either sold to other final users whose expenditure patterns are not reflected in the HICP (government or investment expenditure) or are used as inputs into the production of goods and services.

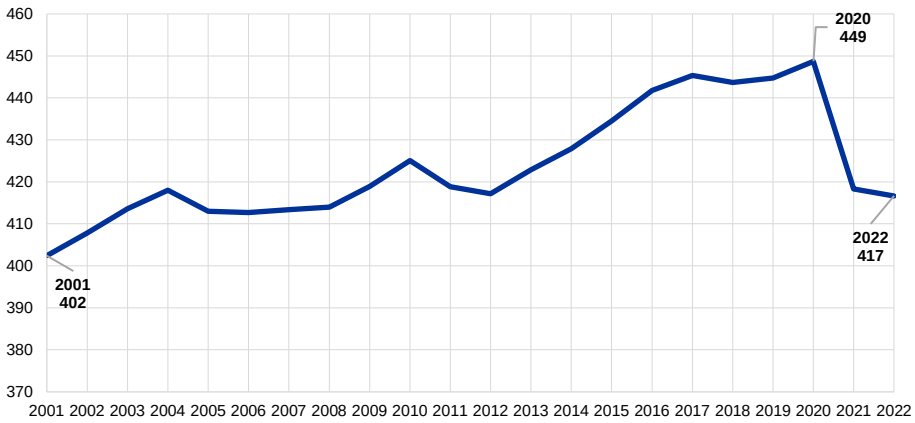
Chart 10 shows that the secular rise in the importance of services in consumption expenditure was suddenly and sharply reverse during the period of intense Covid lockdown policies. The future will tell, but the reversal is likely to be reversed going forwards as the lockdowns and restrictions become a thing of the past.

Chart 10

The weight of service prices in HICP, 2001 to 2022

The weight services in the HIPC index of inflation rose for a decade but fell sharply during the pandemic disruptions as consumers switched to spending more on goods

(weight of all services items in basis points)



Sources: Author's elaboration of Eurostat online data.
Note: The series is 'Services (overall index excluding goods)'; 2022 is the estimate used to calculate this year's inflation rate. The total weight is 1000, so the weight of, say, 417 indicates an HICP share of 41.7%.

4.1 Services are three times more important as intermediate inputs into domestic production than manufactures

While the importance of intermediate inputs is widely recognised in goods sectors – that is what GVCs are all about – the focus of most studies has been on intermediate goods (Johnson 2014). This is a missed opportunity since it turns out that services are about three times more important as intermediates than are manufactures.

Chart 11 – which looks at the French economy in 2018 as an example – shows that at the level of the whole economy (right bars), intermediate service inputs account for 30% of the total gross output, while manufactured intermediates account for only 11%. Note that 'gross output' is value added (i.e., GDP) plus the value of all intermediates used up in the production of the final value added.

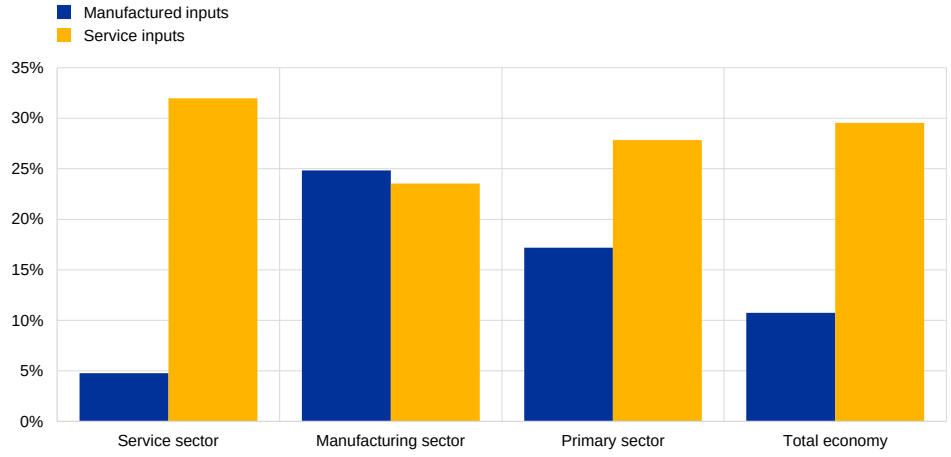
The usage of services and manufactures as inputs naturally varies across sectors as the three leftmost rows of columns show. The share of manufactured goods in all intermediates used by the service sector is only 5% while the services intermediates' share is 32%. When it comes to the manufacturing sector, manufactured inputs account for 25% of inputs while services account for 24% (the rest is from the primary sector). For the primary sector the inputs shares for services and manufactures are 28% and 17% respectively.

Plainly, service inputs are consistently important in primary, secondary, and tertiary sectors, while manufacturing usage is concentrated in the manufacturing and primary goods sectors. This consistency, teamed with the outsized importance of the service

sector (68% of French GDP), is why service inputs are so much more important at the economy-wide level.

Chart 11

Share of services vs manufacturing intermediates by sector, France, 2018



Source: Author's elaboration of calculations produced by Rebecca Freeman and Angelos Theodorakopoulos using the OECD's inter-country input-output data base. See Baldwin, Freeman, Theodorakopoulos (2022).
Notes: The inputs are from all sources, domestic and foreign, and the shares are a percent of the buying sector's gross output.

Looking at the same calculations for the earliest available year, 1995, reveals the growing role of services. In 1995, intermediate services accounted for 25% of France's gross output while manufactured intermediates accounted for 14% (not shown in the chart).

Digital technology applied to services is affecting the euro area economy via an entirely separate route – automation.

4.2 Services sector automation

This impact of digital technology on the service sector requires some background on important but insufficiently remarked differences between ICT and digital technology. Today's digitech impulse is quite different than the impulse that triggered the second automation (called computerisation). It is true that both involve the gathering, transmission, storage, and processing of data, but the way these are employed in the workplace is dissimilar.

When computers and integrated circuits started getting useful in the 1970s, automation crossed a 'continental divide' of sorts. Before, automation was all about mechanisation – it was about providing manual workers with more powerful tools for their hands. Computerisation, by contrast, was a shift from hands to heads. Computers before the mid-2010s, however, could do only a highly restricted type of mental work. They were not thinking in any real sense. They were just following an

explicit set of instructions called a computer program. Today's computing does it differently.

Digital technology pushed computing across a second continental divide. The divide lines up exactly with what the psychologist Daniel Kahneman called 'thinking fast and thinking slow' (Kahneman 2011). Thinking slow is the conscious, explicit reasoning that humans could teach to computers using programming languages. Thinking fast is the unconscious, instantaneous, instinctive thinking that we could not teach to computers by writing code. The ultimate limitation was that humans did not understand how they perform unconscious thinking, so it was impossible to write a programme that would get a computer to mimic the process.

A type of AI called machine learning allowed computers to jump over this limitation. While the technology is well established, it did not really move the dial until 2016 or 2017 when our ability to gather and process data became gigantic. With massive data sets and amounts of processing power that were unattainable in the early 2010s, computer scientists estimated extremely large non-linear statistical models that could recognise patterns in data. That is why today computers are as good or better than humans in some instinctual, unconscious mental tasks – things like recognizing speech, identifying faces, and identifying diseases from X-rays.

The upshot is that computers now have cognitive capacities that they never had before 2017 (which was dubbed the "Year of AI" by Fortune magazine). While machine-learning progress was smooth, in 2016 it started producing models that allowed computers to do shocking things, like beat the world's best Go player. This matters for the issue at hand since some of computers' new cognitive skills are allowing firms to automate some service sector tasks. Before 2016, automation was mostly about farming and factory jobs. Since 2017, automation is increasingly applied to the service sector.

This is leading to automation of services that had previously been thought to be immune to automation. Software packages like Robotic Process Automation, virtual assistants, and chatbots are taking over some service tasks. More sophisticated AI packages like IBM's Watson are automating some aspects of professional jobs. Take as an example the news media industry where the New York Times, Washington Post, BBC, and Reuters are using robo-reporters to write some stories.

The BBC's white-collar robot, 'Juicer,' continuously monitors the news feeds of over 850 global news outlets. Using it, a journalist who is looking for the latest stories on, say Donald Trump, can pull up an inventory of related content in just minutes. No need for hours of research by the reporter or research assistants. Reuter's white-collar robot, 'News Tracer,' tracks breaking news, so journalists can jump straight to the latest news. The Washington Post's white-collar robot, called 'Knowledge Map,' undertakes routine research tasks, and its robot-reporter, 'Heliograf', can write simple stories. Heliograf was first used to expand and quicken coverage of the 2016 Olympics. Similar white-collar robots are used in financial planning, logistics planning, architecture, legal services, and many more service sectors.

In a very different industry, WCRs are automating more sensitive tasks. Some aspects of the work of parole boards in the US are partly automated with WCRs. One such system is called Compas (Correctional Offender Management Profiling for Alternative Sanctions). Designed by the company Northpointe, a criminal justice research and consulting company, it is used in Michigan and New York. It combines standard risk factors (criminal history, age, etc.) with other data to calculate an inmate's probability of breaking parole. The company points out that it should only be used as a tool by human members of parole boards. Northpointe's chief scientist, told the Wall Street Journal that parole boards should override the WCR's conclusion in eight to fifteen percent of the cases (McCaney 2013).

The takeaway from these examples is simply that many service sector and professional tasks that were previously un-automatable are now, thanks to machine learning and massive data sets, partly automatable. Moreover, it is not just routine, unskilled tasks. Algorithms trained by machine learning are essentially data-based pattern recognition. As experience-based pattern recognition is the core of many high-skilled jobs, the new automation is an issue for high-education and low-education workers alike. This is quite different from the impact of ICT over past decades where it tended to help the fortunes of high-education workers but hurt the fortunes of low-education workers.

While both the new globalisation and the new automation is likely to affect the workplace at the task level more than the occupation level, it is useful to look at which types of occupations have a high share of tasks that are either vulnerable to globalisation, or to automation, or to both.

4.3 Which jobs are offshorable and automatable?

A couple of famous attempts have been made to classify occupations by teleworkability and automatability. Here we use the two most well-known efforts to classify jobs, namely Frey and Osborne (2013) for automation, and Dingel and Neiman (2020) for teleworkability. These were done on US data.

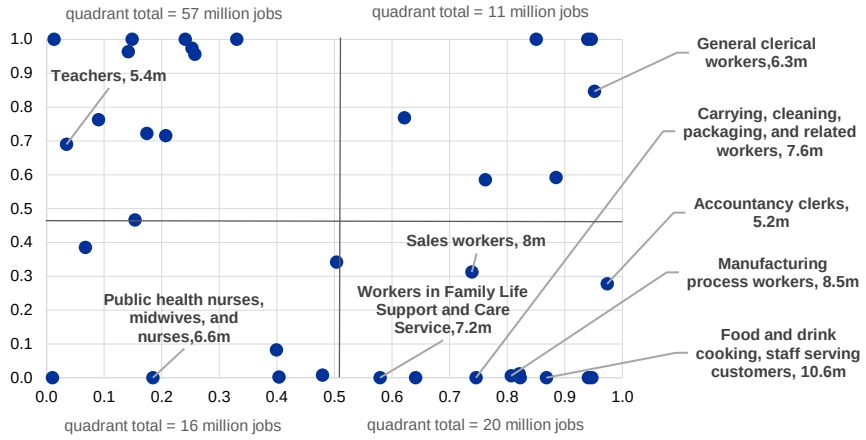
As in Baldwin and Okubo (2022), the data by occupation are presented in a scatter plot (Chart 12) to stress that jobs and thus prices are being affected by both globalisation and automation. The resulting 'globotics quadrant' places each occupation according to whether it is above or below average automatability (horizontal axis) and whether it is above or below average teleworkability (vertical axis). To reduce clutter, occupations are aggregated from the original 700+ Bureau of Labour Statistics categories of occupations into Japan's 37 occupations.

It would be too messy to label every point in the scatter plot, but occupations that have at least 5 million workers are label in the chart. See Table 1 for a full list of occupations by quadrant.

Chart 12

Globotics quadrant for the US, occupations by automatability and teleworkability

(Horizontal axis is Automatability Score (0 to 1, Median=.503), Vertical axis is Teleworkable Score (0 to 1, Median=.466) units)



Sources: Author's elaboration of the globotics quadrant diagram first introduce by Baldwin and Okubo (2022).
Notes: Automatability score based on Frey and Osborne (2013); the teleworkability score is based on Dingel and Meiman (2020). Blue lines indicate median values of the normalised series. The US job categories used by these authors (over 700) are grouped together into Japan's NIRA categorisation of occupations, weighted by employment levels. See Table 1 for a list of occupations in each quadrant.

Observe that there are many occupations in all four quadrants. This means that there is no obvious correlation between automatability and teleworkability as would be the case if most occupations were in the Northeast and Southwest sectors. The clustering of occupations with the lowest possible teleworkable scores but high automatable scores in the lower right corner is noteworthy. Examples include serving staff in restaurants, and cleaners. These non-teleworkable jobs will tend to be shielded from international wage competition but will find competition for at least some tasks from software automation. There is a second clustering of occupations at the other end, namely highly teleworkable but not very automatable in the top left corner. Examples include workers in religion, civil engineers, and architects. These are likely to see heightened competition from telemigrants when it comes to at least some of the tasks they perform today.

The northwest quadrant – which lists occupations that are above average teleworkable but below average automatable – is the most populated. The number of US workers with such occupations adds up to 57 million. The second biggest in terms of jobs is the southwest quadrant with 20 million. These lists jobs that are above average automatable but below average teleworkable. The occupations here include food and drink staff servicing customers, workers in family life support, and manufacturing process workers. The two on-diagonal quadrants – which list occupations that are below-average prone to automatability and teleworkability (Southwest) or above-average prone to automatability and teleworkability (Northeast). The latter is the most vulnerable according to these rankings, but there are only 11 million US workers with such jobs. The most shielded jobs are in the Southwest corner. There are 16 million jobs in this quadrant.

Table 1
Occupations by globotics quadrant

NW quad	Million jobs	NE quad	Million jobs	SW quad	Million jobs	SE quad	Million jobs
Workers in religion	0.1	General clerical workers	6.4	Food and drink cooking, staff serving customers	10.6	Public health nurses, midwives, and nurses	6.6
Teachers	5.4	Management, finance and insurance professionals	1.6	Manufacturing process workers	8.6	Security workers	2.8
Researchers	1.0	Manager of residential facilities and buildings	0.4	Sales workers	7.9	Medical Technology and Healthcare Professionals	1.8
Other specialist professionals	1.1	Office appliance operators	0.2	Carrying, cleaning, packaging, and related workers	7.6	Occupational health and hygiene service workers	1.8
Manufacturing engineers	1.4	Outdoor service workers	0.4	Workers in Family Life Support and Care Service	7.2	Professional social welfare workers	1.7
Management and business consultants	1.4	Sales clerks	1.3	Accountancy clerks	5.2	Manufacturing engineers	1.4
Legal professionals	0.8	Transport and post clerical workers	0.5	Transport and machine operation workers	3.8	Other service workers	1.0
Data processing and communication engineers	4.6			Construction and mining workers	3.4	Doctors, dentists, veterinarians, and pharmacists	0.9
Authors, journalists, editors	0.2			Production-related clerical workers	1.1		
Artists, designers, photographers, film operators	0.6			Other service workers	1.0		
Architects, civil engineers and surveyor	0.6			Agriculture, forestry and fishery workers	0.5		
Administrative and managerial workers	2.5			Agriculture, forestry, and fishery engineers	0.0		
Total by quadrant	19.8		10.7		57.0		17.9

Sources: Baldwin and Okubo (2022).
Notes: See notes for Chart 14.

The whole discussion up to this point has been background and preparation for the next section, namely what all these facts and arguments could mean for the functioning of the euro area macroeconomy in the medium term. Globalisation and automation affect the functioning of the euro area macroeconomy in many, many ways. Here I will focus only on the impact on the HICP.

5 Globotics and HICP developments

When it comes to the evolution of prices, the first thing to note is that goods and services prices in the HICP behave very differently. This is important since services

taken together count for about 45% of the HICP price basket in 2020, so the evolution of services prices has a big impact on HICP headline inflation.

Over past decades, service prices have risen faster than goods prices but have been notably less variable (Chart 13). The service price sub-index rose by 44 points since 2001, while the goods price sub-index rose by only 34 points (left panel). Disaggregated data (not shown) tells us that this faster service inflation was strongest in the low-income euro area members like Estonia, Latvia, and Lithuania.

The observed difference in the trend inflation rate of goods versus services is very much in line with a well-known stylised fact called the Balassa-Samuelson effect. It is typically thought of as arising due to two other stylised facts, namely that productivity advances faster in goods than services, and services are less traded than goods. According to the Balassa-Samuelson mechanism, ongoing globalisation pulls workers into the most productive (export) sectors with the result that wages rise economy wide. As services are nontraded, labour intensive and enjoy slower labour productivity growth, service prices rise faster than goods prices.

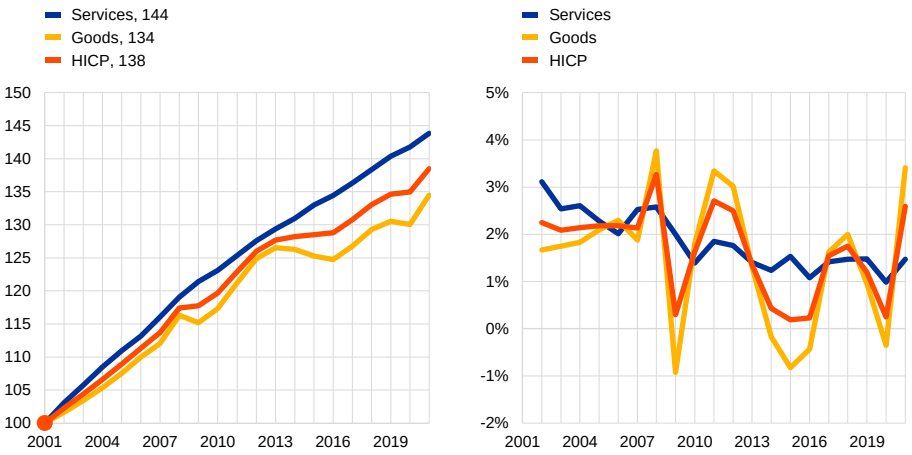
The right panel of the chart shows that services have played a stabilising role in annual inflation rate. For the last 20 years, services prices have been less volatile than goods prices. This outcome is surely related to the fact that the service prices in the HICP involve services that are non-traded and thus not subject to the vagaries of international price shocks in the same way goods prices are.

Chart 13

Euro area HICP index, levels and annual inflation rates, 2001-2021

Goods and services sub-indices of the HICP behave very differently; service prices have risen faster but with less volatility than goods prices since 2001

(left panel: 2001 =100, number are levels in 2021; right panel, annual inflation, %)



Sources: Author's elaboration of online Eurostat data.

A more detailed disaggregation of HICP elements contrasts the price evolution of industrial goods, energy, food, and services (Chart 14). Here we see that – since 2001 – both the food and energy prices have risen even faster than service prices, with industrial goods prices rising the least rapidly over the two-decade period. The twenty-year inflation rate for energy is 77%, while for food it is 52%. For services, the

equivalent figure is 44%. Industrial goods prices – which were deeply affected by the changed nature of globalisation discussed in Section 3 – show the slowest rise with a twenty-year inflation rate of 26%. These twenty-year rises are unweighted. The overall HICP, which rose 38% over this period, is a weighted average of the sub-indices.

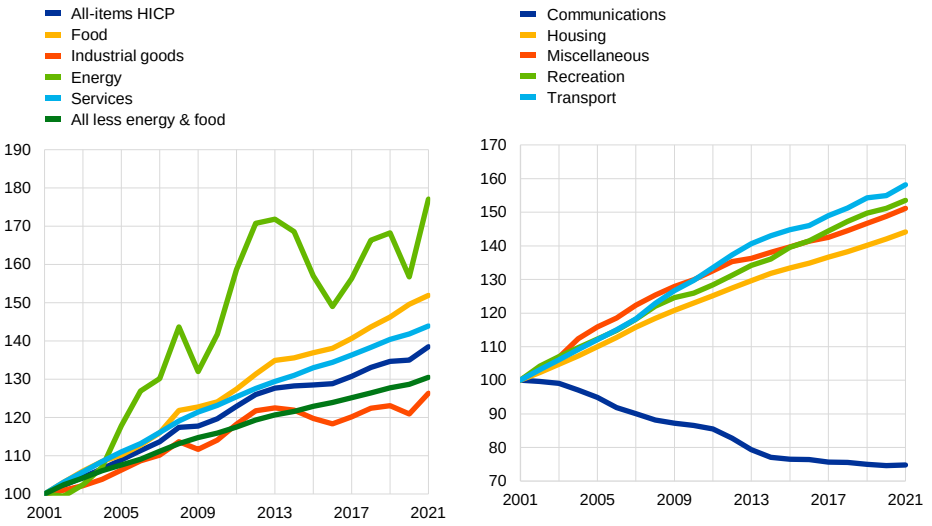
The right panel of Chart 14 displays the trends in the five major HICP sub-indices related to services. The standout item is services related to communication. The price of these services, which are directly linked to the rapid advance of digital technology, have fallen sharply over the last two decades. The rises in the other sub-indices are similar to each other and none of them is particularly volatile.

Chart 14

HICP sub-indices and focus on service sub-indices, 2001-2021

Apart from communication services all service sub-indices rose faster than the all-items HIPC

(indices 2001 =100)

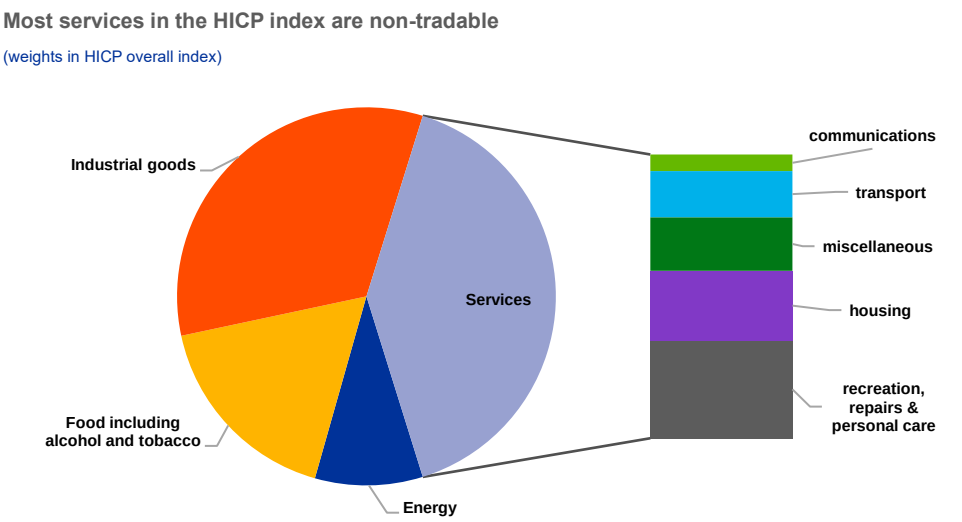


Sources: Author's elaboration of Eurostat online data.
Notes: Food refers to Food including alcohol and tobacco, and Services refers to Services (overall index excluding goods).

In terms of volatility, energy is the most variable since it is the most exposed to international demand and supply shocks. The standard deviation of the sub-index's annual inflation is 6.3% versus 0.9% for the HICP as a whole. Industrial goods and food are the next most volatile with standard deviations of 1.8% and 1.0% respectively. These volatility numbers are not shown in the chart.

Chart 15

HICP weights for sub-indices with a focus on service sub-indices, 2019



Sources: Author's elaboration of Eurostat online data.
Notes: see notes for Chart 16.

The weights of the non-service aggregates are listed in Chart 15 along with the weights of the components of the services sub-index shown in the right panel of Chart 14. The most important fact here is that most of the HIPC weight on services is placed on services that are profoundly non-traded. No amount of digital technology or work-from-home software will make it possible to trade housing, local transportation, or local recreation, repair and personal care services. In the next section, I point to some economic mechanisms that could still create a link between deeper service sector globalisation and these non-traded service prices.

Having laid out the baseline facts, it was my intent when I started this paper to extend to trade in services the 'imported deflation' analyses that had been done in the 2000s for trade in goods. In particular, I thought I could simulate what impact an important increase in services globalisation and automation could have on the HICP in the medium term. Upon reflection, I believe that is not possible without an extensive work programme.

The next sub-section explains the reasoning starting with a quick recap of the classic imported de-inflation analyses (e.g., Auer and Fischer 2010; for a review see Balatti et al 2021).

5.1 The goods-based 'Globalisation of Inflation Hypothesis'

During the offshoring-expansion phase, say 1999 to 2014 as per Chart 7, many analysts presented evidence showing that inflation became less sensitive to domestic cyclical conditions and more sensitive to global factors. The studies include Borio and Filardo (2007), White (2008), BIS (2014, 2015). See Forbes (2019) for a recent re-evaluation of the findings.

The set of empirical findings came to be known as the 'globalisation of inflation hypothesis' (GIH). The received empirical judgement that emerged held that competition from imported manufactured goods held down inflation modestly, but the simultaneous commodity supercycle drove up commodity prices leading to imported inflation that largely offset the imported deflation effect. Forbes (2019) finds that the GIH does not work for wages which are a key determinant of service prices given how labour intensive they are.

Many of the GIH studies approached the mechanism along Phillips Curve lines, namely the linkages between domestic inflation and global versus domestic demand slack variables (IMF, 2016b, ECB 2021a). While there is less consensus on the empirical importance of this mechanism, ECB Executive Board member Professor Isabel Schnabel recently concluded that: "global economic slack matters for domestic underlying inflation and that globalisation may have lowered the sensitivity of inflation to domestic slack, that is the slope of the Phillips curve … a failure to properly account for them may result in significant forecasting errors … the pandemic, and more recently Russia's invasion of Ukraine, are providing tangible evidence in favour of the second hypothesis [the GIH] " (Schnabel 2022).

Many other GIH studies estimate the total impact of imports from low-wage nations on domestic prices using instrumental variables. Still others take a "decomposition approach" that starts from the role of imported prices in a price index such as the HICP. Here I will focus only on the latter approach as it is the most direct, most transparent way to demonstrate my key point – that the impact of services trade on inflation dynamics is a matter that requires much more research.

5.1.1 An accounting decomposition: goods trade and domestic inflation

To structure the discussion and clarify terms, consider a super-simple price index which aggregates the price of imported goods, P_{imp}, and domestic goods P_{dom}, using μ as the weight placed on imports ('mu' being a mnemonic for imports). Thus

$$P = \left(P_{imp}\right)^{\mu}(P_{dom})^{1-\mu} \tag{1}$$

As a matter of pure logic, the impact on the price index of changes in the two prices and the weight is:

$$\%\Delta P = \mu\left(\%\Delta P_{imp}\right) + (1-\mu)(\%\Delta P_{dom}) + \Delta\mu\left(P_{imp} - P_{dom}\right) \tag{2}$$

where Δ stands for change, and $\%\Delta$ for percent change. In the expression, $\%\Delta P$, is the headline inflation rate. The first two terms on the right-hand side tell us that overall inflation is the weighted average of the inflation of the two component prices (domestic prices P_{dom} and import prices P_{imp}). The third term is the share-change effect; shifting expenditure to cheaper goods via $\Delta\mu$ slows inflation if import prices are below domestic prices.

This accounting decomposition points to two mechanical links between globalisation and inflation. First, the direct impact of imported final goods prices. If import prices rise slower than domestic prices (i.e., $\%\Delta P_{imp} - \%\Delta P_{dom}$ is negative), we can say that imports are slowing domestic inflation. Second, if import prices are lower than domestic prices (i.e., $P_{imp} - P_{dom}$ is negative) then a rise in the expenditure share on imports (i.e., $\Delta\mu$ is positive) will pull down the domestic inflation rate. A third indirect link can arise if competition from imports affect the determinants (e.g., wages and markups) of domestic price inflation.

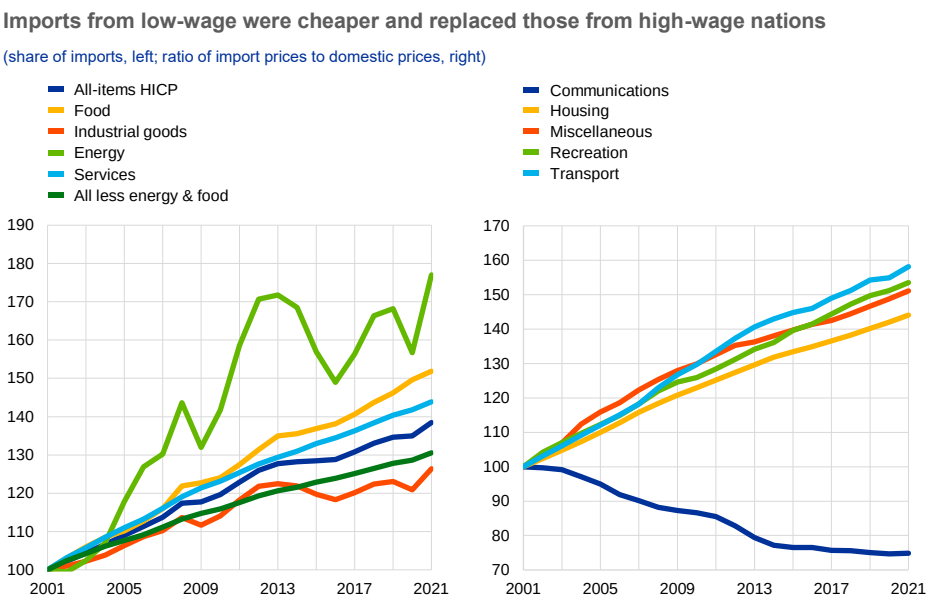
Carluccio et al (2018) implement this approach focusing on France and distinguishing between imported goods from high-wage and low-wage nations. They show that the share-change channel did contribute to lower HICP inflation since expenditure shifted from domestic goods to goods imported from low-wage countries (left panel of Chart 16), and the price of imports from low-wage nations were substantially lower than goods made inside the euro area nations (right panel). The right panel, however, indicates that the direct impact was small since the ratio of prices from low-wage nations rose faster that EA prices (i.e., the ratio of prices was rising in this period).

An additional mechanism concerns the indirect impact of imported goods prices on domestic prices via various economic mechanisms ranging from the impact on price-cost mark ups, lower prices for imported intermediate inputs, and the impact of import competition on workers' wage bargaining power and thus wage hikes.

Carluccio et al (2018), quantified the three channels for France during two decades of the offshoring-expansion phase of globalisation (1994 to 2014). They found that taken together the three channels lowered French annual inflation by a total of about 0.16 percentage points per year on average over the two decades. The three channels of imported deflation were found to be roughly equal in terms of quantitative importance.

Chart 16

Example of an application of the GIH to imported goods prices, Carluccio al (2018)



Sources: Data from Carluccio et al (2018), used with permission.

There are several major difficulties in extending this approach to the globalisation of euro area service sectors.

5.1.2 Many HICP services are intrinsically nontraded and hard to price

The calculations used to estimate the impact of imported goods on the HICP relied on the fact that most of the goods in the HICP are traded. This fact, plus the existence of high-quality price data for imported goods, allowed Carluccio et (2018) to match import prices with domestic prices, which was the first step to studying the impact of globalisation on prices in the HICP. When it comes to services, the situation is quite different.

Only a few of the services in the HICP are clearly traded. The HICP categories are not designed to distinguish between goods and services, but Eurostat publishes an HICP sub-index for “services (overall index excluding goods)”, and five sub-indices (see Chart 15). These service sub-indices are quite aggregate but plainly illustrate the inherent non-tradability of many of the services in the HICP. Most of the services related to communication are tradable, but most of them related to housing are not. But how do we move beyond this eyeballing approach to tradability?

As part of a research programme, it would be useful to classify all the services in the HICP index on a scale of tradability using statistical methods. For example, exchange rate movements of the euro will naturally move the prices of items that are traded but not the prices of items that are not traded. Thus, the estimated passthrough elasticity of euro movements on a panel of disaggregate HICP service price indices could be used as a proxy for tradability. One could expect that the passthrough elasticity for, say, ‘maintenance charges in multi-occupied buildings’ would be zero, but that it would be high for, say, ‘package international holidays.’

Another problem that is unique to services is the lack of import price data. This stems from the way trade in service statistics are typically gathered. In many cases, the service trade statistics are gathered by the central bank as part of its balance of payments accounting. Each international financial transaction has to be allocated to something crossing the border in exchange for the payment. If the thing is a good that has generated a customs form, then everything is clear. If not, it has to be allocated to a service of some kind.

Critically, the absence of a customs declaration obviates the usual source of trade price data. The customs form asks for the value of the shipment and for the quantity in the shipment. Often the quantity is listed in kilogrammes or units, say the number of flat-panel TVs. Dividing the value by the quantity yields a price-like thing called the unit value index. Most service transactions, however, are not associated with a quantity measure and so the unit value calculation is impossible. The other way of gathering service trade statistics is enterprise surveys, but these too fail to ask for quantities as well as values. Indeed, it is not clear how one would define quantity in this setting. The notion of quantity is much harder to define for services than it is for goods since services tend to be customised and bundled.

As part of a work programme, a work-around might be employed. While governments have not seen the merit in gathering price data on traded services, the same is not true for domestic prices. As we saw with the HICP, services account for a massive share of the overall index, so domestic service prices must be gathered. Moreover, services account for the lion's share of GDP for most nations and so national statistical offices must develop estimates of the prices of produced services. Without them, they could not produce real GDP growth figures.

While these are domestic prices rather than traded prices, bilateral gaps between different nations' domestic service prices could be used as a proxy, or as an instrument for gaps between domestic and import prices as in equation (2). Using bilateral weights from official trade in services data, one could define a surrogate for a nation's import service prices.

5.2 Mapping white-collar robots and telemigrants into HICP prices

A fundamental difference between automation and globalisation of goods versus services concerns the economic impact point. When it comes to traded goods, data gathering, and empirical analyses, focus on firms, factories, and products. Masses of papers, for instance, have looked at the automation and globalisation of the auto sector. It has been relatively easy to map these impact points into HICP prices. The statistical classification used for traded goods does not perfectly match the classification used for GDP accounts, but trusted concordances are readily available.

When it comes to services, the data-gathering and empirical analyses have focused on occupations or tasks – not products. The globotics quadrant, for example, is presented in 'jobs space' since it reflects concerns about automatability and offshorability at the level of occupations. This is standard in the future of work literature (OECD 2021), along with an alternative focus on 'task space' (i.e., automatability and offshorability of particular tasks rather than whole jobs). As argued, the explosive pace of digital technology will expose the various jobs to rapid enhancement, transformation, or replacement. The standard concern in this literature is the number of jobs created or lost. There will, however, be price considerations as well.

We can presume that in almost all cases, white-collar robots and telemigrants will be embraced by EA firms in order to lower costs or raise quality for a given cost. The net result will show up in profits, sales, and prices. To run down the price aspect of this, consider the price implication for a service that is highly "globotics exposed", i.e., a service whose production involves lots of workers in the occupations that are highly exposed to competition from white-collar robots and telemigrants. As digitech will lower costs fastest in the most globotics-exposed services, the prices of such services should rise less quickly than average. What is needed is a mapping of occupations into the products and services that appear in the HICP.

Mapping the impact of globotics on occupations to its impact on prices will require detailed knowledge of the intensity of various occupations in the production of the goods and services in the HICP. For example, the HICP sub-index for 'out-patient medical services' includes prices for nine sub-categories. Two of these are 'dental

services', and 'services of medical analysis laboratories and X-ray centres.' The work programme would establish a mapping between occupations/tasks and HICP elements. That is, it would identify which occupations are used in the production of these services and with what level of intensity. The result would be a matrix with occupations in the rows and HICP items in the columns where the elements reflect the relative importance of each occupation for each HICP item. This is far from impossible, but it will require an extensive effort.

With this in hand, we could more accurately simulate the impact of rapidly advancing digital technology on individual HICP items and thus the overall trend in consumer prices. The background assumption in such simulations would be that costs would fall fastest for the services that were most intensive in the use of highly globotics-exposed occupations.

5.2.1 Impact via wage formation

The rapid expansion of cheap imported goods from 1990 to the late 2000s had a measurable dampening effect on wage rises in G7 nations (Autor et al 2013). This channel may also turn out to be important when it comes to the imports of services from low-wage nations. The salient point here is that about three-quarters of Europeans work in service sectors. Not all of these sectors are open to import competition, but many are. Others, as Chart 12 showed, are also subject to automation. Those sectors will be subject to downward pressures on unit labour costs as service imports from low-wage nations multiply in coming years and the abilities of white-collar robots advance.

Thinking hard about quantifying this mechanism probably should also be part of the research programme I am outlining. Ultimately the empirical task would be to measure whether the historical expansion of the imports and exports of services had had an impact on wage formation in the euro area. Such an empirical investigation will be inhibited by the poor state of services trade data, and the lack of a mapping between domestic occupations and services trade categories.

There are at least two ways forward. The first would be to use an expert-based crosswalk between the services trade categories and the International Standard Classification of Occupations used by Eurostat. Given the lack of a natural experiment, one could test the null hypothesis that euro area wage formation – by occupation and by country – was unrelated to the rapid expansion of services trade. Given the cross-sector and cross-country variation in services trade, there should be enough data to reject the null if indeed the globalisation of services has affected wage formation processes.

A second approach would be shift-share instrumenting. The potential exposure of occupations would be defined using the indicators that predicted which occupations are teleworkable as in Dingel and Neiman (2020). An alternative 'vulnerability to the shock' proxy could be based on actual data on how many workers in the various occupations actually worked from home during the pandemic. The overall shock would be based on the rapid growth in service import aggregated to a level that could match

aggregates of occupations. Both approaches would probably require many months of data preparation and matching.

6 Conclusions and future research

The definition of globalisation used by economic historians to establish the starting date for modern globalisation rests firmly on the co-movement of international and domestic prices (O'Rourke and Williamson, 2002). The thinking is guided by two theoretical extremes. In a fully open small economy, domestic prices are entirely unrelated to local supply and demand, while in a fully autarkic economy, domestic prices have nothing to do with international factors. With these extremes in mind, it is natural to think of globalisation as shifting the economy towards a price-setting process that is ever less dependent on domestic supply and demand conditions and ever more dependent on international factors.

Major central banks are in no danger of losing medium-term control of the inflation. Today's mega economies are far closer to the autarky extreme than they are to the free-trade extreme. The total of US goods and services sold to foreign nations never surpassed 20% of its GDP, and US value added accounts for only about 90% of those export sales. This simple reality is down to two facts. International commerce for high-wage nations has hereto been dominated by manufactured goods, and manufacturing accounts for a modest and shrinking share of domestic employment and value added.

The importance of trade in HICP developments could shift radically if the service sectors became as globalised in the future as the manufacturing sectors are today. Opening sectors that employ almost 75% of the workers is likely to have much larger effects than we saw from the opening of goods sectors over the past 25 years. This is why my conjecture – that the future of trade is in intermediate services – should matter to central banks.

Here it is important to note that services are different than goods in a number of ways. First, the data for trade in services is woefully inadequate. Indicators of prices are largely missing, and the classification of service categories is not suited to economic analysis of services trade's impact on jobs, incomes, and growth.

Second, service sector automation and globalisation are being driven rapidly forward by digital technology, but the changes are impacting the economy at the level of occupations and tasks, not products and sectors. This is an important distinction since most of the analysis of the impact of automation and globalisation of goods sectors relied on impacts that happened at the level of products. For instance, globotics is not really a threat to Paris-based accounting firms, it is a threat to the office and professional workers performing intermediate service tasks within the accounting firms. To connect the impact on jobs and tasks to things like HICP prices and the slope of the Philips Curve, a mapping is needed between occupations and products and sectors.

All this is by way of an excuse, or apology for the lack of a “wow number” in my paper. I set out on what I thought was a straightforward mission. To take the excellent analysis that had been done in the 2000s for goods trade and apply it to trade in services. On the way I discovered that several substantial data collection, construction, and mapping exercises would be needed before I had a data set that would allow me to map service imports and prices to domestic sectors and eventually to HICP categories.

I close the paper with a plea for a research work programme that would make it easier to track how developments at the level of services imports, on the one hand, and occupations on the other hand, will impact items in the HICP index. If my conjectures are correct, future structural change will be coming into the euro area via changes in service occupations and imported intermediate services.

Such a work programme would likely yield a high reward in the medium term. The argument is straightforward. Central bank policy is premised on the functioning of the local macroeconomy. The functioning of the macroeconomy is influenced by globalisation and automation. Since globalisation and automation are changing – in my view shifting rapidly to more emphasis on services – it is likely that the functioning of the local macroeconomy will also shift. Without much better data, the nature of the shift will be impossible to pin down.

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Discussion of "Globotics and Macroeconomics: Globalisation and the automation of the service sector" by Richard Baldwin

By Barbara Petrongolo[1]

1 The future of trade at a glance

I very much enjoyed the opportunity to read this thought-provoking paper by Richard Baldwin on globalisation in services. The paper convincingly emphasises that services are the future of trade, against a backdrop of stabilising trade in goods. While services have often been overlooked in debates and analyses about globalisation, they generate more than two thirds of global output, they are used as intermediate inputs in every sector of the economy, and trade in services has been growing faster than in trade in goods for over a decade, following a decline in trade costs. As of 2017, distribution and financial services were the most traded services, followed by telecoms, computer services, transport and tourism (WTO, 2019). During the pandemic, transport and tourism services plummeted, but trade in other services continued to expand.

Technological progress has been one key enabler of this transformation. In particular, digital technology is rapidly overcoming the main barriers associated to services trade – namely the need for suppliers and consumers to be in close proximity – and leading innovation and boosting productivity in the sector. Additional factors include policy reforms that reduce institutional barriers to globalisation in services and enhance international competition, and rising demand for online services reflecting education and demographic changes.

Trade in services is rapidly exposing large sectors of the economy to similar processes of global competition and specialisation that have characterised the boom in goods trade started in the early 1990s and accelerated in the 2000s with the emergence of China as an exporting power. The economic literature has closely followed these trends and produced extensive evidence on the impacts of rising goods trade on productivity, employment, inequality and prices in high-income countries, as well as indirect consequences on political and social issues.

The paper lays out novel evidence and discusses the main challenges that economists face to make progress in the understanding of the impacts of services trade on employment and inflation. In a nutshell, unlike for farm and factory goods, there are no hard capacity constraints when it comes to service exports in emerging

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markets, demand is highly elastic in high-income countries, and the relevance of trade could expand further if services sectors become globalised in the near future as manufacturing industries are nowadays. At the same time, data available to economists on the tradability of various services and their import prices is scant.

I will provide a labour economist's perspective on the consequences of globalisation from the viewpoint of importing countries. The rest of this discussion is organised around three points. First, I will summarise some of the available evidence on the labour market consequences of globalisation in goods for rich economies. Second, I will discuss what lessons can be learned from the recent globalisation in goods for the expected impacts of globalisation in services. Finally, I will draw on evidence from an existing scheme of trade in services, the European posting policy, which has introduced international trade in previously non-tradable services.

2 The recent wave of globalisation in goods

The recent growth in goods trade, associated to the burgeoning importance of low-income countries – most notably China – in global trade relationships, has produced rapidly rising competition for manufacturing firms in most high-income countries. Dorn and Levell (2021) summarise evidence on the consequent decline in manufacturing in Europe and the United States, and the associated rise in earnings' inequality along the skill, industry and geographic dimensions.

Importantly, while all studies document a negative impact of the increase in Chinese import competition on the manufacturing employment share in the receiving countries, the magnitudes of these effects vary from a 0.1 percentage point decline per $1000 increase in annual Chinese imports per worker in Germany and Norway, to 0.6 points in the US, 1 in the UK and a 2.1 in Spain (see Chart 1). Job search assistance to displaced workers likely helped limiting employment losses in Germany and Norway, while the high incidence of fixed-term contracts magnified employment responses in Spain.

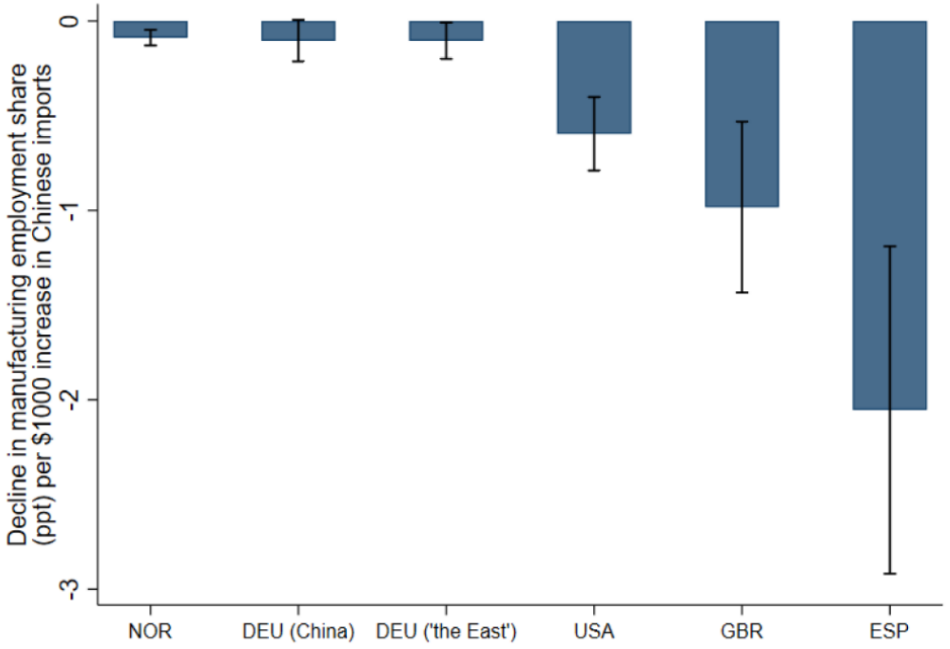
As import competition has been unevenly distributed across industries with varying factor intensities, employment and earnings effects have been more pronounced for low-income, non-college adults and (to a lesser extent) men. In addition, the within-country clustering of import-exposed industries exacerbated pre-existing inequalities across local labour markets, via both direct impacts on those industries and local spillovers resulting from local supply chains and expenditure multipliers.

An additional channel through which trade can shape inequality and welfare is consumer prices. Dorn and Levell (2021) estimate that UK prices fell by about 0.7% for each percentage point increase in Chinese import penetration, and Jaravel and Sager (2021) estimate an impact for the US that is twice as large. In particular, they find that the largest component of the US price decline happened via changes in the price-cost mark-ups of US firms facing stronger import competition – and especially so in industries in which domestic market concentration was initially higher - rather than via lower prices of imported goods. According to the authors' calculations, the

resulting increase in consumer surplus is more than sufficient to compensate those who suffer employment and earnings losses. Finally, changes in consumer prices can have distributional impacts via expenditure channels. While import penetration rose faster for products that sell relatively more to high-income groups (e.g. consumer electronics), prices declined more for products that sell more to low-income groups, such that overall low-income groups benefit proportionally more.

Chart 1

Effect of a unit increase in Chinese import competition on local manufacturing employment across countries



Note. Each bar is the coefficient estimate from a regression of the manufacturing-to-population ratio on the growth of input exposure. Whiskers indicate 95% confidence intervals: Source: Dorn and Levell (2021).

3 Globalisation in services

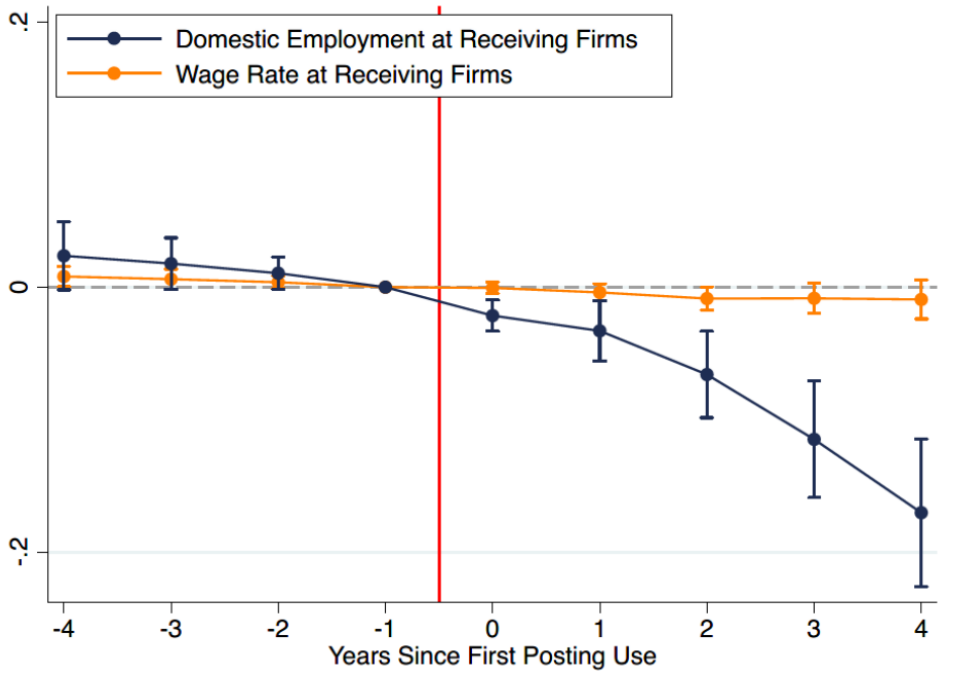
While research on the consequences of services trade in the receiving countries is still in its infancy, can lessons be learned from the observed impacts of goods trade? First, the broad service sector is more intensive in high-educated labour than the manufacturing sector, especially so for “data-driven services” (World Bank, 2021). Thus one would expect that the impacts of import competition in services may not be as concentrated among the less-skilled, as some of the early evidence suggests (Liu and Trefler, 2019). Second, the service sector plays a prominent role in female employment. However women are over-represented in those services that are to date less exposed to international trade (like education, health and social work). Overall, one may therefore expect the import-competition effects of services trade to be more gender balanced than the effects of goods trade. Third, (skill-intensive) services tend to be clustered in urban areas, thus the geographic distribution of trade impacts may be different from what has been observed for goods trade. However, unlike manufacturing, services are extensively used in all sectors of the economy. Hence

impacts of services trade on workers and firm may extend way beyond the domestic service sectors directly exposed to import competition.

Novel evidence on the impacts of trade in low-skill services comes from a recent study of the Europe posting policy (Muñoz, 2022), whereby jobs in sectors traditionally insulated from international trade are offshored "on site", i.e. performed by foreign workers temporarily present in the host economy. These jobs are mostly in construction, cleaning, driving and other manual services. Foreign firms perform services in the customer's country of residence; posted workers remain formally employed by the sending firms but cross the border to perform services in the receiving country. [2] In France, one of the main receiving countries of posted workers within the EU, the number of posted workers currently represents 75% of the total inflow of foreign workers. Muñoz (2022) finds that localities more exposed to the job posting liberalisation of 2004 saw their employment rates decline relative to non-exposed localities. Moreover, detailed firm-level data for Belgium show that the receiving firms on average lose one domestic job for every three posted workers, but wages paid to domestic workers remain unchanged (see Chart 2).

Chart 2

Employment and wages at receiving firms after using poster workers



Source: Muñoz (2022).

I don't know of studies that specifically investigate the impacts of services trade on domestic prices (unsurprisingly so, given data limitations). However there are reasons to believe that the Balassa-Samuelson effect – namely service prices are predicted to rise faster than goods prices because productivity growth is faster in goods, and services are typically not traded – may not hold once services are globalised. At time

[2] Posting is one of the four modes ("namely presence of natural persons") in which trade in services can be performed according to the WTO GATS categorisation.

of mounting concerns over inflation, the key question is therefore whether and how much globalisation in services would lead to price reductions or slower inflation.

4 Conclusions

While reading Richard's paper on the future of globalisation, I could not agree more with his plea for systematic collection of statistics on services trade, and especially import price data. That said, I believe that the current body of work on the impacts of goods trade on receiving countries offers a helpful benchmark for understanding the impacts of services trade. This work has shown evidence that import competition hurts the employment prospects of domestic workers in those industries and tasks most exposed to trade, but it has the potential to increase welfare via beneficial impacts on prices and productivity. While early evidence on services trade suggests that impacts on employment and welfare may be qualitatively similar, winners and losers from new waves of globalisation might be quite different, and the scope of the phenomenon may have much wider reach.

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The effect of rising energy prices amid geopolitical developments and supply disruptions

By Hilde C. Bjørnland[1]

Abstract

Much research has documented how changes in supply and demand cause commodity price fluctuations, with subsequent effects on the global economy. This paper puts the recent energy price surge in perspective amid geopolitical developments and supply disruptions, and analyses the effects on global activity and inflation, focusing in particular on Europe. It highlights the importance of inflation expectations for transmitting energy shocks to inflation, analyses to what extent such energy shocks can have a significant long-lasting effect on actual inflation, and discusses the new monetary policy challenges of stabilising inflation in the wake of the current volatile situation.

1 Introduction

During a few months in 2020, oil prices (i.e., Brent blend) fell by more than 85 percent, from 68 USD dollars per barrel (January 2020) to 10 USD per barrel (April 2020), as energy demand collapsed during the severe economic downturn in the pandemic. Since then, oil prices have gradually increased, at first following the economic recovery in 2020/2021 when the world opened up after the lockdowns, and then with rising geopolitical tensions and subsequent war in Ukraine due to Russia's invasion in February 2022, see Chart 1. The higher oil prices have, together with the rise in other commodity prices, contributed to rising inflation expectations and inflation across many countries. However, it is not only the *level* of oil and commodity prices that has increased. *Volatility* has also increased drastically in recent months, giving concerns that the world will face a new global economic recession.

This paper looks at the recent energy price changes, and analyses the effects on economic activity and inflation, focusing on Europe in particular. Since the seminal contribution of Hamilton (1983), a growing oil-macroeconomic literature has predicted an inverse relationship between oil price changes and economic activity in oil importing countries across the world. However, although the existence of this negative relationship is well established by now, there has been substantial disagreement in the literature as to the magnitude of the relationship. It has been shown to be dependent

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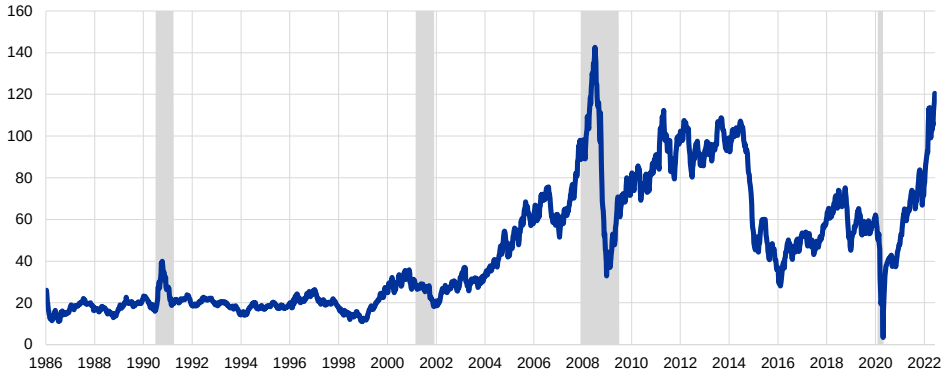
on the causes of the energy price increase, the volatility of energy prices, country differences, such as the share of energy in consumption, industry structure in the countries/regions affected, and the role of economic policy to counteract the inflationary effect of the higher oil prices.

Chart 1

Crude oil price changes and U.S. recessions



Source: Fred database, St. Louis Fed.
Note: West Texas Intermediate (WTI) – Cushing Oklahoma. Shaded areas indicate U.S. recessions.

In this paper, I analyse the energy price – macroeconomic relationship by providing a thorough review of the literature, before zooming in on the recent events that have driven up oil and gas prices, and increased their volatility. As oil and gas are commodities traded in the global market, I will analyse and discuss global effects, before turning to discuss effects for European countries and the implication for monetary policy in the euro area.

I have six key takeaways:

First, the effect of higher oil prices depends on the sources of shocks, country structure and geography. Historically, European countries have been among the most negatively affected by rising oil prices, most likely due to the high dependence on oil and gas in production and consumption. On average, a 10 percent increase in oil prices due to geopolitical tensions or supply constraints will reduce GDP in the euro area by 0.5 percent after two years. Hence, a 50 percent increase in oil prices, therefore, has the potential to reduce GDP in the euro area by 2.5 percent, all other things being equal. The negative effect can be even larger when oil price volatility is also high, due to e.g. elevated uncertainty, which resembles the situation today.

Second, the transmission of oil price shocks to the U.S. economy has changed with the shale oil boom, and non-oil activity, employment and wages in many manufacturing-intensive states now increase following oil price increases. So far, there is little to suggest the real effects will spill over to European countries, as the direct trade linkages are likely to have a modest impact on activity in Europe. Nevertheless, the shale oil revolution might be beneficial to net oil importers by supporting non-OPEC supply growth and thus, mitigating oil price volatility.

Third, inflation expectations and the associated pass-through of oil price shocks on inflation depend on demand and supply conditions in the global oil market. Demand for

oil associated with unexpected large global economic activity shocks elicits a persistent response in both expected and actual inflation. In contrast, when the economy is hit by brief shocks to oil prices due to supply etc., both expected and actual inflation initially increase but then gradually revert to zero. Recent findings suggest we are seeing a mix of demand and supply drivers this time, and that the oil (supply) price shocks have been more persistent than in the past, giving rise to increased inflation expectations.

Fourth, the negative contribution of the oil price shocks on economic activity and inflation is exacerbated when oil price volatility is high, and we find a clear and independent role for oil price shocks in the past and present recessions. Furthermore, the effects of oil price shocks on inflation are smaller when policymakers respond strongly to inflation (i.e., they are 'hawkish'), yet, when volatility is also high, there is still a substantial share of inflation being explained by the oil price shocks. This suggests that during periods of high oil price volatility, stabilising inflation is difficult. We therefore emphasise the importance of being swift in the policy response early on, to prevent inflation expectations and inflation from becoming persistent.

Fifth, the recent energy price increase is due to a combination of increased demand and disruptions of supply. The persistence of shocks combined with the elevated volatility will erode growth in Europe and increase inflation further. With a multiple of commodity prices on a persistent rise, food prices, in particular, the probability of a recession scenario for Europe has increased substantially. Will we also see a repetition of the stagflation of the 1970s? The energy shocks are smaller than the 1970s oil shocks, but involve more commodities and are more persistent. So the risk of more persistent inflation is there. Yet, more credible policy frameworks and nominal anchors, make stagflation like the 1970s less likely. However, this hinges on whether the monetary policy responses have been swift enough to prevent inflation expectations from building up further, leading to a wage-inflation spiral. This should have been the number one priority for policymakers for some time now.

Sixth, while central banks should respond swiftly to prevent inflation expectations from building up, elevated oil prices and contractionary policy will reduce asset prices and economic growth further out. This suggests more troubling and challenging times ahead for European economies and hence also for policymaking. During periods of high oil price volatility, stabilising inflation is particularly difficult, and the costs in form of low growth and employment can be large. Going forward central banks need to balance growth and inflation carefully.

The paper is organized as follows. I start by providing a review of the growing body of literature on the oil-macro relationship in Section 2, taking into account sources of shocks, global demand, short-run price elasticity, and the role of oil exporters versus importers. Section 3 reviews the literature analysing the role of inflation expectation in transmitting oil price shocks to inflation and examines recent empirical evidence. In Section 4 I discuss how high oil price volatility exacerbates the adverse effects of oil price shocks. Section 5 analyses the recent oil price increase in more detail and its effect on economic activity and inflation in Europe in particular. In Section 6 I discuss implications for monetary policy, while Section 7 concludes.

2 The oil price - macroeconomic relationship

Since the seminal contribution of Hamilton (1983), a growing body of literature has predicted an inverse relationship between oil price changes and aggregate activity in several countries, see for instance Burbidge and Harrison (1984), Gisser and Goodwin (1986), Shapiro and Watson (1988) and Bernanke, Gertler, and Watson (1997) for some early studies. Higher energy prices typically lead to an increase in production costs and inflation, thereby reducing overall demand, as both consumers and producers have to pay more for the imported energy products and the complementary products to energy.

Although the existence of this negative relationship is well established by now, there is, however, a substantial disagreement as to the magnitude of the relationship, and what it implies for policymakers. For instance, while Hamilton (1983) found that all but one U.S. recession since World War II had been preceded by a dramatic increase in the price of crude oil, Bernanke, Gertler, and Watson (1997) argued that the recessions that followed the big oil shocks were not entirely caused by the oil shocks themselves, but rather by the Federal Reserve contractionary responses to inflationary concerns, attributable in part to the oil shocks. Hamilton and Herrera (2004), however, later challenged the conclusion in Bernanke, Gertler, and Watson (1997). Instead, they showed that both the nature and the magnitude of the policy actions necessary for the Fed to have the required negative effects on economic activity were not consistent with historical evidence. Hence, the finding that oil price shocks have negative effects on economic activity prevailed according to Hamilton and Herrera (2004). However, as we will see in this paper, the discussion regarding the magnitude of the oil price effects, and the role of monetary policy in dampening the effects, is still very much alive today.

2.1 Demand and supply shocks as drivers of oil prices

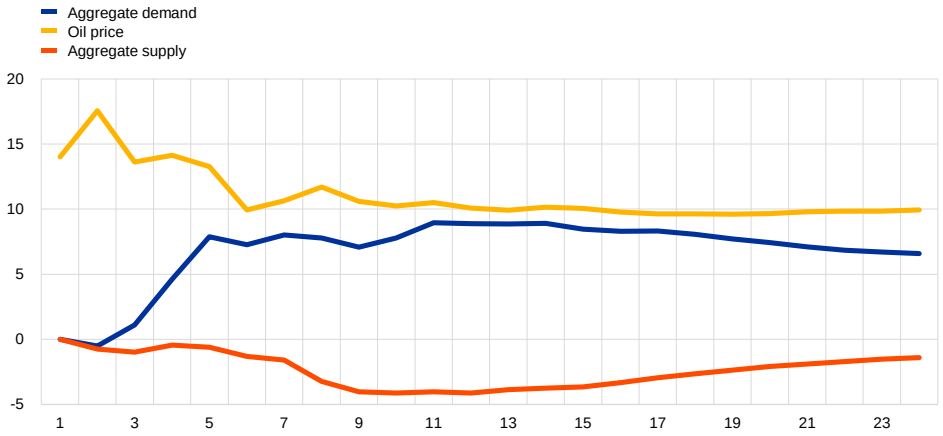
Common to the papers cited above is that they typically focus on the response of macroeconomic aggregates to exogenous changes in the price of oil. Subsequent papers have emphasised the importance of allowing oil prices to be modelled as an endogenous process, see for instance the early paper by Ahmed, Rosser and Sheehan, R. (1988) that analyses the endogeneity of oil prices by changing the order of variables in a four variable vector autoregressive (VAR) model, and the paper by Hooker (1996) for an early study that tests whether oil prices are endogenous using granger causality tests.

In one of the first studies that address the endogeneity issue explicitly, Bjørnland (2000) uses a structural model that allows oil prices and macroeconomic variables to be jointly determined by demand and supply shocks. In particular, Bjørnland (2000) estimates a structural vector autoregressive (SVAR) model for the U.S., Germany, UK and Norway over the period 1960/1966 - 1994, where oil prices, GDP and unemployment are driven by demand, supply and oil (specific) price shocks. The model is identified using a mix of short-run and long-run identifying restrictions. In so doing, the model extends Blanchard and Quah's (1989) model of demand and supply

to the oil market.[2] Doing so, the paper finds that oil price shocks have a persistent negative effect on GDP in all countries but Norway.[3]

Chart 2

The effects of demand, supply and oil market shocks on real oil prices



Source: Bjørnland (2000).
Note: The effect of aggregate demand, aggregate supply and oil price shocks on the level of the real oil price. The horizontal axis measures quarters.

Charts 2-3 provide more details. In particular, Chart 2 displays the responses in the real oil price to aggregate demand, supply and oil price shocks, based on an average of the responses in the abovementioned countries. As discussed above, all shocks can potentially affect oil prices, and in Chart 2, we see that all shocks do, but to a varying degree: Oil price shocks have a persistent positive effect on real oil prices, demand shocks push up oil prices for a prolonged period before the effect fades out, while supply shocks (that can increase output in each country permanently), have negative, but marginal effects on oil prices.

Chart 3a illustrates the effect of demand, supply and oil price shocks on GDP in Germany, while Chart 3b compares the effect of the oil price shock on GDP in Germany, the UK and the US.[4] In the figure, we are examining a one standard deviation shock, i.e., an impact increase in oil prices by approximately 14 percent, see Chart 2.

2 The SVAR model is identified using a mixture of short-run and long-run restrictions (for each country), assuming demand shocks cannot have a long-run effect on real GDP as in Blanchard and Quah (1989). Oil prices can respond to all shocks, but with a delay. Note that no restrictions are imposed on the long-run effects of shocks on real oil prices. However, one would expect demand shocks to also have zero influence on the real oil price in the long term, as the domestic price level will adjust to the new situation. By inspection, this is supported.

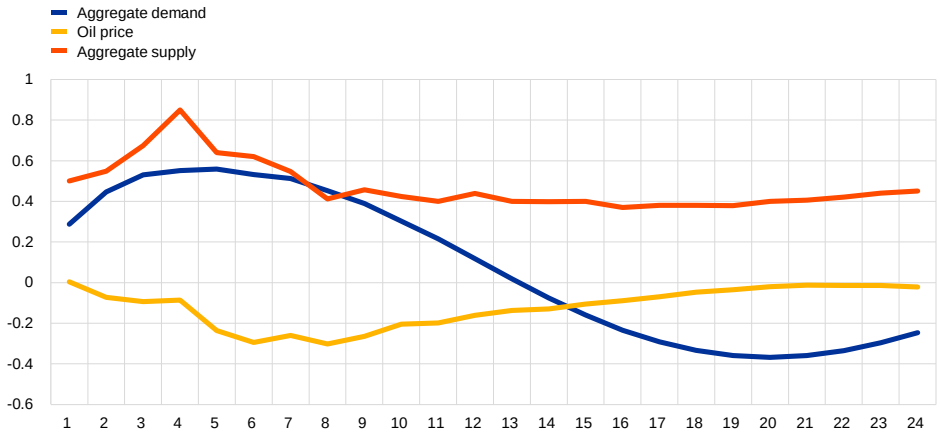
3 The result for Norway is explained by the fact that Norway is a major oil exporter, benefitting from higher oil prices.

4 Results for Norway are not displayed here, see Bjørnland (2000) for details.

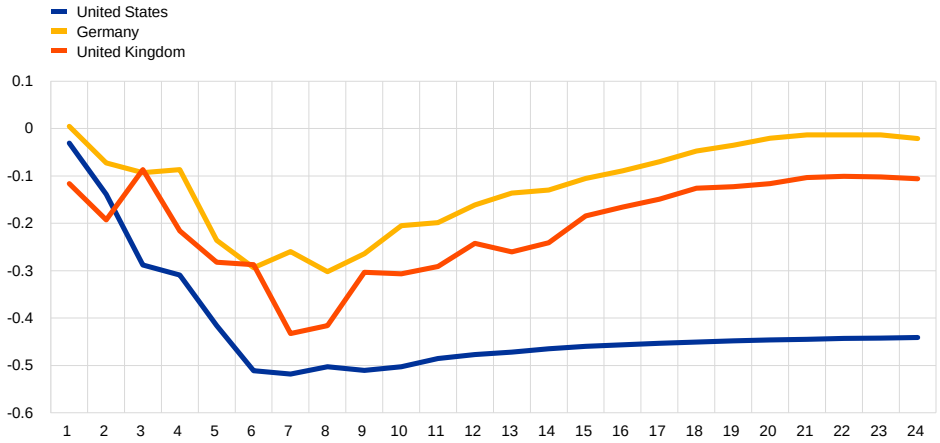
Chart 3

The effect of oil market shocks on GDP

a) The effect of aggregate demand, supply and oil price shocks on GDP in Germany



b) Comparing the effect of oil price shocks on GDP in Germany, the UK, and US



Source: Bjørnland (2000).
Note: The top graph shows the effect of aggregate demand, aggregate supply and oil price shocks on GDP in Germany. The bottom graph compares the effect of the oil price shock on GDP in the US, Germany and the UK. The shock is normalized to increase oil prices on impact by a standard deviation (approximately 14 percent, c.f. Chart 2). The horizontal axis measures quarters.

Starting with Chart 3a, we see that demand and supply shocks have the expected effects on GDP in Germany[5]; a demand shock increases activity temporarily, while the effect of a supply shock is to increase GDP permanently. An oil price shock, however, reduces output temporarily (see Bjørnland 2000 for more details). These results suggest the importance of separating aggregate supply and demand shocks from (adverse) oil price shocks, as they have very different effects on economic activity.

Turning to Chart 3b, we compare the effects of the oil price shock on GDP across countries. We see that in all three countries, GDP falls following the oil price shock. U.S. responds the most strongly, with GDP falling by 0.6 percent after two years, and this effect is stronger than what was found in related studies where the oil price is exogenous, i.e., Shapiro and Watson (1988). In the U.K. and Germany, GDP falls by

[5] Similar graphs can be provided for all countries.

approximately 0.4 and 0.3 percent respectively after two years, before the effect gradually dies out.

These results illustrate the importance of modelling oil prices and the macroeconomy together. Furthermore, the results also illustrate that when controlling for aggregate demand and supply shocks, an adverse oil price shock that increases oil prices will have a negative effect on real activity in European countries, as seen here for Germany and the UK.

2.2 Global shocks in the oil market

The abovementioned analysis captured the reverse causality from the macroeconomy, (via demand and supply shocks), to the oil market. Still, the model is limited in the sense that it identifies these demand and supply shocks within each country (although these shocks may of course be correlated across countries, as the business cycle is synchronized).

Subsequently, Barsky and Kilian (2002) and Kilian (2009) have pointed out the importance of allowing for a reverse causality from the global economy to the oil market (not just individual countries as in Bjørnland (2000)). In particular, Kilian (2009) has emphasised the role of the global economy as the main driver of oil prices, which needs to be modelled explicitly. Doing so, the paper shows that the price of oil is driven by distinct global demand and supply shocks to the oil market, which can have very different effects on the real price of oil and hence on the macroeconomy. The paper further finds an important role for global demand as a driver of oil prices over the recent decades.

In the years following the influential paper of Kilian (2009), much of the literature evolved around identifying the causes of oil price increases and analysing the effects of various structural oil market shocks on different economies, see e.g. Hamilton (2009), Lippi and Nobili (2012), Kilian and Murphy (2012, 2014), Cashin, Mohaddes, Raissi, and Raissi (2014), Aastveit (2014), Aastveit, Bjørnland and Thorsrud (2015) and Stock and Watson (2016) among many others.

In Kilian (2009), global real economic activity is a key determinant behind movements in macroeconomic variables and commodity prices. To approximate global activity, Kilian (2009) constructed an indicator based on the cost of shipping. The idea was that the market for shipping would be driven by demand and supply shocks. Since then, the indicator has been used in multiple studies. More recently, however, this indicator has been criticised on various grounds, and alternative indicators for global real activity has been proposed in the literature, see e.g. Aastveit, Bjørnland and Thorsrud (2015), Baumeister and Hamilton (2019), Ravazzolo and Vespignani (2020), Hamilton (2021) and Delle Chiaie, Ferrara and Giannone (2022). In the following I will base my discussion on Aastveit, Bjørnland and Thorsrud (2015), focusing in particular on results for countries in Europe.

During the last decades, the global economic landscape has shifted dramatically. Emerging market economies have experienced rapid growth in economic activity and

international trade, outperforming most developed countries across the world. Building on Kilian (2009), in Aastveit, Bjørnland and Thorsrud (2015) we examine explicitly the importance of emerging versus developed economies as drivers of the real price of oil, by replacing Kilian's global indicator with separate factors for activity in emerging and developed economies. For this purpose, we develop a factor-augmented vector autoregressive (FAVAR) model. The model is identified with a mixture of sign and zero restrictions, see Aastveit, Bjørnland and Thorsrud (2015) for details.

In particular, the paper identifies four structural shocks that have the potential to change oil prices and macroeconomic variables, two shocks related to global demand: Demand in developed economies and demand in emerging economies, a shock to oil supply (that capture unexpected shocks in the global supply of oil), and an oil specific (demand) shock. The oil-specific (demand) shock picks up innovations to the real price of oil that cannot be explained by the three aforementioned shocks. Kilian (2009) argues that such shocks primarily capture precautionary demand for oil driven by the uncertain availability (scarcity) of future oil supply. This is also the interpretation we take in the paper.

Identified in this way, the paper has two goals. First, create two distinct 'global' activity indicators that separate between shocks to demand in emerging and developed economies. This allows one to determine whether the increased demand for oil originates from emerging economies, which have been growing at a pace twice that of the developed economies, or from the developed world, which historically has been the main consumer of oil. Second, having established where demand originates from, the paper analyses how different geographical regions respond to the various oil market shocks that drive up oil prices.

Chart 4a and b illustrate the results. In particular, Chart 4a graphs the effects of demand shocks in emerging and developed economies (that increase oil prices) on GDP across regions. The shocks are normalized to increase activity in either developed or emerging countries by 1% initially, see Aastveit, Bjørnland and Thorsrud (2015) for details. Chart 4b shows the responses in GDP to the two other shocks (that also increase oil prices); oil supply and oil-specific shocks.

There are three main findings:

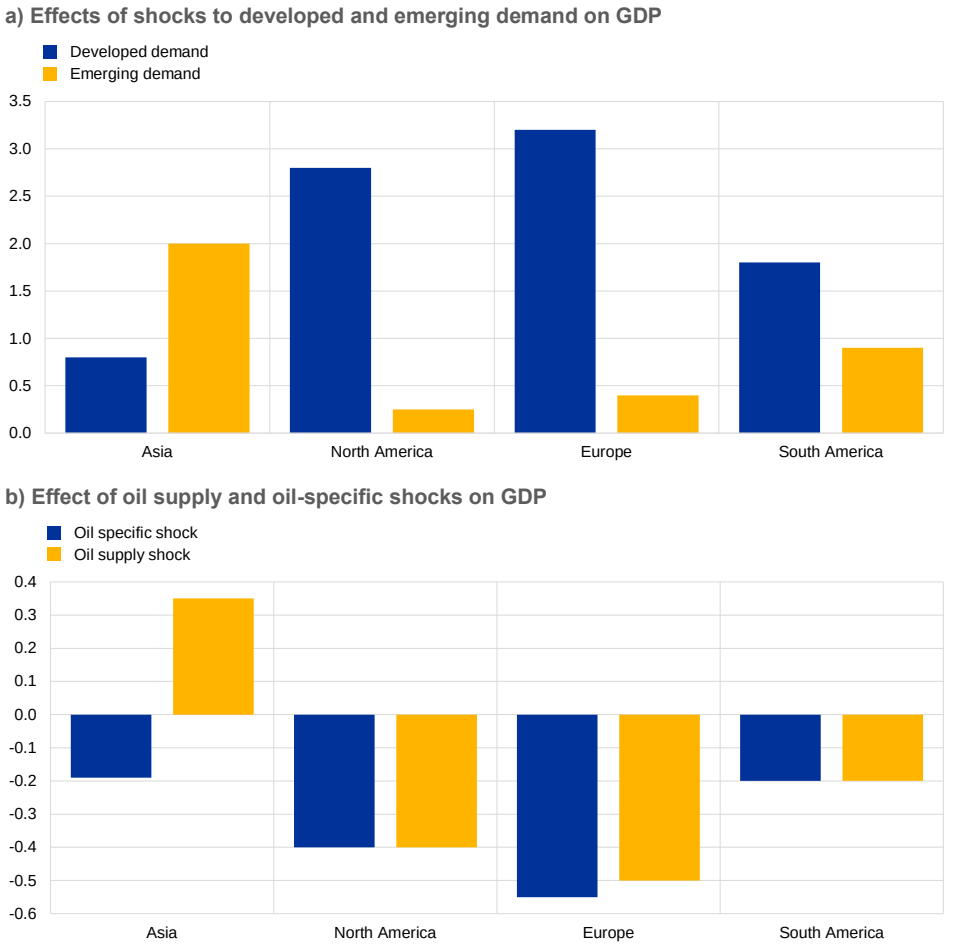
First, we show in the paper that demand shocks in emerging and developed economies together account for 50-60 percent of the fluctuations in the real price of oil over the last decades. Furthermore, demand shocks in emerging markets, particularly in Asia, are more than twice as important as demand shocks in developed economies in explaining fluctuations in the real price of oil and global oil production.

Second, and as seen in Chart 4a., all countries respond positively to either of the demand shocks that drive up oil prices, although the response varies across countries and regions. This emphasises the importance of understanding better where demand is coming from when analysing the effect of an oil price increase.

Third, countries respond differently to the two adverse oil market shocks. [6] We see that while economic activity in Europe and the US declined substantially following the two oil market shocks, economic activity in emerging markets in Asia and South America declined by a substantially smaller amount, and in some cases, GDP temporarily increases with the higher oil price, c.f. Chart 4b.

Chart 4

Effect of oil market shocks (that increase oil prices) on GDP across regions



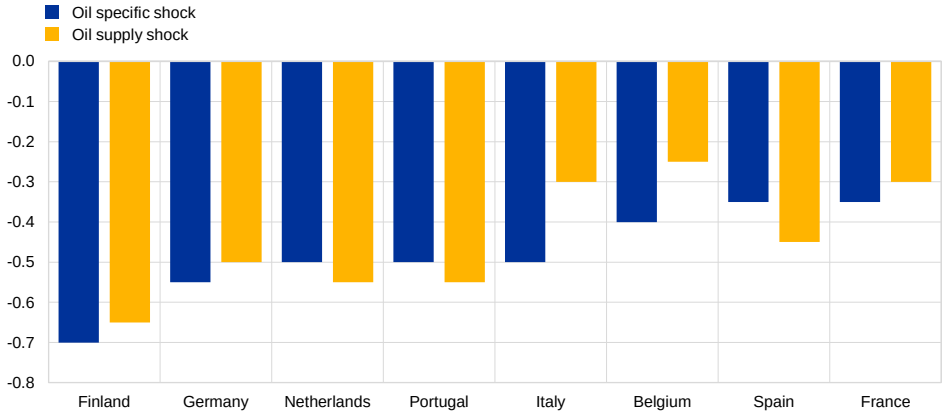
Source: Aastveit, Bjørnland and Thorsrud (2015).
Note: Effect of shocks on the level of GDP in Asia, Europe, North America and South America. All shocks increase oil prices. The developed and emerging demand shocks are normalized to increase activity in developed and emerging countries by 1% on impact, respectively. The oil supply shock is normalized to decrease oil production by 1% (which eventually increases oil prices by 10 percent), while the oil-specific demand shock is normalized to increase the real oil price by 10% on impact. The y-axis reports the median response at the 2-year horizon.

What explains the different results? Aastveit, Bjørnland and Thorsrud (2015) show that some of these differences relate to country characteristics. Typically, countries with a high investment share of GDP and a high degree of openness, are less negatively affected by the adverse oil market shocks than countries with a high consumption share of GDP (i.e., Asia versus Europe). This emphasises the importance of separating demand and supply shocks when understanding the effect of an oil price increase, but also to analyse these effects across countries and regions.

6 Note that both shocks increase oil prices, although supply shocks have a more delayed effect (the peak effect is after two years).

Chart 5

Effect of oil supply and oil-specific shocks on GDP in the Euro area



Source: Aastveit, Bjørnland and Thorsrud (2015).
Note: Effect of oil supply shocks (yellow) and oil-specific shocks (blue) on the level of GDP in various countries in the euro era. The oil supply shock is normalized to decrease oil production by 1% (which eventually increases oil prices by 10 percent), while the oil-specific demand shock is normalized to increase the real oil price by 10% on impact. The y-axis reports the median response at the 2-year horizon.

In Chart 5, I finally zoom in on the responses on GDP in some selected countries in the euro area to the adverse oil specific and supply shocks. The graph shows that responses are consistently negative, although somewhat dispersed. In particular, GDP of countries such as Finland and Germany respond more negatively than GDP of France to adverse oil market shocks.

These results highlight heterogeneity in terms of the effects of oil market shocks on the macroeconomy, with emerging countries in Asia and South America being more important drivers of the real oil price, but less affected by the adverse oil market shocks. In contrast, most European countries respond negatively to adverse oil market shocks, and more so on average than the US for equally sized shocks. It also emphasises that once one has accounted for the difference in demand from emerging and developed economies, both supply and oil-specific shocks have an important negative effect on real activity in most developed countries, in line with what was already seen in Graph 3 above (based on results in Bjørnland (2000)).

Although one should be careful in interpreting too much into the difference in responses, there are some possible explanations for the overall results. A key parameter in determining the consequences of an oil price increase is the share of energy purchases in total expenditures. In particular, a low expenditure share combined with a low price elasticity of demand will imply very small negative effects of an oil price increase, see Hamilton (2009). While the oil consumption share in most industrial economies has generally been flat or declined slightly since the 1980s, it has risen sharply in emerging countries such as China. However, as China began from a much lower level, per capita oil consumption in developed countries is still much larger than in China. This may suggest why emerging countries respond less negatively to the adverse oil supply or oil-specific shocks than i.e., countries in Europe or the US, see Aastveit, Bjørnland and Thorsrud (2015) for more details.

Also, as pointed out by Edelstein and Kilian (2009) and Hamilton (2009), a key factor transmitting energy price shocks to the domestic economy has been the automobile sector. In particular, higher energy prices have typically implied an increase in the demand for energy-efficient small cars at the expense of energy-inefficient large cars (SUVs). This has benefitted producers in emerging countries in Asia, in particular. Going forward, more and more manufacturers in advanced countries are developing energy-efficient cars and equipment, thereby also making car manufacturing producers and consumers in the developed world less vulnerable to oil price fluctuations.

For the European countries, the difference between countries could also relate to the share of energy in consumption, with countries such as Finland, Germany and Belgium having a larger share of oil in consumption (per capita) than France. However, the differences are not large, and not always statistically significant.

So far I have focused on the aggregate macroeconomic effects of oil price changes among primarily oil consumers. In the next section, I will look more into details on the producer side by discussing short-run price elasticity, before discussing the importance of the U.S. once again becoming and oil exporter in Section 2.4.

2.3 The short-run price elasticity

Until recently, oil price-macro papers have often assumed the short-run price elasticity of aggregate oil production to be zero, or at least, small, when identifying oil market shocks, see for instance Kilian (2009) and Kilian and Murphy (2012, 2014), and a series of other papers building on the seminal paper of Kilian (2009), including those cited above. Recent turbulence in the oil market has again sparked renewed interest in the question of how oil prices affect the macroeconomy and vice versa. In particular, the role of supply and demand in generating fluctuations in the price of oil (and the macroeconomy) has been scrutinized, see Baumeister and Hamilton (2019), Caldara, Cavallo and Iacoviello (2019) and Känzig (2021) for some recent influential papers discussing the role of elasticities. I will briefly discuss these below.

Baumeister and Hamilton (2019) criticise the use of restrictive identifying assumptions to identify the oil market shocks, and use instead Bayesian inference with prior information about both elasticities and the equilibrium when identifying the models. The Bayesian inference and identification have the benefit of being based on sign restrictions that are less restrictive than commonly used alternatives in the literature, such as e.g. Kilian (2009) and Kilian and Murphy (2012, 2014) that respectively assume zero or small short run oil supply elasticity, and further has the advantage of accounting for uncertainty about the identifying assumptions themselves. As highlighted by Baumeister and Hamilton (2019), this is crucial for identifying demand and supply shocks to the oil market (see also Baumeister and Hamilton (2015) for general theory). Doing so, they find that supply shocks appear to be more important than what has been found in earlier studies, although many of the previous findings from the literature prevail.

In a related study, Caldara, Cavallo and Iacoviello (2019) use external information from a large panel of countries to impose restrictions on the short-run price elasticities of oil supply and oil demand to identify a structural VAR model of the global oil market. Doing so, they also find an increased role for oil supply shocks in explaining oil prices relative to earlier studies. As it turns out, shocks to oil supply and shocks to global demand each account for about one-third of the fluctuations in oil prices at business cycle frequencies. Further, an increase in oil prices driven by oil supply shocks reduces industrial production in developed countries, while it boosts industrial production in emerging economies, thus helping explain the muted effects of changes in oil prices on global economic activity recently. Interestingly, this is consistent with the findings in Aastveit, Bjørnland and Thorsrud (2015), see Chart 4 above.

Finally, Känzig (2021) proposes a novel identification strategy to shed light on the role of oil supply expectations. Using variations in futures prices around OPEC announcements, the paper identifies oil supply news shocks. Doing so, it finds that oil supply news shocks can have significant effects on economic activity and prices, pointing to a strong channel operating through supply expectations.

The conclusion in the abovementioned papers can be supported by recent evidence from micro studies. While assuming a zero oil supply elasticity may be consistent with the behaviour of conventional oil producers, c.f. Anderson, Kellogg, and Salant (2018), new results for shale producers documented in Bjørnland, Nordvik and Rohrer (2021), Bornstein, Krusell and Rebelo (2021) and Aastveit, Bjørnland and Gundersen (2022) suggest shale oil producers are forward-looking and respond quickly to news about future price signals. This supports exploring alternative identification schemes that relax the assumption of a zero short-run oil supply elasticity, such as the approach recently developed in e.g. Baumeister and Hamilton (2019).

Hence, there is recent evidence that supply shocks matter, and most likely more so than earlier studies suggested. This will have implications for how we should expect the recent supply disruptions in the oil market to affect economic activity in Europe, as we will discuss below in Section 5.

2.4 Energy exporters and importers

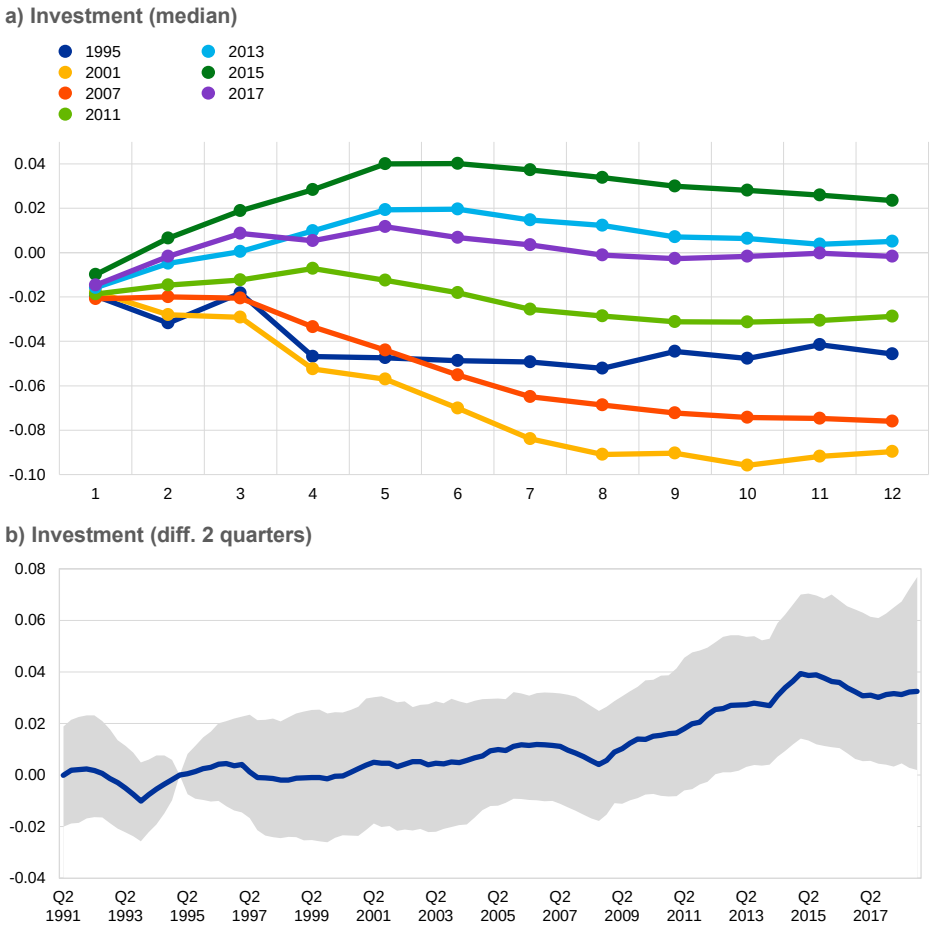
Many papers have pointed out that oil exporters may benefit from higher oil prices through higher income, increased activity and spillovers to other industries, see e.g., Peersman and Van Robays (2012), Bjørnland and Thorsrud (2016), Bjørnland, Thorsrud and Torvik (2019) and Arezki, Ramey and Sheng (2016) for some recent studies.

More recently, the US has gained momentum as an oil and gas producer due to the massive surge in the production of oil and gas from shale rock deep underground. This has in a few years made the United States the world's largest oil and gas producer. Such a transition has not happened by itself. Building up productive capacity requires capital, technology, labor, skills and Learning By Doing (LBD) over a prolonged period of time, and with potential spillovers to other industries, see e.g. Allcott and Keniston (2018) analysing local industries. To the extent that these spillovers affect production

and employment across the U.S. states, could the relationship between oil prices and aggregate U.S. activity also change?

Chart 6

Effect of oil price shock on Non-residential (non-oil) investment in the U.S



Source: Bjørnland and Skretting (2022).
Note: Top frame: posterior median of impulse responses at different points in time. Bottom frame: the difference between impulse responses after 2 quarters, in the period 1991:Q1-2018:Q4 relative to the responses in 1995:Q1, with 16-th and 84-th percentiles. All responses are reported in percent.

This question is addressed by Bjørnland and Skretting (2022). To consistently analyse the effects across industries, geographical areas and time, we identify various shocks to the oil market, while also accounting for heterogeneity in several dimensions. Previous time series studies addressing this issue for the U.S. have typically been aggregated and focused on only a few macroeconomic variables.

Doing so, we find substantial changes in the way oil-specific price shocks are transmitted to the U.S. economy. In particular, we find that higher oil prices have positive spillovers to many industries in the U.S., effects that were not present before the shale oil boom: non-oil non-residential business investment, manufacturing production, and non-oil employment in both oil-producing and many manufacturing-intensive states increase following an oil price rise, see Chart 6 for impulse response for investment at a different point in time (top), and test of significance of changes in responses (bottom). The reason is simply that the U.S. has

increased its reliance on oil, not as a consumer, but by becoming the world's largest oil producer.

Going forward, policymakers need to take into account that the transmission of oil price shocks in the US has changed with the shale oil boom so that in the oil-producing and manufacturing-intensive U.S. states, an oil price increase can stimulate activity, demand and income, and therefore also potentially push up domestic inflation, a topic we will return in the next section.

However, so far there is little to suggest the real effects will spill over to European countries, as the direct trade linkages are likely to have a modest impact on activity in Europe. Nevertheless, the shale oil revolution might be beneficial to net oil importers by supporting non-OPEC supply growth and thus, mitigating oil price volatility (again see Bornstein, Krusell, Rebelo, 2021).

To sum up the discussions in the various parts of Section 2, we have documented strong negative effects on the real economy from oil supply/oil-specific shocks, while demand shocks increase both oil prices and activity. We have also shown that the negative effects from oil supply shocks seem to prevail across most studies, in particular when one uses identifying restrictions that allow short-run supply elasticity to divert from zero. Doing so, many recent studies have found an increased role for adverse supply shocks in generating fluctuations in the price of oil, and hence stronger negative effects on the real economy.

We have further shown that there is evidence of heterogeneous effects across regions following oil supply shocks, with Asia being the least negatively affected (in some instances also positively affected), followed by the US and Europe. In Europe, we have shown that countries with a larger share of energy in consumption are also more negatively affected.

Finally, we have shown that as the US has now become a major oil producer, there is evidence of positive spillovers following an oil market shock to various industries within the U.S. However, so far there is little to suggest the real effects will spill over to European countries. Nevertheless, the shale oil revolution might be beneficial to net oil importers by supporting non-OPEC supply growth and thus, mitigating oil price volatility.

3 Oil prices: the role of inflation expectations and inflation

So far, I have primarily discussed the real effects of oil price shocks. As eluded to above, higher energy prices typically lead to an increase in production costs and inflation, thereby reducing overall demand, as both consumers and producers have to pay more for the imported energy products and the complementary products to energy. This is called the cost channel, as oil price increases directly feed through to prices via higher costs of production. In addition, oil price shocks can also contribute to higher inflation by rising inflation expectations. In particular, inflation expectations can indirectly pass through the oil price increases to inflation via price setting and wage bargaining mechanisms. If so, this suggests that the anchoring of inflation

expectations will be necessary for achieving stable prices, making the degree to which expectations facilitate the inflation pass-through of oil price shocks an important policy question.

So far, there is currently no consensus on the empirical strength of the inflation expectation mechanism following oil price changes. For instance, while Coibion and Gorodnichenko (2015) argue that the high sensitivity of household inflation expectations to oil price shocks in the US can help explain the missing deflation puzzle of the Great Recession, other studies such as Blanchard and Gali (2007) and Wong (2015) suggest that this mechanism is weak at best, and may have altogether disappeared since the 1990s.

In a recent study, Aastveit, Bjørnland and Cross (2022) question whether inflation expectations and any associated oil price pass-through depend on demand and supply conditions underlying the global market for crude oil. The question is motivated by the idea that households may form their expectations of inflation differently when faced with long sustained increases in the oil price, such as the early millennium oil price surge of 2003-2008, as compared to short and sharp price increases that characterised much of the twentieth century. If this hypothesis is true, then it may better help explain how oil price shocks propagate throughout the economy in recent periods.

To model the relationship between oil prices, inflation expectations and actual inflation, Aastveit, Bjørnland and Cross (2022) extend the SVAR model of the global market for crude oil developed in Baumeister and Hamilton (2019) to include monthly measures of expected and actual inflation in the US.[7] The Bayesian inference and identification has the benefit of being based on sign restrictions that are less restrictive than commonly used alternatives in the literature, c.f. the discussion above in Section 2.3.

Doing so, Aastveit, Bjørnland and Cross (2022) confirm previous findings that inflation expectations are sensitive to oil price shocks. In addition, we also provide novel insights that the degree of sensitivity depends on the underlying source of oil market shocks. In particular, we show that demand for oil associated with unexpected large global economic activity shocks, such as the early millennium oil price surge of 2003-08, elicits a persistent response in both expected and actual inflation. In contrast, when the economy is hit by shocks to oil supply, consumption demand, or inventory demand, both expected and actual inflation initially increase but then gradually revert to zero.

The results suggest that how households form their expectations differs depending on the type of oil price shock underlying the global market for crude oil, or more precisely, the persistent effect of the shock on inflation expectations and inflation.

Having shown that both expected and realized inflation are sensitive to oil price shocks, Aastveit, Bjørnland and Cross (2022) investigate their relative effects during

[7] The variables in the inflation block are measured as in Coibion and Gorodnichenko (2015) and Wong (2015): Inflation expectations are measured by the median one-year-ahead inflation expectations Michigan Survey of Consumer Inflation Expectations. Inflation is the annualized month-on-month rate of change in the US consumer price index (all items).

some important economic periods. They find that much of the fluctuations in expected inflation are accounted for by unanticipated fluctuations in demand for crude oil. For instance, there is a close mapping between consumption demand and inflation expectations during the 1997/98 Asian Financial Crisis, while demand from economic activity played a key role in driving the persistent increases in expectations throughout the oil price surge of 2003-08 and the subsequent collapse in expectations in 2009. Finally, consumption and economic activity shocks jointly explain the persistent reduction in inflation expectations since the oil price drop of 2014/2015.

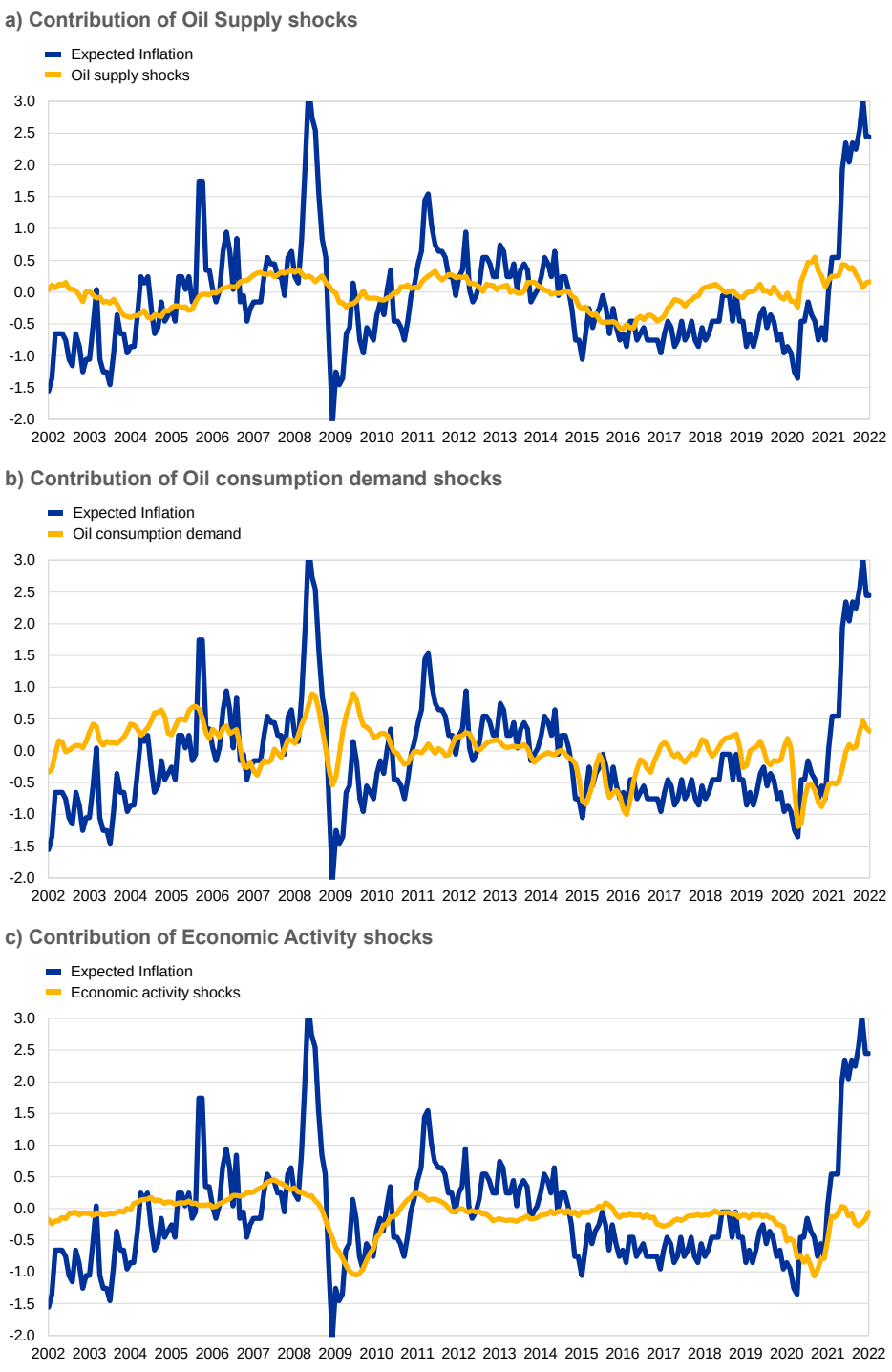
Below we have updated the model discussed above to include data throughout 2021. Chart 7 shows the historical decomposition for expected inflation, using the extended sample. Adding a few additional years, we confirm previous results, but now also clearly show that oil price shocks have had an important effect on the elevated inflation expectations in the recent two years. In particular, oil supply and oil consumption demand have been fuelling a large part of inflation expectations, and subsequently inflation in the last two years, c.f. Chart 7.

Hence, these results support existing evidence that inflation expectations are sensitive to oil price shocks. Furthermore, the degree of sensitivity depends on the underlying source of the oil market shock. In particular, demand for oil associated with unexpected large global economic activity shocks, such as the early millennium oil price surge of 2003-08 elicits a persistent response in both expected and actual inflation. In contrast, when the economy is hit by shocks to oil supply and consumption demand, the effects on expected and actual inflation are more short lived. Despite this, there is clear evidence that the recent oil market shocks (oil supply and consumption demand) have increased inflation expectations for a more prolonged time, c.f. Chart 7, although other shocks have also played a role. The persistence of the shocks and subsequent responses suggest that the oil market shocks may feed into inflation, through elevated inflation expectations.

On a final note. We have shown that how households form their expectations differs depending on the effect of the oil price shock underlying the global market for crude oil. Still, although households may not be aware of the source of the shock, they care about its persistence. For instance, because gasoline prices are among the most visible prices to consumers, households pay particular attention to them when formulating their expectations (Coibion and Gorodnichenko, 2015). We will come back to the role of persistence in inflation and sources of shocks when we discuss the role of monetary policy in Section 6.

Chart 7

Historical decomposition: Expected inflation and contributions of various shocks



Source: Aastveit, Bjørnland and Cross (2022) and own calculations.
Notes: Observed excepted inflation (blue lines) and the median estimate of the historical contribution of separate structural shocks (yellow lines).

4 Oil prices and non-linear effects

So far, the discussions have been based on linear models, assuming stable effects over time. A growing and important literature is focusing on non-linear time-varying responses to oil price changes, see Mork (1989), Hooker (1996), Hamilton (1996, 2003, 2011), Clark and Terry (2010), Baumeister and Peersman (2013a,b), Bjørnland, Larsen and Maih (2018) and Delle Chiaie, Ferrara and Giannone (2022) among many others.

The early literature mostly focused on the asymmetric response to oil price increases and decreases, c.f. Mork (1989). The idea was that an increase in oil prices would have a larger negative effect on real activity, than the positive effects of a similar sized fall in oil prices. Hooker (1996) argued in addition that the negative effects had vanished over time, in particular since the oil price collapse in 1985/86. However, as pointed out by Hamilton (1996), many of the oil price increases observed since 1985 were corrections to even bigger oil price decreases in the previous quarter. Looking at the net increase in oil prices over the year, results suggest that the historical correlation between oil shocks and recessions prevailed.

More recent papers have analysed if the relationship between oil prices and the macroeconomy has changed over time due to structural changes in the economy. In particular, using non-linear models that allow for time-varying changes, Baumeister and Peersman (2013a,b) have shown that there has been a decline in the price elasticity of demand for oil over time, which has dampened the effect of supply disruptions on the macroeconomy. Furthermore, they have shown that the contribution of oil price shocks to the variability of oil prices has declined over time, and supply shocks explain a smaller part of the recession and inflation since the 1970s.

Delle Chiaie, Ferrara and Giannone (2022), on the other hand, have shown that the importance of global factors in explaining the variations of a large group of both oil and non-energy commodity prices has increased since the 2000s.

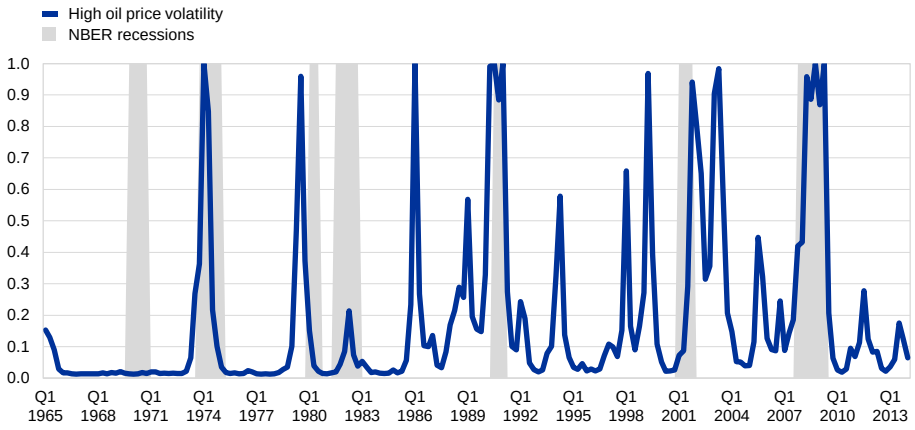
Bjørnland, Larsen and Maih (2018) take a different perspective and analyse if oil price shocks have a larger negative effect when oil prices are volatile. They ask in particular if there has been a decline in oil price volatility that coincides with the period of the great moderation, i.e., the period of a more stable macroeconomic environment since the mid-1980s, which has been suggested by Nakov and Pescatori (2010) and Blanchard and Gali (2007). The framework used in Bjørnland, Larsen and Maih (2018) is based on a Markov Switching New Keynesian model that allows for different regimes for oil price volatility, general macroeconomic volatility and different regimes for active (‘hawkish’) and passive (‘dovish’) monetary policy responses.

Doing so we find no evidence of a decline in oil price volatility that coincides with the Great Moderation. Instead, we find several short periods of heightened oil price volatility throughout the whole sample, many of them preceding the dated NBER recessions. If anything, the post-1984 period has had more episodes of high oil price volatility than the pre-1984 period. According to these results, then, we cannot argue that a decline in oil price volatility has been a factor in the reduced volatility in the

macroeconomy observed across countries post-1984. Instead, the paper confirms the relevance of oil as a recurrent source of macroeconomic fluctuations, not only in the past but also in recent times.

Chart 8

The probability of being in a period with high oil price volatility



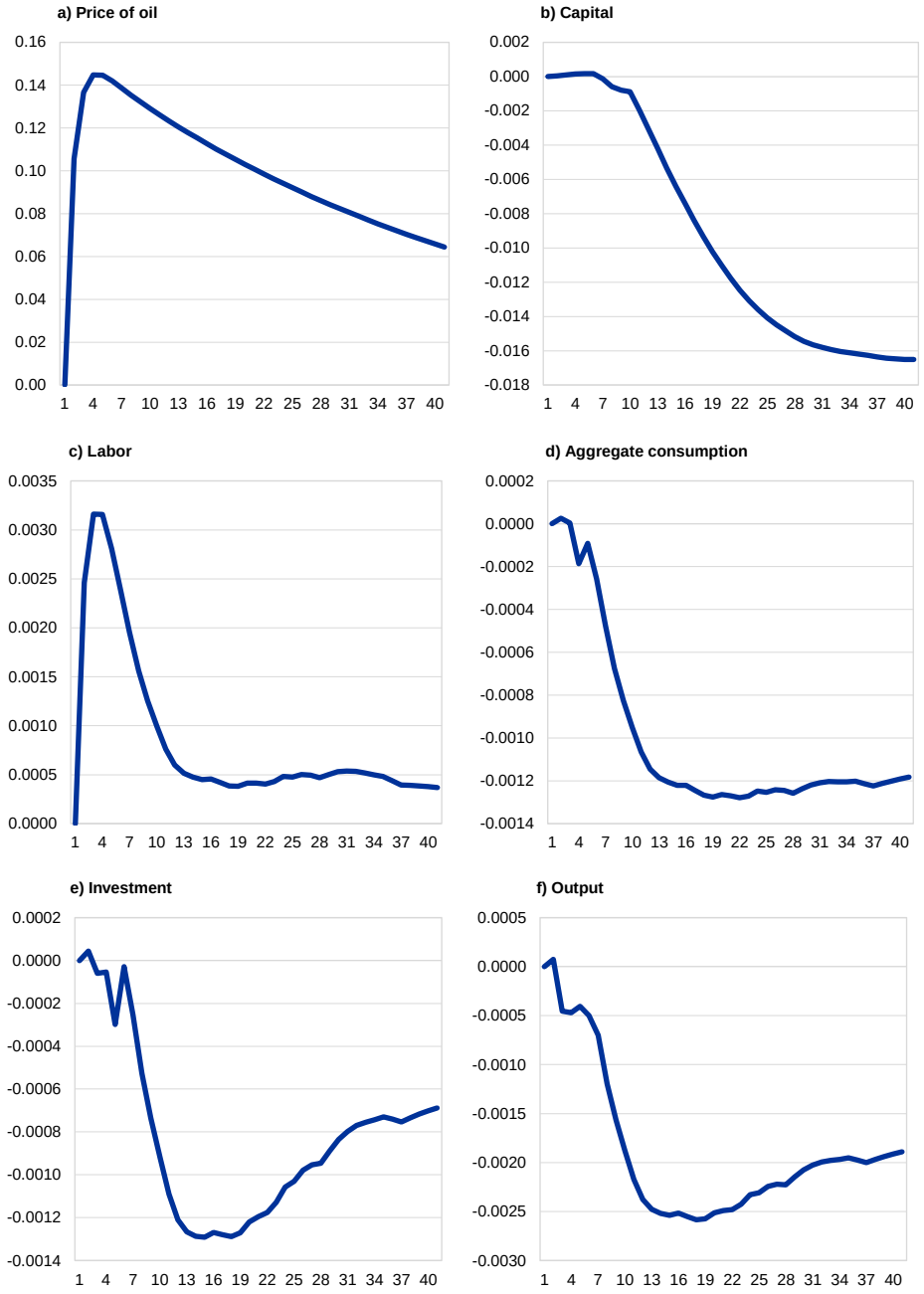
Source: Bjørnland, Larsen and Maih (2018).
Notes: The figure presents the smoothed probabilities for being in the high oil price volatility state. The shaded areas correspond to the dated NBER recessions.

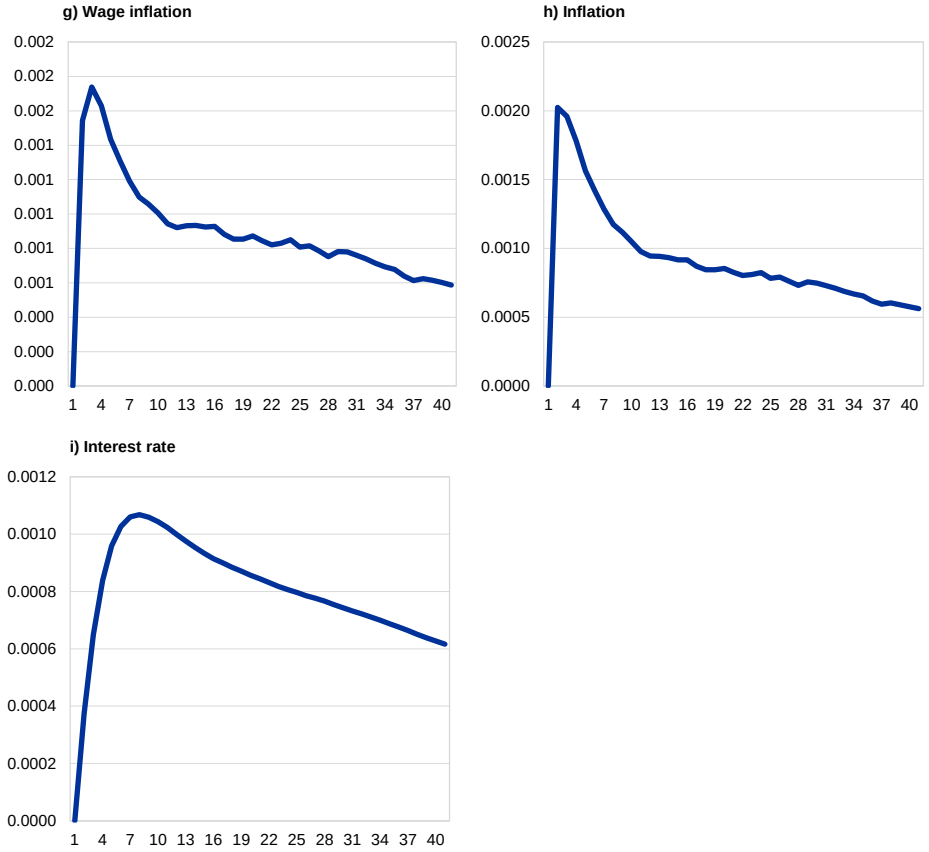
Chart 8 illustrates this. It graphs the probability of being in a period with high oil price volatility, together with periods of recessions. The figure suggests there is no support for the hypothesis that a fall in oil price volatility coincided with the decline in macroeconomic instability from the mid-1980s. Instead it shows that the oil price has displayed several periods of heightened volatility throughout the sample, many of them coinciding with recessions. Thus, there is no support for the hypothesis that reduced oil price volatility has contributed to reducing macroeconomic instability over time, as was put forward by Nakov and Pescatori (2010) and Blanchard and Gali (2007). Interestingly, we note that the episodes of high volatility correspond well with the historical episodes identified as exogenous oil price shocks in Hamilton (2013).

Having observed the coinciding pattern of heightened oil price volatility and the NBER-dated US recession, a natural follow-up question is how an oil price shock affects the macroeconomy given various periods of volatility. Chart 9 addresses this question by graphing the generalized impulse responses (over all regimes) to an oil price shock (see Bjørnland, Larsen and Maih (2018) for probability bands). The figure shows that following a standard deviation shock to oil prices of approximately 15 percent, US GDP declines gradually, by 0.4-0.5 percent within two years, as the cost of production increases. This will lower profit and reduce capital accumulation and investment by firms, and eventually also consumption by households. With an increased cost of production, firms wish to substitute with labor, hence, the use of labor increases, pushing up wage growth and inflation rapidly by 0.2–0.3 percentage points. The latter motivates an increase in interest rates of 0.1 percentage points.

Chart 9

Impulse response to a generalized oil price shock





Source: Bjørnland, Larsen and Maih (2018).

Historical decompositions in Bjørnland, Larsen and Maih (2018) confirm that there is a large contribution of oil price shocks to the variability in wage and CPI inflation. In fact, throughout the 1970s, the oil price shocks contributed to both high wage and CPI inflation, and eventually also higher interest rates. But also since the mid-2000s, oil prices have contributed to higher inflation, (and subsequently higher interest rates). Without these shocks, the rise in CPI inflation (and interest rates) would have been lower. Interestingly, this is also consistent with the findings in Aastveit, Bjørnland and Cross (2022) reported above regarding the missing disinflation after the financial crisis.

The main take away is that the contributions of the oil price shocks are substantial when oil price volatility is high. In these periods, oil price shocks account for approximately 10 percent of the variability in GDP and around 65 percent of the variability of inflation (after 1–2 years). In contrast, oil price shocks explain a modest 1 percent of GDP and 12 percent of inflation in periods of 'normal times', see Bjørnland, Larsen and Maih (2018). These results suggest an independent role of oil price shocks in past and present recessions. However, they also suggest that high oil price volatility can exacerbate the effect of oil price shocks on inflation.

Finally, an important question to address is to what extent it was the oil price shocks themselves that depressed output over time, or the central bank's contractionary response to inflationary concerns. According to Bernanke, Gertler, and Watson (1997), the contractionary policy was mostly to blame. Bjørnland, Larsen and Maih

(2018) confirm the role of monetary policy in magnifying the negative effects of the shocks, as the effects are stronger when the policy is hawkish (strong response to inflation). The main reason is that the increase in interest rates in the contractionary phase, although effectively curbing inflation, will exacerbate the oil-led contraction of the economy. However, as it turns out, since the policymakers have mostly been in the high-response (hawkish) regime since the early 1980s, oil price shocks have been contractionary for the US economy in the whole period of the Great Moderation (post-1983/1984), and not just in the Volcker era (1979–1987) as suggested in Bernanke, Gertler, and Watson (1997). This suggests an independent role of oil price shocks in recessions.

Importantly, although the effects of oil price shocks on inflation are smaller when policymakers are hawkish than dovish, there is still a substantial share of inflation being explained by the oil price shocks. This suggests that during periods of high oil price volatility, stabilising inflation is difficult. However, this also suggests that central banks need to be swift in their response so inflation expectations do not increase substantially.

I conclude this section by emphasizing that volatility matters and tend to exacerbate the effects of adverse oil market shocks on aggregate activity and inflation. We have shown that the effects of oil price shocks on inflation are smaller when policymakers are hawkish, whereas the effects on output are larger. The main reason is that the increase in interest rates in the contractionary phase, although effectively curbing inflation, will exacerbate the oil-led contraction of the economy. We have also emphasised the importance of being swift in the policy response to prevent inflation expectations and inflation to become persistent. We will return to this discussion in Section 6.

5 The recent energy price increase and its consequences for Europe

What are the key drivers of the recent energy price increase? How will it affect real output and inflation in Europe? These questions are of vital interest to researchers, businesses and policymakers, especially in light of the ongoing pandemic and recent war in Ukraine.

In Chart 10 we plot the Brent blend zooming in on the period 2020-2021. As can be seen, during the first few months of the covid pandemic, the oil price fell sharply, by 85 pct. In the summer of 2020, however, the oil price started to gain momentum, and by the summer of 2021, it had already surpassed the pre-pandemic levels. With rising geopolitical tensions and the subsequent war in Ukraine, the oil price has fluctuated widely since then, being more than 130 USD a Barrel in a period. As this is written (June 6, 2022), Brent oil stands at 124 dollars a barrel, 80 percent higher than the pre-pandemic levels, see Chart 10.

Such volatile oil prices are recurrent sources of economic fluctuations, c.f. the discussion in sections 2 and 4, and many of the spurs have preceded recessions, c.f.

Bjørnland, Larsen and Maih (2018). Furthermore, as inflation expectation picks up, this will most likely transmit the oil price shocks to inflation, c.f. the discussion in Section 3.

Chart 10

Crude oil prices, Brent blend, 2020-2022

Source: Fred database, St. Louis Fed.

Several factors can explain the increase in oil prices since June 2020, and may also have the potential to affect the global economy going forward. Below I will suggest four factors behind the commodity price changes, and in the end, I will discuss some likely consequences for economic activity and inflation, focusing on Europe in particular.

5.1 The initial plunge was offset by increased demand for oil as economic growth picked up

When the pandemic hit the world more than two years ago, oil prices collapsed. The main reason for the decline was the abrupt fall in economic activity and oil demand. In addition, uncertainty was extremely high, in terms of both the severity of the recession and the possible outcome of the pandemic, pushing oil prices down.

The oil producers met the collapse in oil prices by adjusting production levels, in particular, shale producers cut both production and deferred investment, but there is a limit to how much one can delay production without damaging capital installation and reservoirs. Storage capacity was also limited, and although shale producers can store underground (by waiting to complete (initiate production) or refracture a well, c.f. Aastveit, Bjørnland and Gundersen (2022) and Bjørnland, Nordvik and Rohrer (2021) unconventional producers do not have this option. Overall this led to the price collapse.

In the summer of 2020, however, oil prices started to pick up again, mainly due to the increased demand for oil following the easing of lock downs, and the cut in production capacity. Throughout 2020/2021, the strong economic rebound increased demand for oil and oil-related products further, and by the summer of 2021, oil prices were back to pre-pandemic levels.

5.2 Geopolitical concerns and war

During the fall of 2021, geopolitical tensions between Russia and Ukraine added to the oil market concerns, pushing oil prices far away from any fundamentals. Following the outbreak of the war against Ukraine in February 2022, oil prices have increased further, and volatility has also increased. Although oil prices are a bit down from the highest level recorded, volatility is still high, and oil prices have been fluctuating well above 100 USD a barrel.

Such volatile oil prices have been recurrent sources of economic fluctuations over time, and as discussed above, many of the oil price spurs have preceded recessions. There is a deep concern that this will also be the case this time. In addition, as we saw above, the elevated oil prices are already increasing inflation expectations and will also push up inflation going forward.

5.3 Reduced oil supply due to lack of investment

The main driver of the increased oil prices from the summer of 2020 relates to oil demand. However, due to the ongoing pandemic, the increase has not been met by a sufficient increase in supply capacity. OPEC has increased oil production somewhat, but has limited spare capacity and may also want to take advantage of the gains from high oil prices to boost the economy, see Wall Street Journal, May 5, 2022. Except for shale producers, which can switch on production in a short time, c.f. Bjørnland, Nordvik and Rohrer (2021), conventional producers have long leads between investment and production. On average, it can take 5-7 years between the moment one finds resources to production can start, c.f. Arezki, Ramey and Sheng (2016). As shale producers still make up a small share of total oil and gas production, supply constraints will likely affect the energy market for a long time going forward.

There is also uncertainty as to how many new oil fields will be developed. There is a push for diverting capital investment from oil and gas towards green investments. This makes the potential for a sustainable increase in supply less likely, implying that oil prices may remain high for a prolonged period, other things being equal.

5.4 Other commodity prices

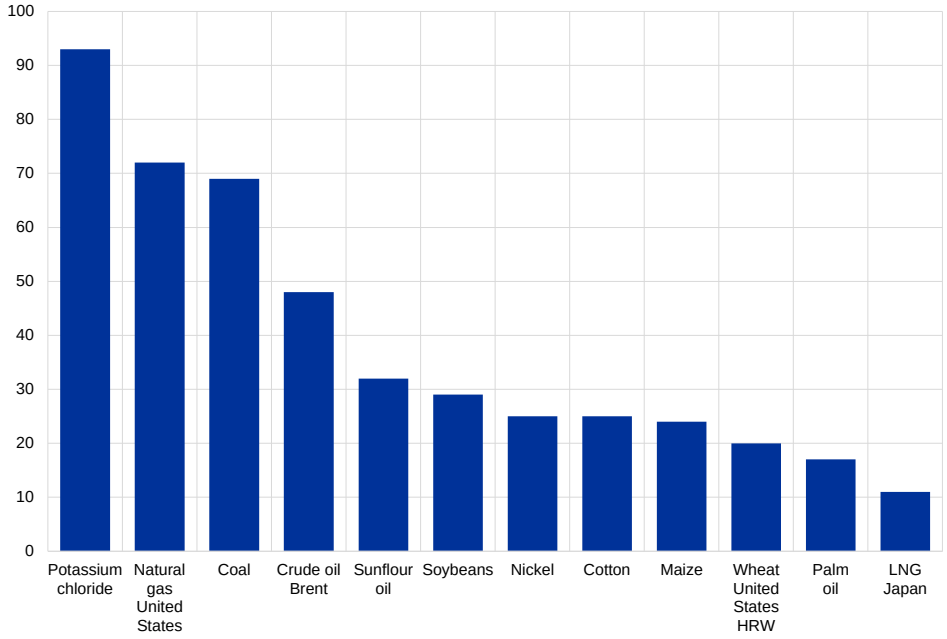
The war in Ukraine has also had a large effect on other commodity markets, due to blockades of trade, destruction of productive capacity in Ukraine, and sanction of Russia. As Russia and Ukraine are major commodity exporters, this has had a large effect on commodity prices. Russia is one of the world's largest exporters of natural gas, wheat, pig iron, nickel, coal, oil and fertilizers among others. Ukraine is an important exporter of food commodities, in particular, wheat and sunflower seed oil, see Baffes and Nagle (2022).

The consequence of the disruptions of production capacity has been that we are now witnessing large price increases in a series of commodities, food commodities, in

particular, see Chart 11. These commodity price increases will not only impact energy, electricity and fertilizers, we are seeing inflation increase for industrial production, production of digital equipment and their services, food, drink and tobacco, and chemicals, to name just a few groups.

Chart 11

Commodity price changes in 2022, percent



Source: World Bank.
Note: Percentage changes in commodity prices, January-June 2022.

Going forward, high and volatile commodity prices pose significant risks to the global economy and inflation in Europe. In a recent study, Peersman (2022) has argued that exogenous shifts in international food commodity prices can explain almost 30% of euro-area inflation volatility over the medium term. Increased commodity price shocks have an impact on food retail prices through the food production chain but also trigger indirect inflationary effects via a depreciation of the euro and rising wages. However, as also pointed out, due to asymmetric wage responses, the inflationary effects are different across European countries, depending on whether they are exporters or importers of affected commodities and how higher prices affect household and corporate income.

5.5 Prospects for European economies

It is clear that during the spring of 2021, most of the increase in oil prices was adjustments from the oil price decline during the start of the pandemic, as global demand was picking up again. To the extent that global demand is kept high, this increase in oil prices will not have any negative effects on the European economies However, from the fall of 2021, geopolitical tensions and the subsequent war in Ukraine have pushed up oil prices further, with negative effects on the European economies. As we saw above, short-term inflation expectations have also picked up in

this period, and the persistence of the oil price increase gives cause for concern for more persistent inflation expectations, which is what matters most for monetary policy. Still, recent evidence suggests that long-term inflation expectations have remained stable. In line with this, Consolo, Delle Chiaie and Vansteenkiste (2022) suggest that while short-term inflation expectations tend to respond to commodity price changes, long-term inflation expectations remain more stable following oil price shocks. That these prices remain stable should be the main priority for central banks going forward.

There is also a concern that most commodity prices are now elevated, and are expected to remain high for long period. In the last months, inflation has been increasing further. Although bottlenecks are expected to eventually ease as capacity constraints will ease, there are expectations of commodity supply shortages in several sectors also in 2023. As a result, many forecasters (i.e., IMF) have projected inflation to remain elevated for a prolonged period in advanced, emerging and developing economies.

As I have argued above, high and volatile commodity prices pose significant risks to the global economy and Europe in particular. The effects will be felt on both inflation and growth and will fall unevenly across countries, depending on how higher prices affect household and corporate income. Still, it is expected that higher commodity prices will increase overall inflation in Europe also in 2023.

On top of this, adverse oil supply shocks will hurt growth further. To put some numbers behind the recent events, we have seen above in Chart 5 that a 10 percent increase in oil prices due to conflict/war (oil-specific shock) will reduce GDP in Europe by approximately 0.5 percent after two years. Hence, a 50 percent increase, such as what we have experienced in 2022, will reduce GDP in Europe by 2.5 percent, assuming other things are equal.

The war in Ukraine has also increased uncertainty that was already on the rise due to new outbreaks of the pandemic, which will affect the global outlook more negatively. Although most countries have opened up since the major outbreaks of the pandemic, there could be new variants in the winter that can lead to higher infection and further disruption to supply chains. Inflation pressure could strengthen even further, and demand even more contractionary monetary policy responses. If the lockdowns in China due to the strict zero-COVID strategy prevail, this could push China’s economy further down, with huge consequences for trade. This will most likely dampen the global recovery, affecting in particular emerging and developing economies.

To conclude, the mix of rising energy prices and other commodity prices, plus the disruptions to trade that have followed the covid pandemic, have already changed inflation expectations and elevated inflation. Supply shortages due to the war could increase these pressures further, pushing up energy, metals, and food prices. This leaves monetary policy at a crossroad in Europe. On the one hand, inflation expectations are on a rise, suggesting the ECB should have responded earlier. Against that is a weaker domestic growth outlook, that will be a new concern for ECB, as it is challenging to dampen inflation without causing a severe economic downturn. I turn to this now.

6 New challenges for monetary policy

Although the recent commodity spurs are beyond the control of central banks, second round effects via inflation expectations are not. Empirical evidence (see the discussion above) suggests that demand driven oil price shocks were already transmitted into inflation expectations throughout 2021 and are having an indirect effect on inflation. The war in Ukraine has further increased commodity prices (c.f. Chart 11) and intensified supply disruptions, adding to inflation fears. This will affect countries in Europe differently, depending on energy dependence in consumption and production, and fiscal space, among others.

In the US, fears of inflationary pressures have been emphasised for some time due to expansive fiscal space adding to domestic demand pressures. European countries, on the other hand, are more directly affected by the war in Ukraine, as their import of commodities (gas in particular) is affected. This could lead to broader and more persistent price pressures, and in some countries, also likely a recession (gas dependent countries such as Germany and Italy in particular). Thus, the inflationary effect will differ across countries, and the appropriate monetary policy response should therefore also vary. In Europe, and for the ECB in particular, this will be challenging. The ECB needs to prevent higher commodity prices to feed further into wages and inflation expectations, thereby driving up prices. This should be their main priority now. Yet, there will be trade-offs between supporting growth and containing inflation in many countries, in particular, if the commodity prices remain elevated for a long period.

The mix of increased energy and commodity prices, the war in Europe, and a pandemic that has not yet fully ended will be challenging. Still, central banks need to prioritize anchoring inflation expectations. During the pandemic inflation expectations were well anchored in most economies. Now inflation expectations are on a rise. With already high inflation and rising energy and food prices, higher inflation expectations could become more widespread also in Europe, and, in turn, lead to further increases in prices. To avoid a wage-price spiral, monetary policy should respond timely and firmly.

Bjørnland, Larsen and Maih (2018) emphasised this dilemma for monetary policy. Independently of whether monetary policy is in a hawkish or dovish state, inflation increases and output falls for a prolonged period of time following an adverse oil price shock. This suggests an independent role for oil price shocks in past and present recessions, as emphasised above. However, the paper also shows that inflation remains out of control for a longer period when monetary policy is not responsive. On the other hand, the negative effect on output of an oil price shock is magnified when the policymakers are responsive. One reason is that the increase in interest rates, although more effectively curbs inflation, will exacerbate the oil-led contraction of the economy.

However, the analysis above also shows that during periods of high oil price volatility, stabilising inflation is difficult. In particular, we show that there remains a substantial share of variance in inflation explained by the oil price shocks, even when central

banks are responsive (hawkish). This suggests that early on, central banks need to prevent this by being swift in their response to curb inflation.

In Europe, short-term inflation expectations and inflation are now on the rise, while the probability of recession has increased. The importance of monetary policy for stabilising inflation expectations requires swift actions from policymakers to prevent the wage-inflation spiral from building up. This should be the main priority for the ECB now. Yet, further out, there will be trade-offs between supporting growth and containing inflation in many European countries, in particular, if the commodity prices remain elevated for a long period. This suggests that there may be a limit as to how far monetary policy may go, once interest rates have been elevated. This will most likely be the main challenge for central banks in the months ahead.

On a final note, monetary policy also works by affecting financial markets, see Rigobon and Sachs (2004) and Bjørnland and Leitemo (2009) among others. In particular, there is an interdependence between the interest rate setting and real stock prices, and stock prices will also fall sharply following contractionary policy responses. The combined effect of higher commodity prices, lower growth and asset prices and elevated inflation, suggests more troubling and challenging times ahead for European economies and policymakers the next year.

7 Summary and conclusions

This paper discussed the recent energy price changes following the global pandemic, the recent geopolitical tensions, and the supply disruptions due to the war in Ukraine, and analyses subsequent effects on economic activity and inflation in Europe. Since the seminal contribution of Hamilton (1983), a growing oil-macroeconomic literature has predicted an inverse relationship between oil price changes and economic activity in oil importing countries. Although the existence of this negative relationship is well established by now, there has been substantial disagreement in the literature as to the magnitude of the relationship.

We provide a thorough review of the growing body of literature on the oil-macro relationship, taking into account sources of shocks, global changes, short-run price elasticity, and the role of oil exporters versus importers. First, we confirm recent evidence that global demand shocks increase both oil prices and macroeconomic conditions, and that in recent years, demand from emerging countries has been the main source of oil price fluctuations. Second, we also find an independent role for adverse oil market (i.e., supply) shocks in the past and present recessions, i.e., recessions are not only due to the Central Bank's contractionary response to inflationary concerns. Third, we show that European countries are among the most negatively affected globally by these adverse oil market shocks, and that high oil price volatility will exacerbate the adverse effects of oil price shocks on the macroeconomy.

We focus in particular on the effect of inflation expectation in transmitting oil price shocks to inflation and look at evidence following the recent oil price increases. We show that inflation expectations and the associated pass-through of oil price shocks

depend on demand and supply conditions in the global oil market, and economic activity (demand) shocks have a significant long-lasting effect on inflation expectations and actual inflation. Still, oil supply shocks also matter, and the persistence of the recent adverse oil supply shocks can explain a large part of the increase in inflation expectations witnessed the last year. This should give cause for concern for central banks, emphasising a need to be swift in their response.

We also find that during periods of high oil price volatility, stabilising inflation is difficult. In particular, we show that in recent decades, a substantial share of the inflation variance is explained by the oil price shocks, even when central banks respond strongly (they are hawkish). Again, this suggests that central banks need to be swift in their response to prevent oil price shocks to transmit into inflation via inflation expectations, but also that there is a limit as to how much they can do once inflation has picked up.

In Europe, short-term inflation expectations and inflation are now on the rise, mainly due to energy and commodity price shocks, while the probability of recession has increased. The importance of monetary policy for stabilising inflation expectations requires swift actions from policymakers to prevent the wage-inflation spiral from building up. This should be the main priority for ECB now. Yet, the next year there will be trade-offs between supporting growth and containing inflation in many European countries, in particular, if the commodity prices remain elevated for a long period. This suggests central banks may soon be at the limit of how far the interest rates can go in this cycle. All in all, I see troubling and challenging times ahead for European economies and policymakers, in particular, trying to balance growth and inflation in the long run.

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Energy price volatility and energy sources in Europe

By Christian Zinglersen, Bart Vereecke[1]

Abstract

This paper argues that the current energy crisis is mainly a gas crisis brought about by the aftermath of the Covid pandemic and the Russian invasion into Ukraine. Given the critical role of gas in the energy mix and the flexibility it offers, gas is here to stay for the foreseeable future. Energy prices are expected to remain on the higher end though due to tightness in the gas market and infrastructure as Europe aims to diversify away from Russian gas. It is argued that the EU needs to focus more on the demand side and push for demand reductions and secondly further invest in the energy transition as means to diversify away from Russian gas. Lastly, the EU should exploit its resources of renewables at scale. This will, however, only work best if the EU adopts an increasingly shared resources model, in turn requiring political acceptance of enhanced mutual reliance.

1 The current energy shock is gas driven, with near-term implications

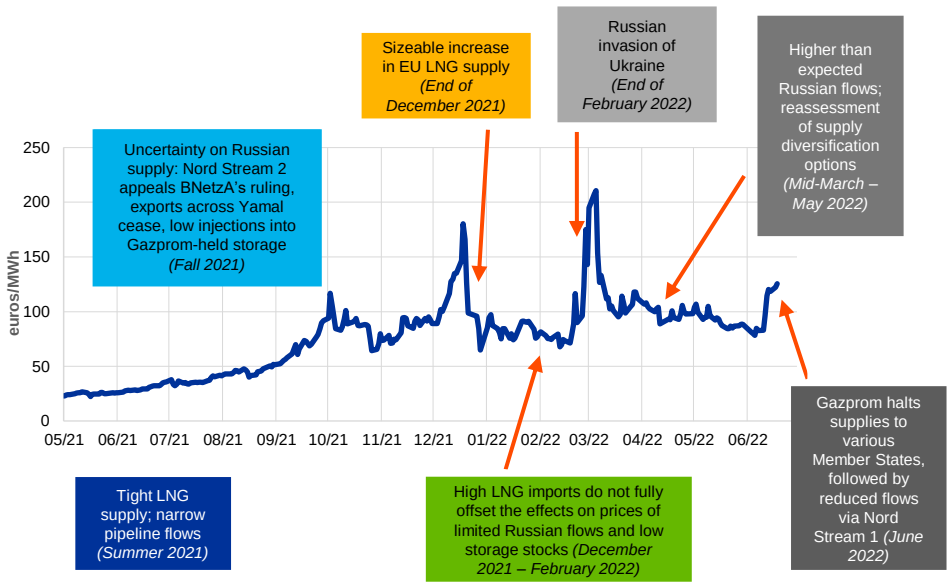
The current energy crisis is in essence a gas price shock, which also impacts electricity prices (see chart 1). Three distinct phases can be observed. First, with the economic recovery in 2021, global gas demand bounced back to pre-pandemic levels and outstripped supply. Despite increasing LNG deliveries to Europe (linked with the rise in gas prices), sharply decreasing Russian gas pipeline supplies and the related geopolitical uncertainty put strong upward pressure on prices. In 2022, Russia's invasion of Ukraine initiated a second phase which heightened the crisis resulting in unprecedentedly high gas and electricity prices. In the latest phase, price developments were first affected by extreme near-term uncertainty, very recently also by the scarcity risk as seen by reduced flows via the Nordstream I gas pipeline. The current energy crisis severely impacts consumers, retail suppliers, market participants and others.

[1] Christian Zinglersen is Director of the European Union Agency for the Cooperation of Energy Regulators and Bart Vereecke leads the Strategy and Communications team.

Chart 1

Three phases, each with different dynamics

Overview of events and market fundamentals driving EU gas prices – TTF month-ahead contract (EUR/MWh) – May 2021 – June 2022



The gas price surge can be split into three distinct phases. In the latest phase, price developments were first affected by the extreme near-term uncertainty, very recently also by scarcity risk.

Source: ACER based on ICIS Heren's price data.

In view of securing continuous supply for the upcoming winter, it has become crucial that gas storages are filled maximally. As of end of June EU gas storages are filled for around 55%, hence on track to meet the EU target by 1 November 2022[2]. However, Europe is not out of the woods yet as it comes to the filling rate. Uncertainty as to the continued delivery of gas from Russia is increasing, hence it remains to be seen if the EU will be able to reach the set target by the November.

Another aspect to watch is electricity generation as in various jurisdictions in Europe, gas – fired generation is the marginal price setter. The rise in costs of sourced gas for gas-fired power generation drove up electricity prices, due to the strong influence of gas fired plants in setting electricity prices in the short-term EU power markets. However, additional factors such as unfavourable wind conditions, maintenance on nuclear reactors and growing emission allowance prices under the ETS further amplified electricity prices.

A third point to watch is electricity adequacy or security of supply. Gas generation roughly accounts for 20 percent of electricity production across the EU. While current high prices have a dampening effect on the actual volumes of gas-fired generation this has been so far only to a small degree. Actual use of gas for generation can be reduced further if a number of measures are taken but there are limitations to this

[2] The EU introduced legislation in 2022 establishing a gas storage policy for the EU, seeking to ensure gas storage is filled to a minimum of 80% capacity by 1 November 2022, rising to 90% minimum gas storage obligations in the following years - Regulation (EU) 2022/1032.

driven by factors like weather (is it a harsh winter or not), hydro reservoirs (full or less full), etc.

2 The stubborn resilience of gas. Why it is unlikely to go away

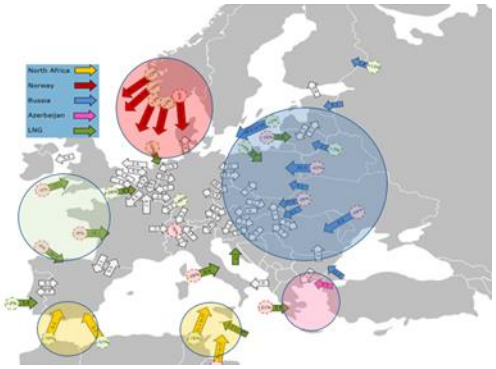
Gas consumption is engrained across the EU. It meets significant of the energy needs in the EU. It is a critical fuel to the overall EU energy supply accounting for almost 24 percent of gross available energy with oil and petroleum taking 34 %. The rest of the energy mix being renewables, nuclear and solid fossil fuels[3].

Gas has also been a key provider of seasonal flexibility needs covering notably much of the seasonal heating needs in winter times. Also in the context of the energy transition it is one of the reasons why gas is likely to continue to play an important role for many years ahead in the EU. And while gas consumption is expected to decrease over the next decade, gas peak demand needs may well increase and gas is well positioned to play such a flexibility role.

As the map in Figure 1 shows there a relative predominance of East-to-West gas pipeline dimensioned infrastructure due to legacy, sourcing costs competitiveness and up to recently supplier reliability. Given the current situation though this will need to be complemented to a certain degree with targeted new LNG and 'West-to-East' pipeline infrastructure. However, this will take time. In the meantime other non-Russian pipeline suppliers are expected to complement for lower Russian gas imports but they do not have that much spare capacity.

Figure 1
Geography matters: 'East-to-West' pipelines dominate

EU and Energy Community countries cross-border gas flows (2021, bcm/year)



The gas system has so far accommodated flows in response to price signals (greater volumes from East to West). New emphasis on West to East flows requires new investment.

Source: ACER calculation based on IEA and ENTSOG.

[3] Data for 2020 (Eurostat).

3 For the medium term, gas market tightness is likely here to stay

Hence, what to expect for gas markets as Europe aims to diversify away from Russian gas? Overall, for the coming years, gas market tightness is likely here to stay.

When looking at gas forward market prices, current contracts suggest these will remain high over the course of next year and would only see a decrease in a year from now, noting however that prices are unlikely to go back to pre-crisis levels of 25-30 Euros/MWh. Another observation is that due to continuous uncertainty and sudden supply patterns shifts, forward prices have also seen significant shifts over the last months.

One of the key fundamentals for European energy prices development over the next 2-3 years is the reliance on and availability of LNG. As the EU aims to diversify away from Russian gas it finds itself in an increasingly global competitive LNG market. LNG is a key venue to attract new gas flows into Europe. The EU's RepowerEU plan foresees a maximum of 50 bcm of extra LNG flows entering the EU this year. Pro memorie, the overall Russian import flow was 155 bcm in 2021 and the EU aims to cut this dependency by two thirds this year. 50 bcm of LNG is very significant. It means that the EU needs to scoop up an extra 10 percent of the global LNG trade market this year. The EU has been helped so far by lower demand for LNG from China but it is unclear if this will remain so in the very near future.

When looking at the LNG supply side, The LNG capacity market is also expected to be tight over the coming years with not much new capacity of LNG coming online in the coming years (around 18 bcm/y during 2021-2024 compared to 40 bcm/y during 2016-2020). The IEA expects that only from 2025-2026 sizeable capacity will come online[4]. The EU will compete for these extra volumes of LNG with chiefly Asia which will see growing demand, partly for overall economic growth, partly for lowering coal use.

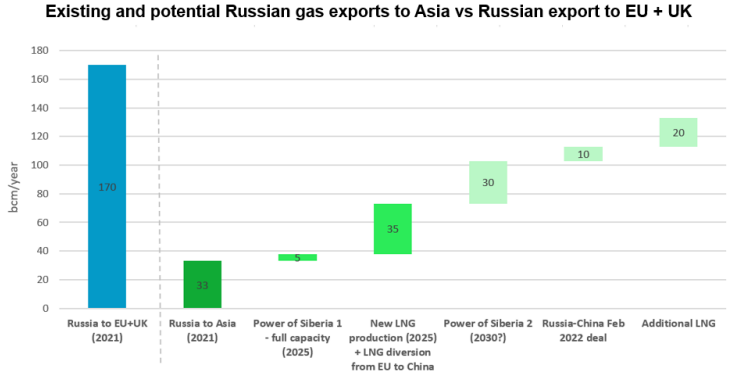
Given higher demand for gas, and the cyclical nature of the gas commodity business, one would expect new investment to be underway in more upstream gas production capacity. However, to date global investments are not at pre-covid levels yet except for the Middle Eastern national energy companies[5].

[4] IEA Gas Quarterly Report Q2 2022.

[5] IEA's World Energy Investment Report, June 2022.

Chart 2

Current Russian gas supply cannot just 'go elsewhere'



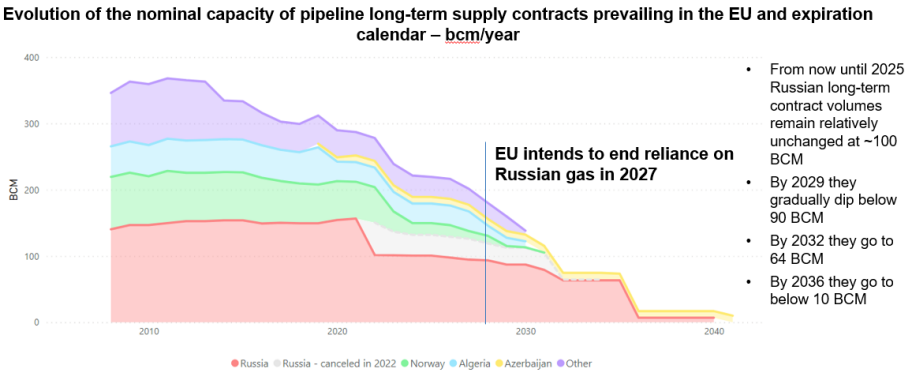
Russia expected to prioritise new export capacity, in particular towards China. This will involve significant investment and price concessions. Volumes are highly unlikely to make up for current EU + UK exports.

Source: Eurostat Energy database; Centre for Strategic and International Studies (May, 2022); IEA: Energy Fact Sheet: Why does Russian oil and gas matter?

Additionally one could argue that Russian gas flows will find their way to other clients hence markets will balance out. This is unlikely to happen in the coming years. The chart 2 above explains that Russia is expected to prioritise new export capacity, in particular towards China. This will involve significant investments over the coming years and will likely involve price concessions. However, for the coming years Russian gas exports to Asia are unlikely to make up for current EU and UK exports.

Chart 3

Russian long-term contracts hold resilience



Russian long-term contracts towards EU markets last significantly beyond 2027. This adds complexity to current considerations.

Source: ACER calculation based on Cedigaz and NRAs.

There is a final challenge in getting out of Russian gas and that is a contractual one (see chart 3). There is a prevalence of long-term gas contracts with Gazprom towards EU member states even beyond 2027, the target year the EU has set itself to get out of Russian gas. Hence, barring separate action to end such contracts and/or non-delivery by Russia of the contracted volumes, the EU would still be supplied by Russian gas by the virtue of the existence of these long-term contracts.

4 Turning to no-regrets and early lessons for energy transition policies up ahead

Moving to the other part of the diversification puzzle, the energy transition and what can be done here.

Energy efficiency will need to play a key role and efforts will need to be accelerated. This is less about global price markets signals – after all, what more incentivising price signals could one have than the present ones - but more about institutional and behavioural barriers that need to be tackled. Some of these initiatives may be seen as heavy-handed or intrusive, thus possibly meeting resistance.

The other part of the puzzle is increasing clean energy supply where indeed also more needs to be done. This discussion is also less about price signals and capital availability – at least currently- but more about targeting permitting delays and inadequate infrastructure grids. Reassuringly, this is one of the areas in the energy transition where there has been significant progress made and significant cost reductions observed. However, unlike the past there is a currently upward pressure on costs due to select labour shortages, supply chain bottlenecks and material cost increases. So while new-build will still occur and put downward pressure on prices, the impact could be less than a couple of years ago.

The main challenge is about striking the right balance when it comes to measures to be taken. Some early lessons would seem relevant here.

First, it would seem that supply side measures or restrictions may have been given too much focus over the last years. This carries risks. If there are supply-side restrictions which do not go hand in hand with demand side measures targeting that which one wishes to restrict, this puts upward pressure on prices, hence leading to inflationary pressures. Whereas when these are matched with an adequate focus on demand side measures, this can have more deflationary impacts.

A second lesson pertains to the role of the market. The current electricity and gas markets in the EU are delivering quite significant benefits in terms of trade and volatility mitigation (compared to an isolated system), innovation signalling and security of supply. Of course in times of very high prices it is absolutely legitimate to protect the more vulnerable consumers and one would expect this to be done. However, tampering too much with price formations and market functioning, absent situations of true physical shortages, carries risk. Another approach would be to target sound redistribution measures, i.e. those that are well-designed, transparent and ex ante implemented. This could pertain e.g. to long term support instrument or tax policy measures.

Finally, there are opportunities ahead for the EU. Europe can leverage its respective renewables and other endowments at scale (see figure 2). This is in essence a shared resources model across EU Member States (to a certain degree, the current gas storage access or LNG access solidarity are examples of this).

Figure 2

The EU has advantages. Will these be leveraged?

"…whilst increased energy independence vis-à-vis (particular) third-countries is a policy objective of growing importance, realising this may well depend on enhanced energy inter-dependence amongst EU Member States."

Further strengthening a 'shared resources' model across the EU requires investment; in infrastructure, rules, institutions and governance. Importantly, it also requires political investment in the 'comfort levels' of being more (inter-)dependent on other Member States for one's energy needs.

Source: ACER's Final Assessment of the EU Wholesale Electricity Market Design, April 2022.

However, in order to make this model a reality at the scale of hundreds GigaWatts (the vision of some), some Member States will need to be comfortable with becoming a structural exporter (and to draw the implications), whilst others will need to be comfortable becoming a structural importer (and to draw the implications thereof). This has significant impact in terms of future investment in infrastructure, in rules and in governance. However, the main 'investment' will likely prove to be political in terms of anchoring and defending enhanced mutual reliance amongst Member States. That is likely a key issue facing EU policy makers in the coming years, once the very immediate energy shock has been tackled; and one where opposing national pressures may prove to be significant obstacles.

Making CBDC (not too) successful

By Ulrich Bindseil[1]

Abstract

This note covers two topics: first, it discusses the design of CBDC from the perspective of some key policy objectives (beyond the foundational one to preserve the anchoring role of central bank money), namely competition, innovation and inclusion. It is explained that the digital euro project gives high importance to all three, derives this from basic principles and policies, and touches upon some design implications. It then takes up the issue of competition from another perspective, namely the one of co-existence of CBDC and commercial bank money, and the related implications an introduction of CBDC could have for the banking system. It is argued that it is essential to distinguish the store of value and the means of payment functions of money, and that for the letter the implications on digital euro design are more subtle in view of the strong network effects of payment instruments.

1 The role of CBDC in achieving broader policy objectives such as competition, innovation and inclusion

Competition, innovation and inclusion rank high amongst the digital euro objectives next to the foundational one to preserve the anchoring role of central bank money in a digital age. Let me first discuss competition and innovation, and afterwards inclusion which is of a rather different nature.

The ECB's commitment to competition and innovation follows directly from the EU treaty. Efficient and reliable means of payments are the very basis of the modern economy. Innovation and competition are key to efficiency. Innovation has been impressive in electronic payments over the last decade, while competition not necessarily so. Payments being a network function may lead to market concentration and abuse of power by leading providers. This has two implications for CBDC:

- First, it supports the merits of introducing CBDC in a digital world as the mere existence of CBDC as competitor can limit the potential abuse by dominating private retail payment solutions providers. Economies of scale and pricing in accordance with simple cost recovery (instead of profit maximisation) can make CBDC cheap and competitive as means of payments.
- Second, CBDC should be designed in a way to support the development of a surrounding innovative and competitive ecosystem: distributors, acquirers, service providers of all kinds ("third party providers") should be incentivised to

[1] European Central Bank.

support CBDC through a business model that attracts them while also making them compete and innovate continuously. This would speak in favour of an open model in which no supporting function is assigned to single providers or type of institutions, but to several ones, or even anyone fulfilling a set of conditions. It would also suggest to transfer innovative approaches, such as PSD2-style open banking based on APIs into the world of CBDCs.

Regarding innovation, interestingly, the "technology" of banknotes has remained fairly stable since they were first introduced in Sweden in 1658. Of course, innovation was permanent in terms of security features and the ability of forgers to replicate those. But for the rest it is fair to say that it was a payments technology that was fit for purpose without much change for 350 years. This seems unthinkable in the field of electronic payments. And if central banks enter this field, they must accept that they will need to swim with the market and follow innovations with a high pace. This again leads to the conclusion that CBDC solutions should rely on a variety of service providers, on an ecosystem, which will bring this innovation through openness and competition into the CBDC space. A segregated central bank developed and run payment solution will likely fail this test and will moreover be expensive as it will fail to reap synergies.

Let me now turn to inclusiveness. There are areas in the world where the role of CBDC for inclusiveness is totally obvious, namely for currency areas which have a relatively low share of unbanked: countries like Nigeria, in which the share of people with mobile phones is significantly higher than the share of people with bank account, CBDC can really make an easy and decisive contribution to financial inclusion. But also, for advanced economies such as Europe this is a very important topic. First of all, let me mention that inclusiveness has generally been a part of the retail payment strategies of both the ECB and the Commission. The ECB has obviously taken into account inclusiveness aspects in banknote design since the launch of the euro. The European co-legislator has supported it for example through the bank account directive. It is therefore not even a question that the digital euro will also aim at being inclusive. Keeping in mind that CBDC aims also, in the medium to long term, to address the possible case in which the usage of banknotes is – against the intentions of central banks – more and more marginalised, then CBDC be designed such as to take up the important role that banknotes have played for the inclusiveness of money. This may come at some cost, as it may require special devices (form factors) and more intense customer support. The central bank may not want to do the customer support itself, but it will still not come for free and it has to be carefully planned.

2 Implications of CBDC on the banking sector

Barrdear and Kumhof (2016) explained, in one of the very first publications using the term "CBDC" (if not the very first one) that: "upon the introduction of CBDC a substantial portion of retail transaction balances might be expected to switch from bank deposits to CBDC, thereby leaving a larger portion of bank financing dependent on the wholesale market, at higher interest rates." This theme has been taken up repeatedly since then and a growing size of papers has tried to be more conclusive on the issue and to develop tools to address this risk. In a CPMI – Markets Committee

report on CBDC of March 2018 (MIPC-MC, 2018), central bankers still seemed very concerned on the matter. I believe that today, we are more confident that we can design controls to address the risks (Bindseil and Panetta, 2021). One may also note that the fact that central bank money competes and co-exists with commercial bank money is not new at all, and that the policy choices made in this respect always had repercussions of various kinds, including profitability of banks, financial stability and therefore also monetary policy. There have also been for a long-time different views on how to answer this question.

There is one school – and today's central banks have distanced themselves very clearly from it, which would argue that central bank money is just better for financial stability as commercial bank money would be inherently unstable. For example, there has been a referendum in Switzerland in 2018 on introducing such sovereign money or "Vollgeld" but 75% rejected the idea (and so did the SNB at that time).

Central banks take the explicit view that CBDC would not be introduced to crowd out the private sector, but to preserve what has worked well so far, namely the co-existence of commercial bank and central bank money, i.e. one could even say that the idea behind CBDC from the perspective of central banks is more a conservative one than a revolutionary one.

When analysing this matter further, it seems crucial to distinguish the payment and the store of value dimension (Bindseil, Panetta and Terol, 2021). Let me start with the second as this is the one which has been seen as early as 2016. In the field of financial intermediation, store of value function of money and investment, central banks want to avoid that CBDC becomes a store of value exceeding the current role of banknotes and thereby cannibalising bank balance sheets, both structurally and in times of banking crises. So again, central banks are conservative and seem to believe that commercial banks play an important role, in the process of transforming savings held in the form of deposits into loans. How to do that? Amongst economists one may dare to say that the constant zero remuneration of banknotes is more an anomaly than something natural. Regardless of whether central bank rates are like in Turkey (14% at the time of this conference) or like in the euro area (-0.5%), banknotes have zero remuneration. Incentives to hold banknotes as store of value depend strongly and unintendedly of the interest rate level. This would not be needed under CBDC as electronic means of payments can from a technology perspective be remunerated. Remuneration is definitely not needed for every interest rate level. For example, if nominal risk-free rates are 5%, then a zero remuneration of CBDC incentivises against large holdings. But what if the short-term risk-free market rate is -60 basis points, as it has been for some years now in the euro area? For large holdings a zero remuneration would not make sense obviously as it would undermine financial stability and monetary policy in the most obvious way. Therefore, the idea of tiered remuneration: citizens could hold CBDC up to a certain amount at an interest rate which would never be negative, but for large holdings the remuneration would be slightly (say half a percentage point) below the short-term yield of risk-free investment assets. Fortunately, or unfortunately, we do not live in a world of economists only. Lawyers, citizens, politicians, may all be very sceptical and fearful if they hear about non-zero remuneration or tiered remuneration of CBDC. Even if economists may find

this fear irrational, it is likely a reality, and there may be insufficient appetite of economists to convince all other stakeholders that tiered remuneration makes users better off than limits. And indeed, CBDCs which have been deployed so far tend to rely on hard limits for holdings per citizen/wallet. Limits are seen to have the advantage that they really prevent surprises, also in crisis situations. They have the disadvantage to be inelastic, and solutions need to be found for corporate usages. Anyway, both limits and tiered remuneration can be calibrated such as to contain the role of CBDC as large-scale store of value. Overall, the balance sheets effects of CBDC can therefore be controlled relatively easily I believe. Putting limits per capita is even a rather trivial solution, although it implies that there can't be anonymous holdings like cash.

The co-existence of central bank and commercial bank money in the field of payments may actually be more complex than the one in the field of deposits with store of value connotation. CBDC should allow to preserve the co-existence of private and public means of payments in a digital world, in which citizens would no longer find cash convenient. Can this be achieved? It is certainly one of the tricky parts of CBDC design to find tools to support a balanced market share of CBDC in digital retail payments. Both extremes are possible.

Central banks could certainly be very successful in imposing CBDC if they manage to deliver a convenient design, if they set very low or zero merchant fees, and have CBDC be supported by legal tender status. But CBDC could also end up with a low market share if not really attractive for neither, users, distributors, and merchants. The success of CBDC is not yet a fait accompli. Hitting the middle ground will require a certain distinguishability of CBDC from private payment solutions. It will be essential to on one side cover the essential use cases including POI and P2P for the sake of network effects, but at the same time to have some distinguishability, some unique value propositions, and maybe also offer certain features missing of private solutions, while at the same time leaving other features to private solutions only. By designing CBDC use cases and functionality such as to have overlapping, but not identical habitats with commercial bank money, a balanced co-existence of the two forms of money in retail payments can be supported – such as to preserve the system that has proved to work well for decades.

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The digital euro: privacy, smart CBDC, monetary transmission, and different CBDC strategies

By Markus K. Brunnermeier[1]

Abstract

The introduction of Central Bank Digital Currencies (CBDCs) raises many issues. The remarks address three of them: Ledger interoperability empowers digital money but raises serious privacy challenges. How the introduction of CBDC impacts the monetary transmission mechanism. Main strategic motivation to introduce digital money differs across different parts of the world.

1 Introduction

In many parts of the world, central banks have considered introducing central bank digital currency (CBDC). For the euro area, the digital euro raises an array of interesting monetary issues. In my remarks I will zoom in on three of these aspects: first, the importance of protecting privacy, second, how the design of the CBDC impacts the monetary transmission mechanism, and third, how the motivation for introducing CBDC differs across different parts of the world.

2 Privacy and Ledger Interoperability

Money is all about trust and freedom. Privacy is one of the most important aspects for any form of money.

As our world becomes more and more digitalized it is possible that cash loses its importance and with it the central bank its direct connection to its citizens. Most digital money is issued by private institutions, like banks. Digital reserves are issued by central banks, but they are only held by private banks and not by citizens. The only central bank money that is directly held by citizens is physical cash. The introduction of a central bank digital currency, like the digital euro, would allow for a direct connection between the central bank and citizens. However, CBDC is digital and hence different from cash.

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2.1 Digital Money Ledger, Automatic Payment Execution

Digital money is special since it is based on and can be connected to a digital ledger. Cash, by contrast, is “ledger free”. Nobody knows or sees the full distribution of cash holdings across the economy. Hence, privacy is ingrained in physical cash. In contrast, CBDC is part of an overall ledger and hence privacy is not guaranteed. One needs a specific institutional arrangement and governance structure to ensure basic privacy for citizens, as pointed out in Brunnermeier and Landau (2022). Ideally, nobody should be able to see the full ledger. The central bank and the institutions, including private banks, that operate the app should only be able to see a part of the overall ledger. Like a jig-saw puzzle, nobody should see the full picture but only a few jig-saw puzzle pieces.

While digital money raises the issues of privacy, the connection of digital ledgers also opens up many opportunities. In particular, the digital money ledger can be connected to other ledgers, like blockchain ledgers of B2B platform ledgers, and hence automatic payment executions. It also enables to the introduction of smart contracts.

2.1.1 Connection to end-users and social media platform ledgers

For end-consumers this might be desirable since it makes payments more convenient. Payments will be recorded, and citizens receive perfect overview about their spending patterns and correct behavioural biases like impulse purchases. These data can also improve consumers’ investment decisions. As platforms observe most payments, they will use modern, AI, machine and deep learning mechanisms to better predict each citizen’s credit worthiness. More importantly, credit enforcement will be more powerful as the platform sees all the transactions and can ensure that the debt repayment is deducted before additional funds are spent for other purposes. Whether extending further credit to many citizens is socially desirable has to be carefully evaluated.

2.1.2 Connection to Industry 4.0 platform ledgers

For industry one can envision many B2B platforms with blockchain ledgers that record the movement of every item, from say an engine to a little screw. It is not unreasonable to assume that every industry will have their own supply chain platform: for example, one for the automotive industry, one for the textile industry etc. Whenever a piece of material is moved or a service executed, this is recorded on the corresponding platform ledger. All of these platforms will have their own payment rail, possibly with a platform specific token. The fact that the payment ledger can be connected to the supply chain ledger allows the execution of many “smart contracts”. The platform is in a unique position to provide trade-credit. It can extend credit directly or connect with a fund which does so. The platform has the advantage for several reasons: First, as they see all the payments on the platform, they can ensure that the credit is paid back first before other payments happen. Second, platforms have superior information exploiting big data of transactions using modern AI and deep learning mechanism. Third, and most importantly, they have the power to exclude specific firms (in debt)

from the platform. Defaulting on debt will be extremely costly for debtors and hence they will be very committed to repay their debt.

2.1.3 Smart contracts and Smart CBDC

Private tokens (independently whether they are pegged to a particular currency or not) grant platforms these advantages as “smart contracts” can be written based on entries on the platform ledger. CBDC is also based on a digital ledger but it only has the same advantages if the CBDC ledger can be perfectly linked with the platform ledgers. We refer to this as “Smart CBDC” in Brunnermeier and Payne (2022). If the official CBDC ledger can be integrated with private platform ledgers, e.g. with Industry 4.0 supply chain ledgers, then payments can also be automatically executed but privacy considerations are more challenging.

2.2 The Privacy Challenge

The big challenge however is to find a governance structure for a “smart CBDC setting” that on the one hand grants citizens and firms’ privacy and on the other hand does not destroy the extra welfare-enhancing synergy effects. So far, the discussion on CBDC has ignored this important point of ledger interoperability and integration.

Information that is specific to an individual should stay private, while anonymized information that reveals patterns and statistical models should be public in order to benefit the general public. Individual payment histories, someone’s DNA or X-ray data belongs to the first category. Models and correlation patterns between payment histories and default probabilities, or between DNA and health outcomes belong to the second category.

In addition, information that is needed for crime prevention should not be made available to law enforcement agencies after a court ruling. Money laundering is a classic example. More generally, the right balance needs to be found between granting citizens a right to privacy and the need to prevent crime.

3 CBDC and Monetary Transmission

Whether and to what extent CBDC will affect the transmission of monetary policy depends crucially on the design of the digital Euro. Three important aspects come to my mind.

3.1 CBDC and the Uniformity of Money

First, a digital Euro plays an important role to maintain the uniformity of the Euro. As we have seen during the euro crisis, the euro is subject to fragmentation. For example, a Euro from Greece was not necessarily the same as a euro from Germany during the

euro crisis. Historically, establishing a single uniform currency as common standard as unit of account was a major achievement in monetary history. If there is a common digital euro that e.g. bank deposits can be converted into, then uniformity is better guaranteed than without a digital Euro. This component is the main message in Brunnermeier and Landau (2022).

3.2 CBDC to Defend Transmission Mechanism

Second, CBDC competes with private digital tokens and foreign digital currencies. Issuing a CBDC helps a country to maintain its monetary sovereignty, which includes the power of conducting effective monetary policy. A central bank should be able to stimulate a depressed economy and cool down an overheated economy. Among the roles of money, the role as unit of account is key for monetary sovereignty. Citizens should “think” in the local currency and debt contracts should primarily be denominated and settled in the local currency. If a currency loses this power to another digital currency, then it is “digitally dollarized”. The monetary transmission mechanism becomes ineffective.

3.3 CBDC Interest Payment and Transmission mechanism

Third, the key design element that impact on the transmission mechanism of CBDC is whether CBDCs pay positive and/or negative interest rates. If the introduction of CBDC makes cash less relevant and CBDC can carry a negative interest rate, the effective lower bound in the policy rate is less relevant, which increases the monetary policy space. If CBDC pays a positive interest rate, CBDC is more competitive with bank deposits, forcing private banks to also offer a higher deposit interest rate. That is, a monetary policy tightening of is more directly transmitted to households and firms. Of course, such a shift also affects banks’ optimal maturity mismatch choice and can have larger effects on the financial architecture.

4 CBDC around the World: A Conjecture

One of the common drivers for most countries to introduce CBDC is to provide a “digital form of cash” in an increasingly digitized world in which physical cash became less important. However, there are also secondary motivations to introduce CBDC that differ significantly from country to country. It is helpful to contrast the situation of the euro area, the US, China, and emerging market economies. Given these motives one can speculate about different paths various parts of the world will take.

4.1 Euro Area: Digital Euro as a Catalyst

In the euro area, the digital euro should strengthen the uniformity of the currency and avoid fragmentation but it should also act as a catalyst to digitize the economy. Often

private institutions enjoy rents from payment inefficiencies and hence they are reluctant to update and digitize the current framework. In addition, harmonizing the current framework requires often difficult coordination across member countries of the euro area. Introducing or simply threatening to introduce a competitive CBDC helps to focus the minds of various players and acts as a catalyst for change to a more digitized environment. When all the merchants have to update their payment terminals to be consistent with the digital euro, it is easy to harmonize other payment processes at the same time. In addition, the digital euro could break the dominance of the existing credit card companies and hence provide Europe more geopolitical independence from these companies. So far, the digital euro is very much focused on retail consumers and less on supply chain platforms. The role of a “smart CBDC” is not discussed.

4.2 US: Dominance via US Dollar Stable Coins

In the US, the situation is very different. There exists strong opposition against the introduction of a digital US dollar. Private entities are eager to issue private stable coins that are pegged to the US dollar. The seigniorage from initial coin offerings ends up in the hands of private issuers rather than the central bank. Stable coins issued by supply chain platforms can also be integrated into the supply chain platform and allow automatic execution of payments conditional on delivery of goods and services within an industry. Smart contracts also allow the extension of trade credit with low default rates, as platforms have superior information and can exclude parties from their services. The fact that more than 95% of the stablecoins are pegged to the US dollar makes the dominance of the US dollar even stronger. Hence, given the politic-economic forces from the private sector it is likely that the emphasis is on introducing financial regulation that ensures the stability and soundness of stablecoins rather than introducing a digital dollar.

4.3 China: “Yuanization” via Medium of Exchange Apps

One way which China could increase the global role of its currency, the Yuan, is to promote the online and payment platforms Alipay and WeChatPay in other countries. The connection to other digital services would make the digital tokens on these platforms denominated in Yuan a convenient medium of exchange in many countries. Hence, the Yuan would compete with local currency of many other countries and their economies would be partially digitally “yuanized”. The fact that China is clamping down on the Ant Financial, the owner of Alipay payment system, argues against this strategy.

4.4 Emerging Economies: Protecting Monetary Sovereignty

Emerging economies and developing countries were the first to study and introduce CBDC. Their main motivation is to avoid a “digital dollarization” of “yuanization”. They try to maintain their monetary sovereignty, so that their monetary policy remains

effective in stimulating or slowing down the economy. In addition, they are worried about losing their seigniorage income.

While these forces are different in different parts of the world, the possible future developments, and political forces and hence introduction of CBDC is difficult to predict. Hence, the above conjectures are highly speculative. Nevertheless, the underlying current of increased digitalization and possible marginalization of physical cash suggest that CBDC remains a relevant topic in the future.

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Digital Currencies Panel: Technology Considerations for Central Bank Digital Currency

By Neha Narula[1]

Abstract

Making good technological choices is vital to the success of a central bank digital currency (CBDC), but those choices should ultimately be driven by the social goals of the CBDC project, which should then shape the design and the choice of underlying technology. CBDCs do not need to be built on a blockchain, as many of the desirable features and components commonly associated with blockchain technology can be achieved with other system designs. When designing CBDCs, we should consider how to use innovations in technology to approximate and improve upon the privacy and accessibility of cash, rather than being constrained by the limited model of commercial bank accounts. To strengthen the security and privacy of the system, we should limit the data that is seen and stored at the central bank. Ideally, there should be a technology-policy loop in which technologists and policymakers work together to make design choices for CBDCs.

1 Technology in context

Central bank digital currency is in part a technological innovation, and as such making good technology choices is vital to its success. However, in the past few years of discussion there has been an overemphasis on technology questions. When considering designing or launching a CBDC, it is important to start with social goals, use those to determine policy goals, then derive design choices to achieve those goals, and finally determine what technology can best implement those choices.

However, note that technology research and development should be done in parallel and in conjunction with developing these goals, in order to determine what is even possible. For example, technical innovations in cryptography and distributed systems can enable new architectures or functionality that might not have been possible in previous payment systems, like programmable payments and smart contracts. Ideally, there is a technology-policy loop where rigorous technology experimentation and design feeds into policymaker design choices, and policymaker priorities influence technology experiments.

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1.1 The role of blockchain technology

A CBDC does not require a distributed ledger, or blockchain technology. “Blockchain technology” is an umbrella term spanning many different specific techniques, systems, and designs, and CBDC designers can pick and choose from these individual components. For example, it is possible to achieve programmability, cryptographic designs for privacy, auditability, and real-time settlement, all without using a blockchain.

A core component of blockchain technology is distributed consensus, or protocols for multiple equally-weighted, distrusting properties to agree on the same data. This means blockchains are most helpful in situations requiring distributed governance, or when there is no clear central trusted party to run the system. Distributed governance could be useful when there are several roughly equal partners with no centralized decision-making body. For example, blockchain technology might make sense in cross-border CBDC designs, which involve multiple jurisdictions and no single governing body (BIS Innovation Hub 2021). However, in contexts where there is a clear operator or governing body, like in a retail central bank digital currency, distributed consensus protocols might not be the right choice because they introduce performance overhead and complexity (Lovejoy et. al. 2022).

Beyond technology, an important question in CBDC design is around the operational structure of the entire CBDC system, across the public and private sectors. Many described CBDC models involve the central bank and the notion of some payment service provider (PSP) intermediary (Auer et. al. 2020, Bank of England 20202, Soderberg et. al. 2022). These models oversimplify what will probably emerge in practice–many different types of potential intermediaries that will take on a variety of roles, in cooperation. For example, some intermediaries might provide services which help users custody CBDC, while others could provide services like dispute resolution, KYC, or transaction data management. Services can be unbundled and unlike today’s banking model, it’s not the case that one type of intermediary needs to provide all services. This raises the question: what core platform services should be operated by (or for) the central bank, and what should be done by these various intermediaries? What are the interfaces through which these intermediaries can cooperate, and how do they evolve? These design choices could have a large impact on who sees what data (i.e., privacy) and how easy it will be to innovate on this architecture in the future.

2 Framing CBDC as digital cash

We should consider approximating some of the most useful features of cash as a payment technology. In addition to working without a connection to the internet (or even electricity), people can use cash without a sophisticated mobile device. They do not have to sign up for a user account with a company or sign a terms of service agreement to use cash. Similarly, a CBDC should have offline capabilities to preserve access for users in low-connectivity areas like emerging markets, or in the event of a natural disaster that damages communication infrastructure.

It is also worth imagining CBDC capabilities that go beyond the features of cash. Technology can enable many more possibilities, such as cryptographic designs for privacy or strong accountability. But for the best chance of achieving the promise of CBDCs, we should approach design from the perspective of creating a flexible, interoperable digital bearer instrument, rather than being constrained by the existing paradigm of commercial bank accounts that do not interoperate and are hard to innovate upon.

3 Cybersecurity

The best way to secure data is not to see or store it at all, so CBDC designers should consider designs that minimize what data must be seen and stored at the central bank. This creates resilience in the design by ensuring that the central service supporting the CBDC is not an attractive target for cyberattacks. This approach to data security also works to protect user privacy (Fanti et. al. 2022).

It is also important from a security standpoint to use well-understood and hardened technology, which means familiar cryptographic primitives and best practices from resilient system design. While CBDCs owe much to cryptocurrencies, they should not necessarily rely on the latest, untested blockchain designs.

3.1 Distributing risk

Using advances in technology, especially cryptography, we can introduce designs into a CBDC which reduce risk by removing the need for users to rely as much on third parties who might fail, disappear, lose user funds, or prevent users from being able to access their funds. The technology has an important role to play in improving cybersecurity and reducing risk, and we need to introduce that thinking early in the design process.

As discussed earlier, CBDCs offer an opportunity to consider new architectures for an intermediary ecosystem, which might help distribute data and risk. However, this does mean that sensitive user data will likely be spread across the ecosystem, and there needs to be a plan for how this data will be safely managed and secured.

3.2 Mitigating cyberattacks

Effective, useful CBDC design will eventually require a public-private partnership. One area where this will be helpful is in determining how to mitigate cyberattacks on CBDCs. We already have instances of the public and private sector working together to develop technological standards and potentially self-regulate. For example, Sheltered Harbor is an industry-wide data recovery standard for banks in the United States, developed by the non-profit Financial Services Information Sharing and Analysis Center (FS-ISAC), through which participating banks' data can be recovered even if their local backups are destroyed.

From a regulation perspective, we should consider the risks and roles that various intermediaries take on and regulate accordingly. And we must think about how to promote transparency, competition, and openness so that users will have recourse if an intermediary fails or is hacked.

4 Conclusion

The technological choices made in designing a CBDC will shape its capabilities as well as its security risks. We should think about how to combine existing technologies with appropriate and relevant innovations derived from the cryptocurrency world to create a digital bearer instrument that builds upon the privacy and accessibility of cash. Since CBDCs will likely involve a variety of third-party intermediaries, we must think about what roles they will play, what risks they will take on, and what kinds of user data will be stored and seen throughout the system. Ideally, we should store as little data as possible to mitigate the risk of cyberattacks.

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Contribution to panel discussion at ECB Forum about CBDC and the digital euro project

By Cecilia Skingsley[1]

1 Can a CBDC be designed in such a way that makes it attractive enough to meet public policy objectives but not attractive enough to crowd out other market alternatives?

There is no given answer to this question. Different countries may issue CBDC for different reasons. They will function differently and they will target different parts of the retail payment market. One will have to look at this case by case.

In general, regarding the crowding-out problem there are two dimensions we have to consider. CBDC as a payment service and CBDC as money. The crowding-out problem looks quite different in these two dimensions. Let me start with the CBDC as money.

CBDC as money relates to the CBDC as means of payment and store of value. Here CBDC competes with bank deposits. Looking at what makes a CBDC attractive as a store of value, we should focus on interest rates, caps and that the CBDC is risk free. Interest rates, caps etc. have been discussed by central banks as tools to steer the CBDC demand. Here I think that the central banks that launch CBDC will have the adequate tools to ensure that the CBDC does not crowd out private money.

The CBDC as means of payment is somewhat different. Here, what makes the CBDC attractive is how liquid it is, i.e. how widely accepted it is in the economy and the easy by which it can be transformed in to the desired goods and services. This has to do with network effects and how easy it is to convert CBDC into other forms of money. A part of this is also what legal status the legislator has assigned to the CBDC. Is it a legal tender or not and what does that mean in concrete terms?

I think it is more difficult for the central bank to calibrate the CBDC's attractiveness as means of payment than as store of value. We can do some things within the rule-book of the CBDC and we can decide on the convertibility to other types of money through the design of the CBDC.

This brings me to the last point, the CBDC as payment service. The CBDC, if very popular, could crowd out other payment services. For good and for bad. To my knowledge, all central banks that are considering CBDC are looking at a distribution model where intermediaries provide CBDC payment services to the general public.

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Here, the central bank faces a key trade off. To what extent should it steer the design of these services? We all want the private sector to innovate on the CBDC and then they must have the freedom to do so. But this implies that the central bank loses some control of the CBDC services and, consequently, how attractive they will be. A private sector innovation on CBDC could, at least in theory, crowd out other private services. But if we limit the freedom to innovate, we may end up with other un-attractive results.

Finding the “Goldie Lock zone” for the CBDC where it is not to small and not too large will not be easy but it is nothing that keeps me awake at nights. We have to accept that there are uncertainties and that we cannot control everything. The change from a CBDC will be gradual over time and we will have the time to react.

2 How could a CBDC help overcoming obstacles in cross border payments?

Our current cross-border payments face many challenges, such as high funding costs, long transaction chains, complex compliance checks, and mismatch of operating hours, to mention a few.

I guess it is fair to say that CBDC is not the silver bullet that will solve all the problems. However, CBDC could address some of them. For one, CBDC is central bank money – the safest settlement asset that we have, and it would reduce the settlement risk. In addition, CBDC systems will almost certainly be built to be available 24/7 and would then remove any mismatch of operating hours between jurisdictions.

On the other hand, we still need to harmonize and ensure that we can have more efficient compliance checks. This is nothing that CBDC in itself can solve, but CBDC can act as an additional incentive to push this work forward.

I think it is important to highlight that the role and impact of CBDC for cross-border payments is still uncertain. We are still in the exploratory phase, and the final designs are yet to be determined. Two key questions for central banks are going to be how to grant access and how to make systems interoperable.

When it comes to access, we can think of two dimensions.

First, how are we granting access to foreign PSPs? Would we grant them direct access or indirect via domestic PSPs – a sponsor type of model – or are we thinking of a closed access model where only domestic PSPs are participating? I think we should strive towards a more open and direct access model since this would enhance cross-border payments by shortening the transaction chain. This of course put pressure on our ability to align regulatory frameworks and supervision.

Second, are we allowing non-residents to use the CBDC? And would such access be limited through caps or fees? There is a spectrum here. We could grant tourists access or non-residents with some connection to the issuing jurisdiction. We could also have a very open policy where anyone could use the CBDC. I think the latter case would raise concerns regarding negative spillovers.

In general terms, granting very generous access to non-residents could lead to risks with currency substitution in other countries, especially in some emerging markets. To mitigate this, we could put restrictions on the use outside of the jurisdiction, and we could have limits or fees that restrict the use by non-residents. Or not grant access at all to non-residents.

While access is one key question, interoperability is another. Systems can be made interoperable in different ways. We can think of three broad classifications here: compatibility, interlinking, and single system. While compatibility would not require any formal connection of systems but would rather rest on some common standards (such as messaging standards) that help PSPs to facilitate cross-border payments.

On the other end of the spectrum, we have a single system type of model where jurisdictions would actually share a common technical platform. In between, we have interlinking, where jurisdictions build connections between our domestic systems. Interlinking can be done in different ways. We could have bilateral arrangements or a hub-and-spoke type of model, where a central hub connects to all the different systems.

There are several benefits of sharing a platform and from interlinking. We could for example offer instant settlement of cross-border retail payments in central bank money. Having instant PvP settlement in central bank money would, of course, reduce the risk, increase the speed and bring overall benefits to cross-border payments.

One advantage we have right now with CBDC is what we often call a clean slate opportunity. CBDC is new to us all, and we are all working on it. Given this, we have an opportunity to consider the cross-border functionality from the start. Now, this of course requires us to cooperate and coordinate, and I think it is important that jurisdictions take a cross-border perspective into account in their domestic work.

Let me make one final point on this. I think there is also a diversity and competition aspect to this. Just by offering an alternative to those we have today could bring benefits and potentially serve segments of the market that is currently underserved. For example, say that we domestically manage to enhance financial inclusion through CBDC issuance. In turn, this would likely also improve financial inclusions in the cross-border context. I also think that with the right design CBDC could improve overall competition in the payments market, both domestically and with respect to cross-border payments. It might put pressure on other private solutions to improve their services.

References

"Options for access to and interoperability of CBDCs for cross-border payments" (2022) Joint report to the G20 by the Bank for International settlement's committee on Payments and Market infrastructures, the BIS Innovation Hub, the International Monetary Fund (IMF) and the World bank.

Real estate booms and busts: implications for monetary and macroprudential policy in Europe

By John Muellbauer[1]

Abstract

Housing is the single largest component of wealth for the majority of households in the Euro area countries with implications for consumer spending, and residential investment is a volatile element of aggregate demand. Real estate collateral plays an important role in bank lending. In advanced countries, financial crises often begin with an overvaluation of asset prices, especially of housing and commercial real estate, preceded by poor quality of lending and excessive credit growth funded by sometimes highly leveraged lenders. Interactions between the credit cycle and real estate have important financial stability implications. This paper examines the empirical evidence on the complex channels of transmission of monetary policy and loan standards to lending interest rates, and via house prices, to residential investment, debt, wealth, consumption and non-performing loans. Though relevant both for monetary and macroprudential policy, most current central bank policy models have an inadequate coverage of these channels.

[1] John Muellbauer is Professor of Economics at Oxford and Senior Research Fellow at Nuffield College and the Institute for New Economic Thinking at Oxford's Martin School. Acknowledgements: I am grateful to my long–term research collaborators Janine Aron, the late Gavin Cameron, Valerie Chauvin (Bank of France), Riccardo DeBonis (Bank of Italy), John Duca (Dallas Federal Reserve), Felix Geiger (Bundesbank), Danilo Liberati (Bank of Italy), Ronan Lyons, Keiko Murata, Anthony Murphy (Dallas Federal Reserve), Concetta Rondinelli (Bank of Italy), Manuel Rupprecht (ex-Bundesbank) and David Williams (ex-Bank of Canada). At the ECB, Celestino Giron, Phillip Hartmann, Jan Hannes Lang and Annachiara Tanzarella have been especially helpful, but I have benefitted also from the advice of Elena Angelini, Nikola Bokan, Matteo Ciccarelli and Srecko Zimic. AnnaMaria Cavalleri and Boris Cournède of the OECD have kindly shared some of their data. For information on the Netherlands, Robert-Paul Berben of the DNB has been unfailingly helpful. Olympia Bover, Samuel Hurtado, Eva Ortega, Carlos Perezmontes and Irene Roibas, all from the Bank of Spain, have helped navigate the Spanish data. Paul Egan and Adele Bergin from the ESRI have been very generous with advice and data on Ireland. Fabio Busetti and Guido Bulligan from the Bank of Italy have provided helpful additional information on the quarterly model. I have also benefitted from the advice of Vitor Constâncio, Matthieu Lemoine, Rainer Martin, Eric Monnet, James Tatch and Clara Wolf. David Murakami provided some research assistance. I am grateful for comments on earlier versions to an anonymous referee and to Valerie Chauvin, John Duca, Roland Meeks and Lars Svensson and to my discussant Giovanni Dell'Arricia for a considerable expansion of the evidence base on the themes of the paper. Above all, I am very grateful to Janine Aron for many helpful suggestions and improvements in the paper.

1 Introduction

Real estate collateral plays a critical role in bank lending and financial stability. Financial crises in advanced countries often begin with a serious overvaluation of asset prices, especially of housing and commercial real estate, alongside poor quality of lending and excessive credit growth funded by often highly-leveraged lenders (Jordà, Schularick, and Taylor (2015) and Müller and Verner (2021)). The value of non-performing loans (NPLs), including those for commercial and residential real estate, while low and stable in boom periods, can rise sharply when the crisis breaks. Rising NPLs raise funding costs for banks, damaging their efficiency and profitability. As banks apply tougher lending standards for firms and households, a credit crunch may follow with falling GDP or stagnant economic growth. Thus, the interaction of the credit cycle and real estate has important financial and macroeconomic stability implications.

Housing and commercial real estate markets, and the associated credit markets, are also important for the channels of monetary transmission and the fiscal and monetary policy choices for macroeconomic stabilisation. There is considerable heterogeneity in real estate-related monetary transmission across countries, which depends on housing market institutions, and this should affect policy choices. For most households in Euro area countries, housing is the single largest component of their wealth, and potentially affects levels of consumption. Moreover, commercial and residential building investment is one of the most volatile elements of aggregate demand. Yet the role of real estate has been neglected in research on monetary transmission,[2] though less so since the Global Financial Crisis (GFC), see for example, Mussa et al. (2011), Calza et al. (2013) and Nocera and Roma (2017). This neglect is reflected in the central bank structural models currently in use. By contrast, detailed attention has been given to risks linked to real estate and associated credit markets since the GFC in the comprehensive framework of financial supervision, risk assessment and development of macroprudential tools at the ECB, the European Systemic Risk Board, the European Commission, the IMF and the BIS, as well as at national central banks.

The Global Financial Crisis triggered what has been little short of a revolution in macroeconomic thinking away from the dynamic stochastic general equilibrium (DSGE) approaches with representative agents and towards heterogeneous agent models in an incomplete market setting (Appendix 1 gives a bird's eye summary). Heterogeneity, trading and search costs, asymmetric information, and credit constraints are ubiquitous in housing markets, see Glaeser and Nathanson (2015), yet were neglected in DSGE model approaches. There is now a greater understanding of how real estate markets, the financial sector and the real economy interacted in the financial accelerator that operated during the GFC. This has helped change the conventional wisdom about monetary transmission. One result is a new focus on household balance sheets and the related distributional effects that have aggregate

[2] As an example of this, in the edited collection by Angeloni, Kashyap and Mojon (2003), gathering the results of the 1999-2001 Network on Monetary Transmission, there is barely a mention of housing, real estate and mortgage lending, quite apart from any analysis. The few exceptions are in chapters on the bank lending channel for the Netherlands and Spain.

consequences. Another is that new attention is being given to bank balance sheets, the role of banks in generating credit and which factors drive the variation in lending standards, all important for financial stability and macroprudential policy. Evidence-based research on real estate requires a flexible approach, and semi-structural econometric policy models provide greater scope to learn from data than the previous generation of DSGE models.

Comparative housing market history is important for examining previous booms and busts, some connected with major banking crises. Comparing the different histories across countries is helpful for understanding drivers of housing fluctuations and why institutional differences matter. For housing market participants, history shapes attitudes to housing market participation and tenure choice and recent history affects expectations of future appreciation. Accordingly, the paper begins by reviewing comparative national data in the Euro area on ratios of house prices to the general price level, to income and to rents, and rates of growth of nominal house prices (section 2). Corresponding data on the mortgage debt of households relative to income and for mortgage and other interest rates are examined. Comparisons are made of the historical record on residential investment, demonstrating the remarkable volatility of this component of aggregate demand.

An overview of the role of real estate in the financial accelerator during the GFC is given in section 3, with reference to several countries strongly affected by house price shocks, including the US, Spain and Ireland. The financial accelerator propagates and amplifies real estate shocks to the wider economy, especially if a banking crisis results. Institutional heterogeneity in real estate markets across the different countries, and the institutional evolution over time, affect the transmission channels of real estate prices and the scope for an amplification of such shocks.

There are parallel implications for an understanding of how real estate is involved in the channels of monetary transmission. I argue that six elements should be distinguished in the monetary transmission process to aggregate demand, operating via mortgage and housing markets. The first concerns transmission from monetary policy to interest rates set by lenders to borrowers in housing markets. The second covers the determination of interest rate-sensitive house prices. The third and fourth elements concern two important components of aggregate demand: transmission from house prices and interest rates to residential investment, and transmission from house prices and interest rates to consumer spending. The fifth is the determination of mortgage debt, important both for its consumption implications and for financial stability. The sixth element concerns non-performing loans and the credit cycle. There is also the possibility, in some countries, of an income expectations channel in which higher house prices are associated with greater optimism about growth.

The transmission via a real estate channel to inflation is briefly considered in Appendix 2. This concerns the transmission to inflation other than operating through the unemployment rate or the output gap, the traditional ingredients of Phillips curve models of inflation. Rents are an important component of the cost of living, potentially strongly affected by developments in real estate markets. Little research has been carried out for Euro area countries on possible channels by which monetary policy, via

real estate prices or the cost of finance, might transmit to rents or indeed to wage setting.

Model evidence on the six housing-related transmission mechanisms presented in section 4 gives a new perspective to the long-run transmission of monetary policy. A tabular typology is provided assessing the degree to which these six elements are currently captured in the equations of seven central banks' semi-structural policy models. A key finding of the paper is that well-specified equations for the six channels of monetary transmission need to include controls for non-price credit conditions or lending standards to avoid major distortions in both dynamics and long-run relationships.

The inclusion of these controls is also essential for the analysis of risks to financial stability and the formulation of macroprudential policy. This is because, as the opening paragraph indicated, loose lending standards which increase real estate prices and credit growth, often precede a financial crisis or a recession in which NPLs rise. Variations in lending standards are an important driver of real estate prices, credit growth, consumer expenditure and residential investment and hence economic activity, but eventually also of NPLs, as are interest rates. This is one side of the connection between lending standards and the credit cycle, including NPLs. But higher NPLs lead to tighter lending standards which amplify the downturn in the economy, which is the other side of the connection between NPLs and lending standards. But as interest rates themselves affect NPLs and hence lending standards, a full appreciation of the complex channels of monetary transmission is strongly complementary to an understanding of how credit shocks can be transmitted and amplified in the financial accelerator.

These conclusions are supported by empirical evidence for France. France has good historical data on NPLs, which is not the case in all Euro area countries. Fortuitously, France also spans an intermediate position between Germany and Italy on one side, and Ireland, Spain and the Netherlands on the other, in terms of the scale of the house price cycle and of those institutional characteristics that tend to heighten the importance for the economy of the housing/credit cycle. Our analysis builds on the empirical model for the household sector developed in Chauvin and Muellbauer (2018), which showed that non-price credit conditions (lending standards) could be extracted as a latent variable in a system of equations. This lending standards measure proves to be important for explaining house prices, mortgage debt and consumer spending. The measure of lending standards, since 1991, after financial deregulation, is strongly driven by the NPL ratio. New equations for pass-through of policy rates to mortgage interest rates, for residential construction and for forecasting the NPL ratio complete the analysis of the six channels of monetary transmission and of the French credit cycle (section 4).

Section 5 summarises the key implications from this empirical survey of the six real estate-related channels, for both monetary policy and stabilisation policy. It also proposes several improvements in current central bank policy models, the better to incorporate real estate features. Concrete proposals are made for improving risk monitoring and for estimating house price over-valuation. For macroprudential policy, a difficult issue is to track the quality of lending standards by correctly interpreting the

data on house prices, credit growth, and any data that may be available on loan-to-value and loan-to-income ratios. An alternative possibility is to use the latent variable model developed for France in Chauvin and Muellbauer (2018), which offers a powerful method for extracting information on lending standards from the data, and separates out credit supply side shifts from the demand side. These extracted lending standards measures have major forecasting power for determining future levels of NPLs, and as such are a useful addition to available statistical indicators of risks ahead.

One area where there is a considerable gap in our knowledge concerns the role of commercial real estate, handicapped by severe data constraints. There are important differences between residential and commercial real estate markets for monetary transmission, and also for financial stability, with policy implications, and this is discussed in section 6.

Section 7 addresses financial stability issues related to real estate in more detail. The effectiveness of recent macro-prudential policies in Europe in reducing real estate-linked vulnerabilities is assessed in the context of country institutional heterogeneity highlighted in this paper. Heterogeneity also limits the scope for the ECB to 'lean against the wind' to protect financial stability. The current prospects for financial stability are discussed in the wake of the pandemic shock and huge disruption to energy supplies, supply chains, trading patterns and inflationary shocks from Russia's war on Ukraine. These have exacerbated the post-pandemic inflationary pressures. Country-by-country evidence showing potentially over-valued real estate, and the vulnerabilities of households and the financial sector, is contained in recent reports by the European Systemic Risk Board and its financial stability risk dashboard, the ECB Financial Stability Review, and by the European Commission. The nature of this evidence is discussed.

The final section summarises conclusions for policy-making and discusses how more holistic approaches to policy, through cooperation with branches of government, can help address underlying dislocations in housing markets, especially those linked with inequality, climate risk, and efficient resource allocation.

2 Why housing market history matters

As mentioned in the Introduction, comparative housing market history is important for examining previous booms and busts, some connected with major banking crises. Apart from the OECD house price database, it proved remarkably difficult to obtain long runs of broadly consistent historical data for residential investment, mortgage interest rates and mortgage debt – indeed impossible without help from central bank economists.

The history of house price movements at the national level is displayed in Charts 1 to 3 for the five largest Euro area economies plus Ireland, using the OECD database. These economies cover a sufficiently wide spectrum of historical experiences and institutional differences to be representative of the 19 economies in the Euro area,

discussion of all of which would be beyond the scope of this paper. The behaviour of real house prices following the first oil price shock of 1973 has potentially interesting implications currently, with comparable energy price shocks exacerbated by the war in the Ukraine. Chart 1 illustrates that real house prices tended to rise after 1973, particularly in the more inflation-prone of these countries, so that housing proved a good inflation hedge. Chart 3 shows the remarkable rise in nominal house prices in Italy following the November 1973 oil price shock.

A major difference from the present is that the 1973 OPEC shock was not preceded by significant appreciation. By contrast, with the exception of Italy, real house prices in most of the Euro area have risen strongly since 2015. The significance is highlighted by the UK experience, where the OPEC shock in November 1973 was preceded by a huge house price boom, with prices rising at an annual rate of 50 percent in the first quarter of 1973. UK nominal house prices did not fall in 1974-5, but real house prices had fallen by about 40 percent by 1975 in the consumer price inflation that followed the OPEC shock. The figures illustrate that real house prices fell after the second oil price shock of 1979,[3] in the subsequent recession and with sharp rises in interest rates in many countries. Europe again faces a severe stag-flationary recession, although rises in interest rates on the scale of the early 1980s are most unlikely, given debt levels (discussed further in section 7).

The real house prices and house price to income ratios point to a notable boom in house prices in the late 1980s particularly in Spain[4], Italy and France. This period saw considerable financial liberalisation, with relaxation on cross-border financial flows in much of the EU.[5] In Scandinavian economies and the UK, deregulation was even more pronounced and led to strong housing booms with a pronounced speculative element, especially where mortgage interest tax relief with high marginal tax rates was maintained. In 1990, the Soviet Union collapsed, and German interest rates rose following unification, putting upward pressure on interest rates for those European countries in the exchange rate mechanism (ERM), see Chart 4. The downturn that followed in Italy, Spain and France in the early to mid-1990s was associated with a rise in bad loans at banks. In Norway, Sweden and Finland severe banking crises followed the 1980s boom, see Steigum (2010) for a comprehensive account; in the UK, the Bank of England launched a secret life-boat in 1992 to rescue the providers of mortgage indemnity insurance to the banks. Chart 5 shows the profile of real house prices for these Scandinavian countries and the UK, demonstrating the boom-bust pattern, and providing an interesting precursor for similar patterns in the GFC.

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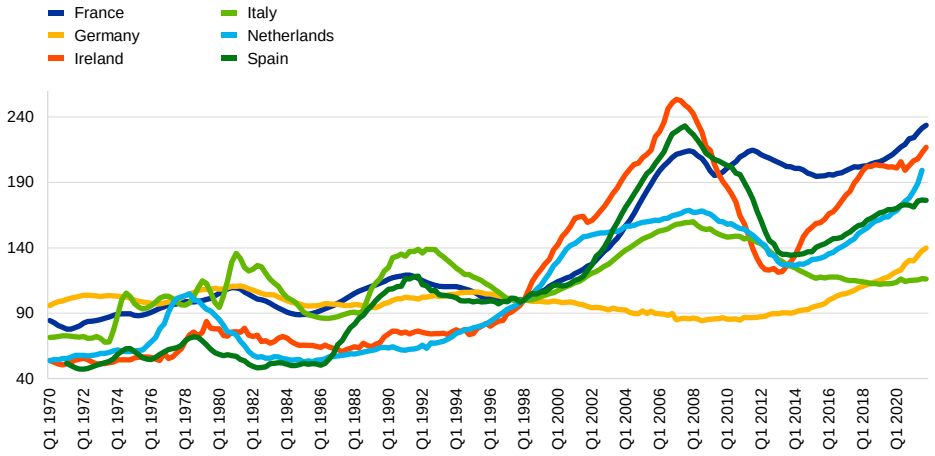
3 Inflation-prone Italy is a brief exception: real house prices rose briefly before following the general downward trend. Chart 3 shows annual nominal house price inflation peaking at over 60 percent in 1981.

4 The Spanish data overstate the rise as before 1987, Spanish house prices were based on those of Madrid, where rises were greater, rather than for the country more generally.

5 See for example Melitz (1990) and the 1993 report of the French banking supervisor.

Chart 1

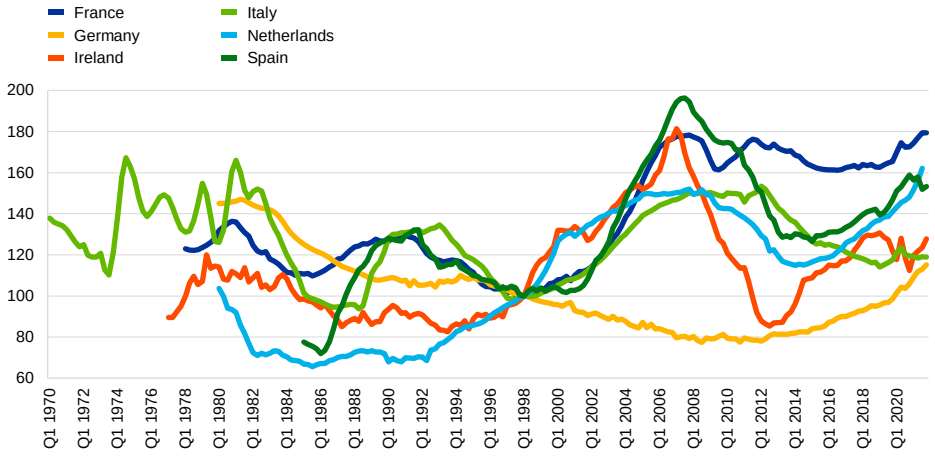
Real house prices in 6 Euro area economies



Source: OECD.
Notes: National house price indices are deflated by national consumer expenditure deflators, 1998Q1=100.

Chart 2

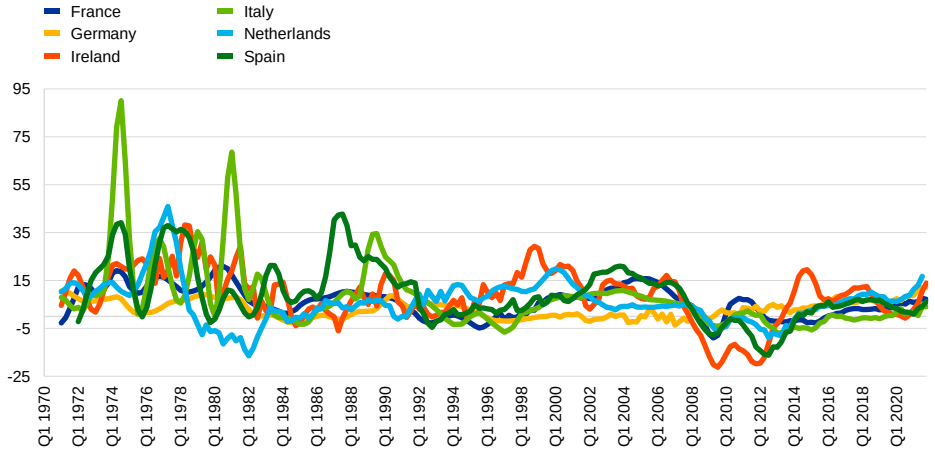
House prices relative to incomes in 6 Euro area economies



Source: OECD.
Notes: National house price indices are deflated by per capita household disposable income, 1998Q1=100.

Chart 3

Four-quarter percentage changes in nominal house prices



Source: OECD.
Notes: Four-quarter percentage change in national house price indices.

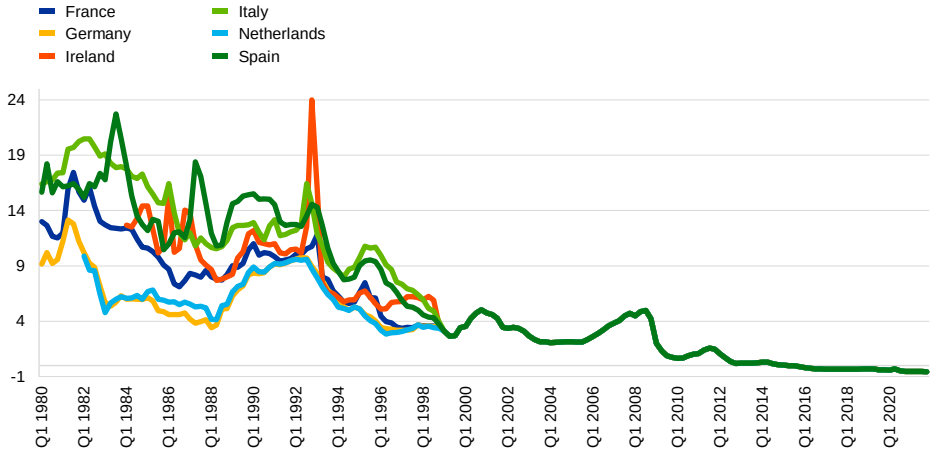
In the run-up to the introduction of the Euro, the common monetary policy and the relaxation of cross-border barriers to financial flows, interest rates fell sharply in the countries with previously high nominal interest rates and historically higher inflation, see Charts 6 and 7. A new upswing in house prices began in 1998, though a little earlier in Ireland and in the Netherlands. Lending conditions became particularly loose in Ireland and Spain. In Ireland, mortgages were increasingly funded from short-term international money markets, introducing serious duration mismatch between long-term mortgage loans and short-term funding. In the Summer of 2007, a liquidity crisis developed in the money markets and funding suddenly dried up. With the onset of the GFC, real house prices fell sharply, especially in Ireland and Spain with major banking crises and also in the Netherlands and Italy. Country risk spreads in sovereign yields relative to Germany rose, see Chart 6, and increased further in the European Sovereign Debt crisis, peaking in 2010-12,[6] giving further momentum to a fall in house prices outside the core Euro area.

After the easing of the sovereign debt crisis, risk spreads narrowed and, through targeted longer-term refinancing operations (TLTROs) in 2014, 2016 and 2019, further unconventional monetary policy brought down long interest rates, see Chart 6. With the exception of Italy, house prices rose in the other five countries from 2015, though earlier in Ireland owing to its early bail-out, a refinance of its banking system and the development of supply constraints.

[6] Bail-outs for Greece and Ireland were agreed in 2010 and for Portugal in 2011. Greece obtained a second bail-out in 2012. The recapitalisation of banks, which in Ireland and Spain was made necessary by a bad real estate debt crisis, preceded by too loose lending conditions for real estate, resulted in large increases in sovereign debt. In September 2012, preceded in July 2012 by Mario Draghi's famous speech, see Draghi (2012), the ECB calmed financial markets by announcing unlimited support through the Outright Monetary Transactions (OMT) programme for all euro area countries involved in a sovereign state bailout/precautionary programme from the 2010 European Stability Mechanism and its predecessor, the European Financial Stability Facility.

Chart 4

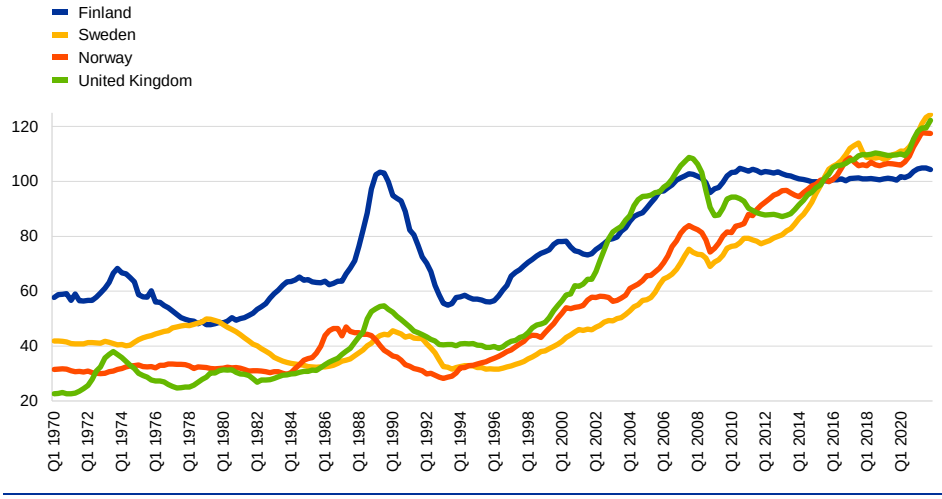
Short-term interest rates in 6 Euro area economies



Source: OECD.
Notes: Short-term interest rates are based on 3-month T-bills.

Chart 5

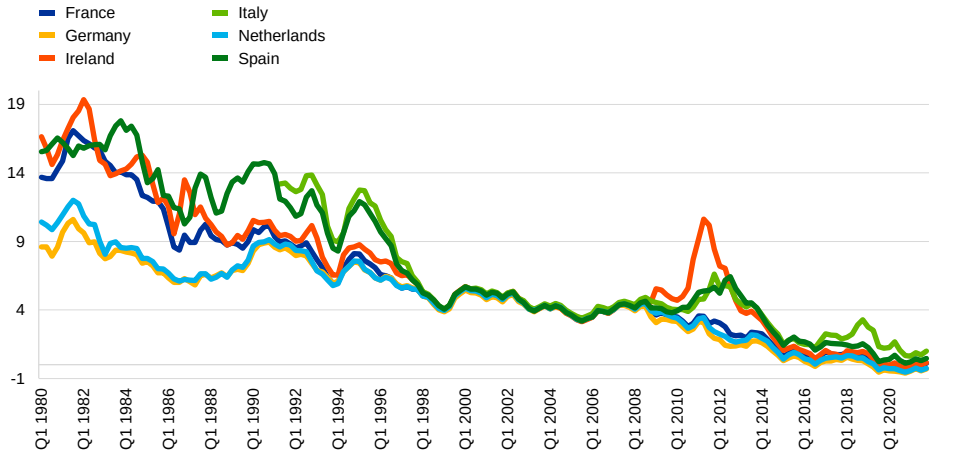
Real house prices in Norway, Sweden, Finland and the UK



Source: OECD.
Notes: National house price indices are deflated by national consumer expenditure deflators, 2015=100.

Chart 6

Long bond yields in 6 Euro area economies

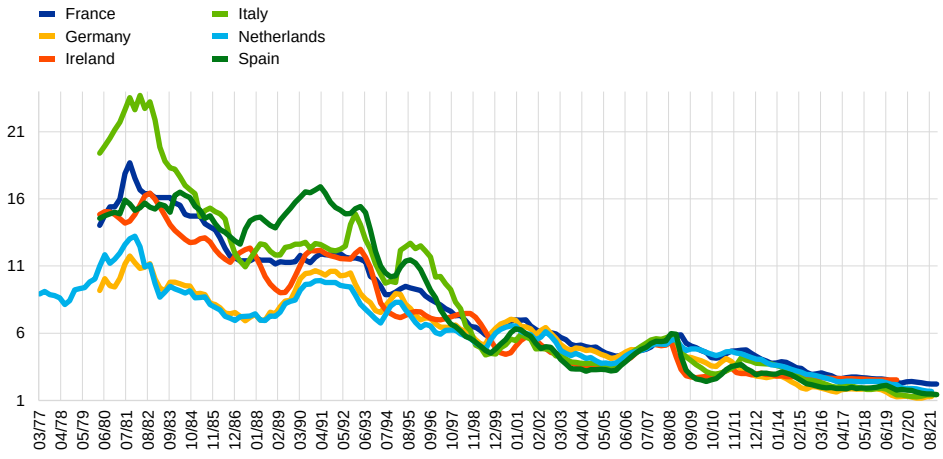


Source: OECD.
Notes: Long term interest rates are based on 10-year sovereign bond yields.

Chart 7 shows mortgage interest rates for these six Euro area economies, displaying broadly similar patterns to those of the long bond yields. However, the convergence following monetary union is far less complete, given idiosyncratic domestic risk factors and bank credit availability. In the sovereign debt crisis in 2010-12, mortgage interest rates diverged between Ireland and Spain on the one hand and core Euro area economies on the other. However, yields on 10-year Treasury bonds diverged even more: evidently, market participants at the time considered domestic mortgages less at risk of default than government debt.

Chart 7

Mortgage interest rates in 6 Euro area economies



Source: National Central Banks.
Notes: The French data are typically for 10-year fixed rate loans and include other charges. Interest rates for other countries exclude fees.

In 2020-2021, despite the Covid-19-linked recession, house prices in most countries rose strongly, with the temporary exception of countries heavily dependent on tourism – Spain and Italy. House prices behaved differently than in prior downturns for several reasons. The initial shocks were very different, the financial system was better

capitalised, and most households were not overly indebted (especially in contrast to the US at the start of the GFC). There was a quick and broad set of economic policy responses. Those relevant for housing were: (a) the use of unconventional and conventional monetary policy to lower long-term interest rates; (b) the imposition of moratoria on foreclosures/home repossessions and renter evictions; (c) the aggressive modification of mortgages to prevent defaults; and (d) large transfer payments to households, the unemployed and furloughed workers, coupled with significant credit support to firms, and (in some countries) employment subsidies that buttressed household income. These actions averted a long recession and a financial crisis. Moreover, a Covid-19-related relative rise in the demand for detached housing (and space in general under lock-downs) initially boosted house prices.[7] On the supply side, lockdowns, pandemic-related supply chain disruptions and labour shortages temporarily reduced the supply of new housing.

Data so far available in 2022 provide little information on how housing and mortgage markets are responding to the enormous global and European shocks resulting from the Russian war on Ukraine. These have come on top of already large rises in 2021 in raw material prices, and rising general inflation induced by supply chain disruptions, tight labour markets, high levels of labour market mismatch and post-Covid demand recovery.

For completeness, Chart 8 shows house price-to-rent ratios, with broadly similar implications for the visualisation of house price cycles to those in Charts 1 and 2. However, though most countries have removed or softened rent controls prevalent in the 1970s and 1980s, the OECD's rent indices are a mixture of rents in subsidised social housing and market rents.[8] For this reason, these rent indices are far from ideal in consistently tracking free market rents. This makes the house price-to-rent ratios a less reliable guide to history.

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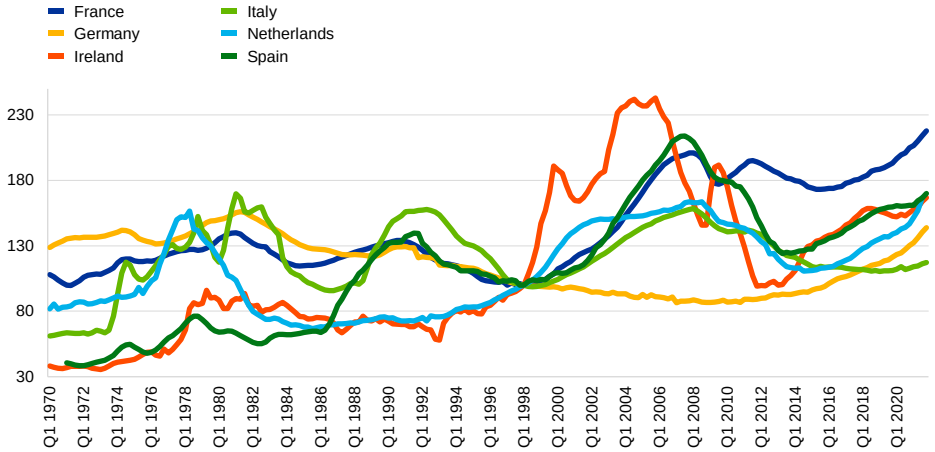
7 See Gupta et al. (2021) for evidence on the flattening of the urban house price and rent gradients between central and more peripheral locations in the UK. Ramani and Bloom (2021) point out the pandemic's "donut effect" on the relative prices of suburban versus urban house prices in the US. Belemi et al. (2021) review literature from 2020-21 on the effects of the pandemic not only on housing but on mortgage markets and commercial real estate.

8 For example, in the Netherlands, three-quarters of rental properties belong to the subsidised social housing sector.

Chart 8

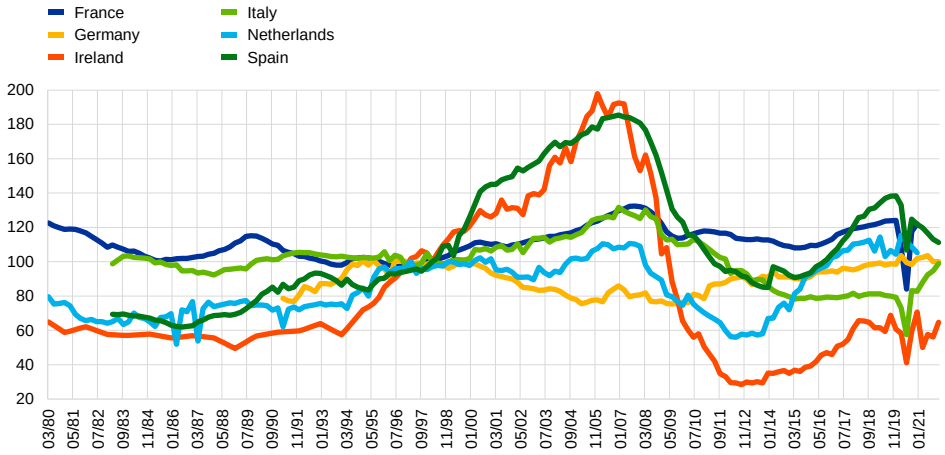
House prices relative to rents in 6 Euro area economies



Source: OECD.
Notes: National house price indices are deflated by OECD indices of rent, 1998Q1=100.

Chart 9

Per capita residential investment in constant prices



Source: OECD.
Notes: Residential investment in constant prices.

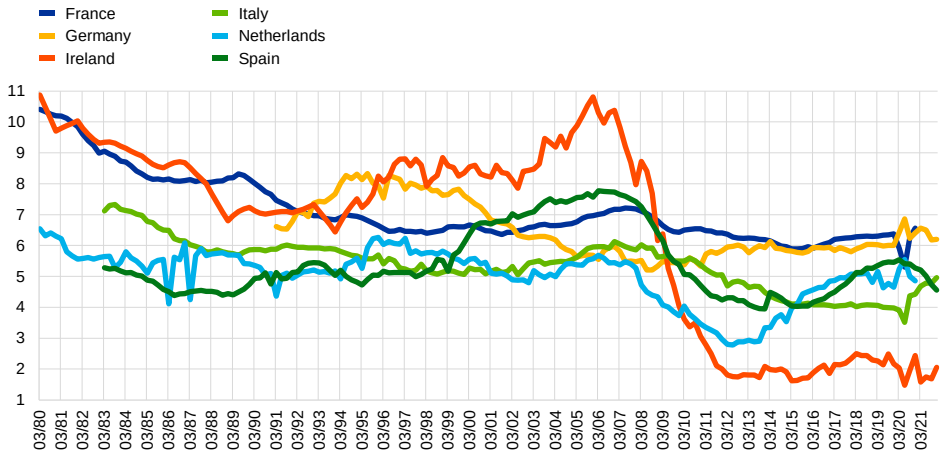
Alongside strongly cyclical house prices, residential investment has proved an extremely volatile component of aggregate demand. Chart 9 shows per capita residential investment on an indexed basis (1998Q1 = 100). The enormous building boom, from 1998 to 2007, especially in Ireland and Spain, was followed by a collapse, particularly severe in Ireland, where even now per capita residential investment remains below its 1995 level. The wave of bankruptcies in the Irish building industry and in the supply chain imply a long-term loss of capacity, making it unlikely that previous model relationships explaining residential investment could remain intact. Spain, the Netherlands and Italy also suffered sharp falls and a smaller decline occurred in France; Germany had no reduction and its house prices appeared immune from the GFC and the sovereign debt crisis.

Chart 9 shows the ratio of residential investment to GDP, both in constant prices. In all countries there are pronounced variations in this ratio, and even in Germany where there was a post-unification building boom with substantial subsidies for investment in the former East Germany. For the countries most affected by the GFC – Ireland and Spain – the volatility is staggering, but is large even for Italy and the Netherlands, which were less affected by the GFC. Unsurprisingly, the relative movements of residential investment are strongly related to the relative movements of house prices (discussed further in section 4).

This examination of the historical evidence on housing concludes by comparing levels and movements in the mortgage debt of households relative to their net disposable income, see Chart 11. The differences in the levels between countries are vast, for example from over 200 percent for the Netherlands in recent years to around 35 percent in Italy. The dynamics of the debt-to-income ratio also differ greatly. There was huge growth in Ireland and Spain before the GFC, large growth in France and the Netherlands, much more modest growth in Germany, while Italy's ratio remained at low levels despite some growth since 1999.[9] These remarkable differences between countries in a common monetary union reflect large institutional differences in housing market and credit institutions and their evolution, and divergent economic histories.

Chart 10

The ratio to real GDP of residential investment in percentage terms

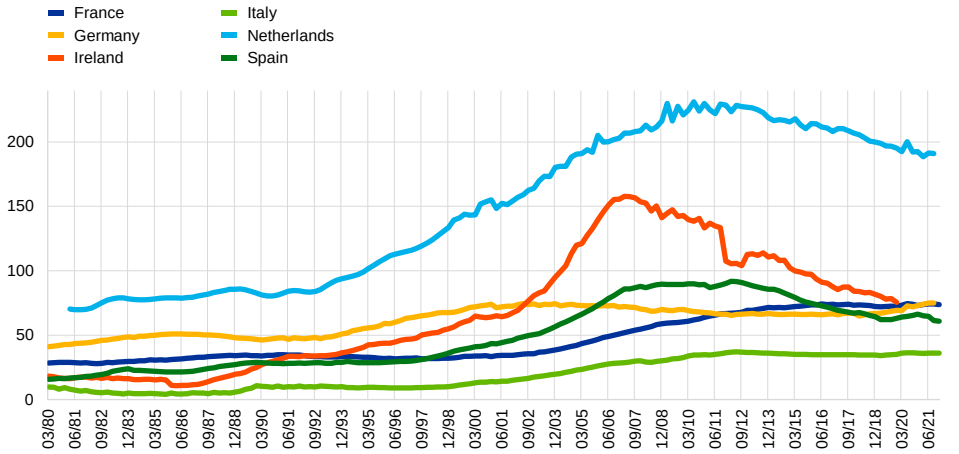


Source: OECD.
Notes: Residential investment in constant prices, GDP in constant prices.

[9] Mortgage debt data in Italy begin only in 1999. In Chart 11, data for total household debt are spliced to the mortgage debt data before 1999. For Spain, the mortgage data begin in 1994 and total household debt data are similarly spliced before then. European data seldom match the comprehensive definition of types of debt on household balance sheets in the Federal Reserve's Z1 whole-economy balance sheets available from 1952.

Chart 11

Mortgage debt to income ratios in 6 Euro area economies



Source: National Central Banks.
Notes: Pre-1999 data for Italy is spliced to total household debt; and pre-1994 data for Spain is spliced to total household debt. Housing loan data may not always be fully comparable, e.g., in the treatment of securitised debt, which is sometimes deregistered from bank balance sheets.

3 Financial stability and monetary transmission: real estate and country heterogeneity

The Global Financial Crisis has triggered a fundamental rethink of macroeconomics and monetary policy away from the mind-set and the associated DSGE models of the New Keynesian 'Science of Monetary Policy' (Clarida et al., 1999). As Goodhart and Tsomocos (2009) argue, firstly "DSGE models are *not* properly micro-founded, in that their basic assumptions are totally at odds with human behaviour" and secondly "that there is no real role for money or banks". They argue that owing to the exclusion of defaults, "the standard DSGE model has been completely useless as a guide to the recent financial crisis, which has, of course, been characterised by default and sharply increasing risk premia driven by concerns about the rising probability of default". Other deficiencies and the implications for the design of better policy models were pointed out in Muellbauer (2010, 2018b) and Hendry and Muellbauer (2018). Since the GFC, the accumulation of evidence, both macro and especially micro, has further undermined key elements of the old framework, particularly as expressed in the representative agent, rational expectations New Keynesian DSGE models, see the special issues in 2018 and 2020 of the Oxford Review of Economic Policy and the 2018 special issue of the Journal of Economic Perspectives. For those interested, Appendix 1 gives a brief overview of these shifts in macroeconomic thinking.

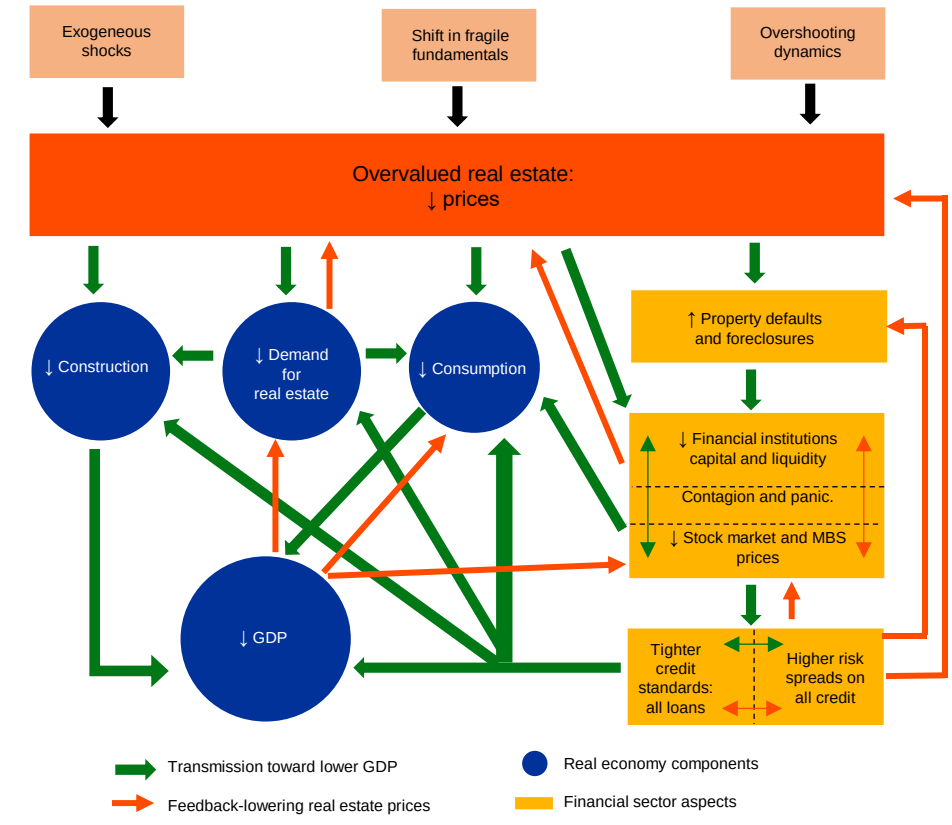
3.1 The financial accelerator: real estate and institutional heterogeneity

It is by now well accepted that the linkages between the financial system and global economy, some non-linear and destabilising, were not well understood before and during the GFC. In that crisis, falling real estate prices were amplified in the financial system and by its interaction with the real economy, leading to further price collapses.

For example, almost all housing economists now agree that many market participants form house price expectations in part by extrapolating past house price changes, see Duca, Muellbauer and Murphy (2021a) and Kuchler et al. (2022). This is one of the mechanisms by which house prices can become over-valued relative to fundamentals, creating serious risks for financial stability. The pre-crisis deterioration of lending standards in the US was a major factor in the boom and subsequent sub-prime crisis, see spatial evidence by Dell' Ariccia et al. (2012). The tightening of standards in the crisis amplified the downturn. Examining how these processes of interaction between real estate the financial system and the real economy operated in the GFC gives important insights into risks for financial stability but more generally illuminates the complex ways in which real estate interacts with the wider economy, including in more normal cyclical fluctuations. This is a helpful background for thinking about the complex channels of monetary transmission via real estate, including the role of institutional heterogeneity, considered in section 3.2.

Depending on local circumstances, the possibility of amplifying transmission and feedback processes, can generate a powerful financial accelerator. Figure 1 illustrates how these processes operated in the US during the GFC.

Figure 1
The Financial Accelerator in the US Sub-Prime Crisis



Source: Duca et al. (2021).

The transmission channels from falling real estate prices to the real economy are shown on the left-hand side of Figure 1. Lower prices, amplified by extrapolation of recent falls which lowered demand for real estate, lowered the profitability of building.

Many home builders, faced with the collapse of cash flow and the value of their land banks, went bust and residential investment slumped. An important demand channel came via weaker consumer spending (the third thick transmission arrow from the left). Lower house prices lowered consumer spending, as housing collateral is an important driver of consumption in economies such as the U.S. GDP fell with consumption and construction.

The transmission channels from falling real estate prices into the financial sector are shown on the right- hand side of Figure 1. With the decline of prices and the concomitant rise of many mortgage payments (due to reset clauses), mortgage delinquencies and foreclosures rose, shown in the small top rectangle.

Real estate losses mounted at financial intermediaries, particularly on commercial mortgage-backed securities and private label (residential) mortgage-backed securities. The combination of losses on commercial and residential real estate undermined the capital positions of commercial and investment banks, including lightly regulated shadow banks, which had accumulated large real estate positions. Contagion within the financial system soon amplified these shocks. This contagion is indicated in the lower half of the middle yellow rectangle on the right of Figure 1.

There were further effects on credit availability and risk spreads – tightening lending standards, and beyond real estate, depicted by the transmission channel from the middle to the lower yellow rectangle on the right, see e.g. Brunnermeier (2009) and Bernanke (2018) and Duca, Muellbauer and Murphy (2021a) for more details.

In the Euro area, Spain and Ireland had severe banking crises, with similar mechanisms at work, but rather simpler structures of their more bank-based financial systems. Elsewhere in the Euro area, e.g., Italy and Greece, banking problems were far more the consequence of the sovereign debt crisis than of real estate problems, per se. Differences in institutions and in financial regulation, see Maclennan, Muellbauer and Stephens (1998) and Cerutti, Dagher, and Dell'Ariccia (2017), explain the relative stability of outcomes in countries such as Germany, the Netherlands and France, even with pronounced credit and real estate cycles in the latter two economies. Table 1 summarises the key mechanisms underlying the different channels and feedbacks for real estate in the financial accelerator, and reports how heterogeneity in housing-related institutions and regulatory changes across countries over time are important for stabilising or amplifying the shocks.

Table 1

Transmission and amplification of a negative house price shock in the GFC

Channels and feedbacks	Key mechanisms	Sources of heterogeneity between countries: amplifying or stabilising?
From falling house prices to the real economy, and back.	Lower construction volumes as profits fall and land banks lose value.	Pre-crisis ratio of real estate investment to GDP differs; elasticity of construction volumes to real estate prices differs; share of public sector housing differs.
	Lower consumer spending as collateral for home equity withdrawal falls.	Access to home equity loans differs greatly between countries, e.g., the US versus Germany.
	Lower spending on property services as real estate demand drops.	Ratio of property services to GDP differs, e.g., with degree of financialisation.
	Amplification as extrapolation of falling prices and lower incomes further reduce demand for real estate.	Tendency to extrapolate is higher where homebuyers are more heavily geared and where property taxes are weakly linked to current market values.
From falling house prices to the financial sector, and back.	Mortgage delinquencies and foreclosures rise.	Greater where lax regulation permits high levels of gearing both for banks and borrowers, and fixed rate mortgages slow transmission of policy mitigation, though when rates rise, the impact is faster in floating rate environments.
	Losses mount at financial intermediaries, particularly on commercial mortgage-backed securities and private label (residential) mortgage-backed securities, undermining capital positions of banks.	Greater where high levels of maturity mismatch exist in funding mortgages.
	Credit availability to the real estate sector falls and risk spreads rise.	Greater where systemic risk is high, i.e. where the degree of leverage, maturity mismatch, the degree of interconnectedness, levels of complexity and/or the prevalence of mispricing of risk pose problems. In turn, these depend on the quality of prudential regulation and financial sector structure.
	Amplification occurs via contagion in the financial sector and falling prices of financial assets (e.g., Brunnermeier, 2009; Bernanke, 2018).	Greater with high interconnectedness and complexity.
From the financial sector to the real economy. **Amplification via feedback on real incomes.**	Credit availability to the other sectors falls and risk spreads rise.	Greater where corporations have high debt levels and vulnerable balance sheets.
	Impact on investment.	Greater where household debt levels are high, liquid assets low, and households are dependent on new credit.
	Impact on consumption via tighter credit and lower financial asset values.	Greater where household illiquid financial assets to income ratios are high.
From the real economy to the financial sector.	Fall in GDP and household incomes cause further drop in profits in financial sector.	Greater where financial sector is heavily geared.

Source: Constructed by author.
Notes: Systemic risk is defined by Adrian et al. (2015) as "the potential for widespread financial externalities—whether from corrections in asset valuations, asset fire sales, or other forms of contagion—to amplify financial shocks and in extreme cases disrupt financial intermediation".

Institutional differences highlighted by Maclennan, Muellbauer and Stephens (1998) were housing tenure structure (including owner-occupation, social and free market rentals), the tax structure (especially the level of mortgage interest tax relief), the nature and rates of annual property taxes and transactions taxes, adjustable versus fixed rate mortgage pricing, typical loan-to-value ratios, ratios of mortgage debt to GDP, the structure of pension provision and financial market capitalisation relative to GDP. The degree to which housing collateral was the basis for bank lending (and hence for easier access to home equity withdrawal) and the ability of lenders to access housing collateral in the event of default were also important differences. We pointed out that Ireland, the UK, and to a lesser extent Sweden, tended to be at one extreme of a cluster of features which would imply high risks of instability given the constraint of a

largely exogenous monetary policy and a fixed exchange rate.[10] Among policy recommendations to reduce the risk of instability were tighter prudential limits on mortgage lending and the use of market price-linked property taxes.

After the experience of GFC, the monitoring of financial stability and the development of macro-prudential policies has become a high priority at central banks and at the IMF and the BIS. Vast changes have taking place in Europe, for example with the setting up of the ESRB and the development of large financial stability sections at the ECB and all the national central banks. Far more attention was now given to institutional differences between countries in accounting for the highly heterogeneous nature and impact of real estate booms and busts, and indeed their absence in some countries. Crowe et al. (2013) compared 27 economies in terms of the monetary policy framework, tax system and regulatory structure. This covers whether credit growth and property prices are explicitly considered in the monetary policy frameworks, and the rates of transactions taxes and the extent or absence of mortgage interest tax relief in the tax system. For the regulatory structure, they consider whether there are restrictions on which institutions can extend mortgage loans, on the type of mortgage, on loan-to-value and debt-to-income limits and on the growth rate of mortgage credit. The nature of loan loss provisioning is assessed, as well as whether real-estate specific risk weights were applied and whether mortgages are full recourse or not. Policy options are discussed for dealing with real estate booms, and experiences in the different countries compared to assess the success or otherwise of policy responses as of the end of 2010.

In their widely-cited panel study, Cerutti, Dagher, and Dell'Ariccia (2017) focus on differences in housing finance between countries as represented by six characteristics (as of 2005): these are the maximum available loan-to-value ratio on a housing loan, the term to maturity, mortgage interest tax relief, whether mortgage rates are fixed or adjustable and the funding type (retail deposit, wholesale, securitised, covered bonds or other). Cerutti et al. analyse an (unbalanced) panel dataset of 50 countries for 1970–2012 and find that house price booms are more likely in countries with higher LTV ratios and mortgage funding based on wholesale sources or securitization. This is consistent with the earlier discussion of leverage. They note that most house price booms end with a recession, and that such downturns tend to be deeper and longer when preceded by booms in both residential mortgages and other private debt, and with reliance on non-retail deposit funding that can cause duration mismatch on lenders' balance sheets.

Table 2 draws on Cerutti et al. (2017) to summarise some pre-crisis differences in housing finance characteristics among Euro area economies. Such classifications can contain controversial elements. The maximum LTV data shown often do not reflect regulatory constraints but local expert judgement on typical upper ranges. The European Mortgage Federation's Hypostat publications indicate the lack of hard data even on average LTVs for most Euro area countries at the time. Another important characteristic relevant for transmission of house prices to the real economy, in addition to those discussed by Maclennan et al. (1998) and Cerutti et al. (2017), is

[10] These arguments proved an important input into the 'Five economic tests' the UK Treasury set in 1997 before deciding that the UK should not join EMU.

whether home equity finance is easily available. Where that is the case, cyclicality tends to be greater. Where a financial crisis can be avoided, downturns will, of course, tend to be less severe. Having a well-capitalised banking system, where an oligopolistic structure with high margins[11] can be a benefit, reduces such a risk. Systems where government guarantees as in the Netherlands, or collective insurance schemes, as in France and Canada, underwrite lenders' risks for large parts of the mortgage market, also reduce risks of banking failures.

Table 2

Key characteristics of housing finance for Euro area economies pre-GFC

Country	Max. LTV	Term to maturity	Tax deduction	Full recourse	Interest type	Funding type
Austria (AE)	80	25	No	Yes	Fixed	Retail Deposit
Belgium (AE)	100	20	Yes	Yes	Fixed	Retail Deposit
Bulgaria (EM)	81	15	No	Yes	Variable	Retail Deposit
Croatia (EM)	50	30	Yes	Yes	Mixed	Retail Deposit
Czech Republic (AE)	100	20	Yes	Yes	Mixed	Retail Deposit
Denmark (AE)	80	30	Yes	Yes	Mixed	Mtg. Bonds
Estonia (AE)	90	30	Yes	Yes	Variable	Retail Deposit
Finland (AE)	80	20	Yes	Yes	Variable	Retail Deposit
France (AE)	100	20	No	Yes	Fixed	Retail Deposit
Germany (AE)	80	15	No	Yes	Fixed	Retail Deposit
Greece (AE)	80	15	Yes	Yes	Variable	Retail Deposit
Hungary (EM)	70	20	No	Yes	Mixed	Mtg. Bonds
Ireland (EM)	100	40	Yes	Yes	Mixed	Wholesale mkts*
Italy (AE)	80	22	Yes	Yes	Variable	Retail Deposit
Latvia (EM)	100	30	No	Yes	Variable	Retail Deposit
Lithuania (EM)	100	25	Yes	Yes	Variable	Retail Deposit
Luxembourg (AE)	80	25	Yes	Yes	Variable	Retail Deposit
Netherlands (AE)	125	30	Yes	Yes	Fixed	Retail Deposit
Norway (AE)	85	20	Yes	Yes	Variable	Retail Deposit
Poland (EM)	100	32.5	Yes	Yes	Variable	Retail Deposit
Portugal (AE)	90	30	Yes	No	Variable	Retail Deposit
Slovenia (AE)	70	10	No	Yes	Variable	Retail Deposit
Spain (AE)	100	20	Yes	Yes	Variable	Retail Deposit
Sweden (AE)	95	45	Yes	Yes	Variable	Mtg. Bonds
Switzerland (AE)	80	20	Yes	Yes	Fixed	Retail Deposit

Source: Cerutti et al. (2017). * Correction of classification: by 2005, funding in Ireland was dominated by wholesale markets. 'Max. LTV' does not usually indicate a formal regulatory ceiling but is based on local expert assessments of typical upper levels.
Notes: Home equity withdrawal was widely accessible only in Denmark, the Baltic countries, Finland, Hungary, the Netherlands, Norway, Sweden, and Switzerland, with limited access in Ireland and Spain (IMF, 2008).

11 For example, as in France, Canada, Australia and South Africa.

3.2 Monetary policy transmission: real estate channels and institutional heterogeneity

How differences in institutions affect monetary transmission and how these asymmetries were likely to affect the impact of a common monetary policy was the subject of Maclennan et al. (1998). Calza et al. (2009, 2013) provided quantitative evidence, finding that monetary policy has stronger effects on house prices and residential investment in countries with more highly developed and liberal mortgage markets. Moreover they found that transmission to consumption is stronger where mortgage equity withdrawals were more widely available and where mortgage rates were adjustable. Evidence on differences in monetary transmission from structural VARs is provided by Nocera and Roma (2017). They include data from 1980 to 2014 on real house prices, consumer price inflation, real GDP, real loans to households, lending rates and monetary policy rates and use Bayesian methods for estimation. They find a significant and highly heterogeneous effect of monetary policy on house price dynamics, for example, a far greater response in Spain and Ireland than in Germany and a heterogeneous impact of what they interpret as housing demand shocks on loans to households and GDP. However, the details of some of these results estimated over a period that includes the GFC, major banking crises in some countries, and the sovereign debt crisis, need to be interpreted cautiously for their contemporary relevance.

Monetary policy affects mortgage rates which affect house prices, and these are the first two channels of monetary transmission via housing and mortgage markets. The remaining four channels of how house price declines feed through the real economy and generate credit shocks in the financial system that feed back into the real economy were shown in Figure 1 and Table 1. These channels, running through residential investment, consumer expenditure, mortgage debt and defaults reflected in NPLs, are obviously also relevant for considering monetary transmission since part of that occurs indirectly via house prices, as well as directly. This means that the differences in institutions relevant for how house price shocks transmitted in the crisis and for the severity of the crisis are also relevant for examining differences in monetary transmission. These six channels of monetary transmission to aggregate demand are addressed in detail in section 4. Whether, and if so how, central bank policy models represent each of these channels is examined with a brief indication of the drivers included in each of the potentially six equations. The discussion in section 3.1 highlighted negative feedbacks in the crisis from credit shocks – a tightening of credit standards which affected house prices, investment, consumer spending and mortgage provision. An implication is that equations for each of the six channels of monetary policy transmission should also include controls for lending standards, or non-price mortgage credit conditions. A brief summary of the policy models is provided in Table 3. This shows that one country model (France) excludes all six channels, while three (Ireland, Italy and the Netherlands) cover all six. Few include controls for lending standards. The differences in the policy models for each of the six channels are discussed in more detail in the next section.

Table 3

Score-cards for the real estate elements of monetary transmission in semi-structural policy models at Euro area central banks

Monetary transmission Mechanisms	Long-run housing or real estate variables	ECB-BASE model		France		Germany	
		Tick-list	Comment	Tick-list	Comment	Tick-list	Comment
To (nominal) mortgage interest rate [Section 4.1.1]	T-bill or euribor rate	✓	Use a risk premium (modelled as a dynamic process) linked to the expected output gap. There is no ECM.	NA	Equation for overall lending rate to households, incl. housing loans.	✓	ECM adjustment coefficient is 0.25. Incomplete pass-through of the T-bill and long bond rate.
	Long bond rate	✓		✓		✓	
	Bank NPLs or Bank credit risk indicators	×		NA		×	
	Other relevant rates	×		NA		×	
To (real) house prices [Section 4.2.3]	Real mortgage rate	×	Impose restriction of 1 on income per housing stock. Low ECM adjustment coefficient (of 0.036).	NA	Real house prices simply follow an AR process.	✓	Instead of the housing stock, the no. of households is used. ECM adjustment coefficient is 0.11 (t=1.84)
	User cost*	✓		NA		×	
	Nominal mortgage rate	×		NA		×	
	Income	✓		NA		✓	
	Housing stock	✓		NA		×	
	Credit conditions**	×		NA		×	
To (real) residential investment [Section 4.3.2]	House price to construction costs ratio	✓	Dependent variable modelled as ratio to housing stock. ECM adjustment coefficient is 0.096. Growth of GDP, but not the level, affects residential investment.	NA	No equation for this element.	×	Residential investment is driven by the growth of building permits and of GDP. ECM in building permits is driven by changes in house prices and real interest rates.
	Interest rate	✓		NA		×	
	Credit conditions**	×		NA		×	
	Real GDP or income	×		NA		×	
To (real) consumption [Section 4.4.1]	Permanent income ***	✓	Only the aggregated net worth concept of wealth is used. ECM adjustment coefficient is 0.22. Assume only current income spent by a fraction of households (36%).	✓	No wealth components at all. ECM adjustment coefficient is 0.12. Assume only current income spent by a fraction of households (26%).	×	Only the aggregated net financial wealth concept of wealth is used. ECM adjustment coefficient is 0.47. Income is split between labour+transfer and other. The real interest rate is based on the 10-year bond yield.
	Disaggregated household wealth components	×		×		×	
	Real interest rate	✓		✓		✓	
	House price to income ratio	×		×		×	
	Credit conditions**	×		×		×	
To (real) mortgage debt [Section 4.5.1]	Real interest rate	NA	No equation for this element.	NA	No equation for this element.	NA	No equation for this element.
	Nominal interest rate	NA		NA		NA	
	Income	NA		NA		NA	
	House price to income ratio	NA		NA		NA	
	Credit conditions**	NA		NA		NA	
To non-performing loans or similar bank balance sheet indicators (ratios to total stock outstanding) [Section 4.6]	Growth of income or GDP or output gap	NA	No equation for this element.	NA	No equation for this element.	NA	No equation for this element.
	Unemployment rate	NA		NA		NA	
	Interest rate/s	NA		NA		NA	
	House price to income ratio or housing wealth to income ratio	NA		NA		NA	
	Credit conditions** (very lagged)	NA		NA		NA	
	Bank credit to private sector	NA		NA		NA	

Monetary transmission Mechanisms	Long-run housing or real estate variables	Ireland		Italy		Netherlands		Spain	
		Tick-list	Comment	Tick-list	Comment	Tick-list	Comment	Tick-list	Comment
To (nominal) mortgage interest rate [Section 4.1.1]	T-bill or euribor rate	✓	Other interest rates include for deposits and the money market rate. Bank risk: ratio of bank capital to risk-weighted assets. Also residual proportion of housing wealth net of the mortgage.	✓	ECM adjustment coefficient is 0.16. Default probabilities drive the risk spread.	✓	ECM adjustment coefficient is 0.13. The credit risk indicator is the bank leverage ratio.	✓	ECM adjustment coefficient is 0.11.
	Long bond rate	×		×		✓		✓	
	Bank NPLs or Bank credit risk indicators	✓		✓		✓		×	
	Other relevant rates	✓		×		×		×	
To (real) house prices [Section 4.2.3]	Real mortgage rate	NA	Long run solution depends on the mortgage stock to income ratio.	×	The long-run demand for housing is driven by net worth and the return on housing incl. capital gains minus the long bond-yield. The inverse demand equation is embedded in an ECM.	NA	Assume nominal house prices are driven by the nominal mortgage stock (see below). Low ECM adjustment coefficient (of 0.04).	×	Includes long-run core inflation. Low ECM adjustment coefficient (of 0.018). Lagged HP appreciation in dynamics.
	User cost*	NA		✓		NA		×	
	Nominal mortgage rate	NA		×		NA		✓	
	Income	NA		×		NA		✓	
	Housing stock	NA		✓		NA		×	
	Credit conditions**	NA		×		NA		×	
To (real) residential investment [Section 4.3.2]	House price to construction costs ratio	✓*	Dependent variable is new dwellings completions. The long run supply elasticity is around 1.9. the ECM adjustment coefficient is 0.07.	✓	ECM adjustment coefficient is 0.23, and supply elasticity w.r.t. house prices is 0.7. Includes post-crisis dummies. Controls for property tax.	✓*	Consumption deflator is used in place of construct-ion costs. Consumption is used instead of GDP. The interest rate is user cost. A moving average of exogenous building permits is a major driver.	×	Low ECM adjustment coefficient (of 0.034). Credit access, measured from the bank lending survey.
	Interest rate	✓		✓		✓		✓	
	Credit conditions**	×		✓		×		✓	
	Real GDP or income	×		✓		✓*		✓	
To (real) consumption [Section 4.4.1]	Permanent income ***	×	Two-way split for wealth: financial assets and housing wealth. ECM adjustment coefficient 0.26.	×	Consumption concept replaces durables expenditure by the service flow of durables. Only the aggregated net worth concept of wealth is used. Low ECM adjustment coefficient (of 0.07).	×	Two-way split for wealth: financial assets and housing wealth. ECM adjustment coefficient is 0.11.	×	Only the aggregated net worth concept of wealth is used. Credit conditions is just the volume of credit – not a CCI.
	Disaggregated household wealth components	✓		×		✓		×	
	Real interest rate	✓		✓		✓		✓	
	House price to income ratio	×		×		×		×	Low ECM adjustment coefficient (of 0.076).
	Credit conditions**	×		×		×		✓	

Monetary transmission Mechanisms	Long-run housing or real estate variables	Ireland		Italy		Netherlands		Spain	
		Tick-list	Comment	Tick-list	Comment	Tick-list	Comment	Tick-list	Comment
To (real) mortgage debt [Section 4.5.1]	Real interest rate	✓	Equation for new lending driven by the real mortgage rate of interest, adjusted LTI and LTV ratios for credit conditions. The change in the mortgage stock = new lending – repayments, proportional to stock.	✓	The return on housing relative to the long bond yield, the nominal mortgage interest rate and its spread to the interbank rate. GDP proxies income. The ECM adjustment coefficient is 0.03.	✓	Ogive dummies for shifts in credit conditions. Disposable income is before taxes and interest payments. The nominal mortgage rates is tax adjusted. ECM adjustment coefficient is 0.04	✓	No income but (housing investment + consumption). ECM adjustment coefficient is 0.013.
	Nominal interest rate	×		✓		✓		×	
	Income	×		✓		✓		×	
	House price to income ratio	×		×		×		×	
	Credit conditions**	✓		×		✓		×	
To non-performing loans or similar bank balance sheet indicators (ratios to total stock outstanding) [Section 4.6]	Growth of income or GDP or output gap	×	Mortgage arrears depend on the rate of unemployment, the mortgage repayment to income ratio, and the equity position of the household. The aggregate rate of corporate insolvency depends on the cost of corporate credit, the unemployment rate, commercial property prices, and the ratio of corporate credit to GDP.	✓	Bad loans for NFCs are driven by the output gap, a real interest rate, and borrowing costs for NFCs relative to the operating surplus of the company sector.	NA	Net impairments for bad loans, influence bank profits, bank capital and the bank leverage ratio.	✓	
	Unemployment rate	✓		×		NA		NA	
	Interest rate/s	✓		✓		NA		NA	
	House price to income ratio or housing wealth to income ratio	✓		×		NA		NA	
	Credit conditions** (very lagged)	×		×		NA		NA	
	Bank credit to private sector	✓		✓		NA		NA	

Source: Constructed by author. Thanks to Zrecko Simic and Elena Angelini for comments on ECB-BASE, Angelini et al. (2019), to Adele Bergin and Paul Egan on COSMO, Bergin et al. (2017), Robert-Paul Berben on DELFI 2, Berben et al. (2017(, Fabio Busetti and Guido Bulligan on BIQM, Bulligan et al. (2017) and Samuel Hurtado for information on Spanish equations, Arencibia Pareja et al. (2017). For the Bundesbank model, see Haertel et al. (2022). As COSMO was developed jointly with ESRI, the version considered here is that held at ESRI.

4 Modelling the six housing channels of monetary policy transmission

France is used as a case-study throughout section 4 to provide new insights into these channels. Monetary policy affects both short and long interest rates, including via unconventional policies. Taking that as given, the further transmission to mortgage interest rates via the Euribor or 3-month T-bill and 10-year Treasury bond yields is examined in section 4.1. Section 4.2 reviews research on the crucial next step in the transmission process from interest rates to house prices with due attention to the role of credit conditions or lending standards, other demand drivers and housing supply. With considerable differences in the structures of mortgage markets, tax systems and financial regulation, heterogeneity in this element of transmission process between countries is pronounced.

The next two channels concern the transmission both from interest rates directly and indirectly via house prices to two important components of aggregate demand,

residential investment and consumer expenditure. Section 4.3 examines the evidence on the link from house prices and interest rates to residential investment, affected by heterogeneity in housing supply elasticities. A case study for France adds new insights into possible biases in previous estimates of these elasticities. The drivers of household consumption, including not only house prices and housing wealth, but also factors such as income, permanent income and credit conditions, are discussed in section 4. A further important channel of transmission to consumption occurs through mortgage debt since household debt, together with liquid and illiquid financial assets and housing wealth, has important effects on spending. Section 4.5 examines the drivers of mortgage debt. As potential over-indebtedness of households is a vulnerability with important implications for financial stability, understanding what drives mortgage debt should help inform macroprudential as well as monetary policy.

The sixth channel outlined above, an important but under-researched link in the process of monetary transmission, concerns the dynamics of NPLs over the cycle, and is the subject of section 4.6. The level of NPLs depends among other things on credit conditions in earlier years, recent interest rates, and factors such as economic growth and the state of real estate markets. Rising NPLs or loan-loss provisions are likely to raise the cost of funding and impair the ability of banks to expand credit supply, inducing tighter lending standards. Section 4.6 provides quantitative evidence showing the second side of the two-way connection between credit conditions and NPLs, using a forecasting model for the NPL ratio for France. A period of easy credit conditions, resulting in lax lending standards, tends to create financial vulnerability among borrowers and potentially among lenders, particularly if followed by an economic downturn. Then, rising NPLs and other credit risk measures result in a reduced ability and willingness of banks to extend credit, resulting in tighter credit conditions that amplify the downturn in the economy. Further negative feedbacks onto the economy may stem from the spending constraints of the indebted households and firms.

It is worth mentioning that a further channel of transmission could operate through expectations. Expectations of future house price appreciation are dealt with in the discussion of the determination of house prices. But there is also the possibility that consumer expectations about future income growth might be affected by recent house price dynamics. At a practical level, this is an empirical question for the formulation of a model for permanent income discussed in section 4.4.

4.1 Interest rate pass-through to the mortgage rate

4.1.1 Evidence from central bank models

Where central bank policy models feature a mortgage interest rate, this is typically explained by variations in a short rate such as the 3-month Treasury bill rate or Euribor and a long rate, such as the 10-year Treasury bond rate. For example, in ECB-BASE, the mortgage rate is given as a weighted average of short and long rates, with known weights, plus a spread, which is explained by its lag and a moving average of

expected output gaps. The spread is interpreted as a risk premium but is used only to model the mortgage rate and otherwise plays no role elsewhere in the model (for example in the house price or mortgage stock equations). There is no link with any balance sheet variables from a banking sector, implying little connection with banks. In the Bank of France's FR-BDF, the mortgage rate does not appear, though there is an overall interest rate for lending to households explained an equilibrium correction model linked to the long rate.[12] For Italy, Nobili and Zollino (2017), formulate the mortgage rate equation entirely in first differences using distributed lags of the short and long rates. In neither case is there a link with banking sector data. However, in the Bank of Italy's BIQM, there appears to be an explicit link with bad loan data.[13]

In the Dutch DELFI 2.0 model, the long-run solution for the mortgage rate is explained by a weighted average of the short and long rates, dominated by the long rate, plus a risk premium explained by the CDS spread and the bank leverage ratio. The latter introduces explicit bank balance sheet data and so links the real and financial sectors. Moreover, as monetary policy can also affect the CDS spread, as well as short and long rates, there is richer scope for policy transmission. Short-run dynamics are quite flexible, with an empirically determined lag structure and estimated for a long sample from 1983. For Spain (see Arencibia Pareja et al. 2017), the long-run solution for the mortgage rate is explained by a weighted average of the short and long rates, with an ECM adjustment coefficient of 0.11.

Perhaps the most far-reaching linkages between the mortgage rate and balance sheet variables and other interest rates are made in the Irish central bank's COSMO model. The long-run solution for the representative variable mortgage rate depends on five variables. These are: household equity given by the residual proportion of housing wealth net of the mortgage stock, the loan-to-deposit ratio, the ratio of bank capital to risk-weighted assets, the deposit interest rate, and Euribor, the representative interest rate on short-term money market funding. An equilibrium correction model is used to capture the short-term dynamics.

4.1.2 New evidence from France

Given the lack of connection in previous research between the mortgage interest rate in France and bank data, a new model for interest rate pass-through from the 3-month Treasury bill and the 10-year Treasury bond rates to the fixed-rate on housing loans was developed for the present paper.

The form of the long-run solution is shown in equation 1.

$$mr_t = p_{0t} + p_1 sr_t + p_2\, lr_t + \ p_3 NPL\ ratio_t + \ p_4\ eurospread_t \qquad (1)$$

[12] See their equation (68). Given the weight of housing loans in overall debt, this rate will be dominated by that on housing loans.

[13] To quote: "Short- and long-term bank lending rates to households and non-financial corporations are modelled in terms of a risk-free rate (with a complete pass-through in the long run) and a time-varying risk spread linked to default probabilities on these loans: indeed, the deterioration of firms' solvency conditions typically induces banks to charge higher premia, thus increasing funding costs."

Here mr is the mortgage rate of interest, sr is the short rate, lr is the 10-year Treasury yield, the $NPL\ ratio$ is measured relative to the total loan book of the banking sector and $eurospread$ is defined as the difference between the average of the Italian and Spanish 10-year yields and that of Germany. This serves as a risk indicator associated with the sovereign debt crisis, see Chart 6 for the divergence then seen in these yields. The time-varying intercept captures structural changes in French mortgage markets in the early 1990s.[14] Definitions and sources are given in Appendix 3 and results presented in Table 4. There is a weight of around 35 percent on the short rate and 65 percent on the long rate in the long-run solution for the housing loan rate, and complete long-run pass-through is accepted by the data. The log ratio of nonperforming loans of banks to total credit extended by banks has a significant positive effect on the mortgage rate (the t-ratio is more than 4). Another important long-run factor is a proxy for the European sovereign debt crisis of 2010-2013, the $eurospread$. As French banks held some of the affected government securities, their ability to extend credit and take on risk was impaired during the crisis, especially at its peak between 2011Q4 and 2012Q4. Hence the higher risk premium.[15]

The long-run solution is embedded in an equilibrium correction model (ECM) incorporating short-term dynamics in house price appreciation, income growth and inflation. Recent house price appreciation tends to increase equity in recently issued loans and, as a proxy for expected house price growth, makes banks feel more confident that negative equity is unlikely to be a default risk in the near future. There is also evidence that, in France, higher real recent income growth and higher inflation, measured over two years, reduce the mortgage rates banks charge, see column 2 of Table 4. The inflation effect appears to be robust to the exclusion of either income or house price growth, and is robust over different samples. However, the combination of the income growth and inflation effects could be reformulated into the effect of nominal income growth. The combination of all three short-term effects indicates mortgage pricing that is sensitive to the state of the housing market: the weaker the market, the lower the spread. The inflation effect should not be interpreted in terms of inflation expectations on the lenders' side as these are likely to be embedded in the long interest rate. The overall ECM adjustment coefficient is around 0.3, very accurately estimated, indicating strong cointegration in the long-run solution.

The sample for which these estimates have been obtained starts in 1990Q4 as 1990 was a year of significant structural change in the mortgage market.[16] With appropriate controls for these shifts in 1990, very similar parameter estimates are obtained with

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14 The evidence is that in 1992-3 there was a gradual fall of close to 0.5 percentage points in the mortgage spread. Part of this may be due to a change in the reporting system for interest rates.

15 In corresponding equations for Italy and Spain, the spread relative to the German yield has the opposite sign. As noted in section 2, during the sovereign debt crisis, domestic mortgages were seen as having a lower default probability than 10-year domestic government bonds.

16 A law against over-indebtedness was passed at the end of 1989 and took effect on July 1990. Among other things, it changed the definition of the maximum rate that can be applied by banks to their clients, both household and firms. Key changes in the 1980s were the following: the banking system law of 1984, the suppression of state direct control over credit volumes (1985), the creation of a true capital market (including commercial paper) (1986), and the end of currency exchange controls (1990). This was followed by the rationalisation of the structure of the French banking industry and more intense competition, see Loupias, Savignac and Sevestre (2003).

data back to 1987, just after major liberalisation took place in French credit markets. The diagnostics for the estimates in Table 4 are very satisfactory.[17]

The bottom line is that the NPL ratio for banks has a significant influence on the spread between the mortgage rate and underlying interest rates. Over the full range of the NPL ratio, there is a difference of around 0.25 percent in the equilibrium level of the spread. In view of the further evidence discussed below for the role of the NPL ratio in also affecting non-price credit conditions, i.e. lending standards, this is important evidence on the dynamics of the credit cycle in France.[18] As far as monetary policy transmission is concerned, the relevance of the NPL ratio and of the sovereign spreads points to important aspects of policy in addition to the more obvious ones of transmission through short and long rates. A rise in short term rates tends to directly raise the NPL ratio, with a further indirect effect through real estate prices, see section 4.6. Furthermore, to the extent that macroprudential policy can prevent lending standards from deteriorating and causing a future rise in NPLs, there is an intimate link between macroprudential policy and monetary policy through the effect on mortgage rates (and probably on the rates at which NFCs can borrow). As noted in section 2, policies pursued by the ECB during the sovereign debt crisis had huge effects on sovereign spreads, with consequences for interest rates charged by banks to borrowers.

[17] The Chow test for parameter stability, tests for lack of residual autocorrelation and of heteroscedasticity, and for normal residuals all have high P-values.

[18] A similar model for the Netherlands using the ratio of loan-loss provisions to the loan book of banks rather than the NPL ratio owing to a longer data set being available for LLPs, finds a strongly significant effect of the LLP ratio on the spread, private correspondence from Robert-Paul Berben of the DNB.

Table 4

Pass-through of short-term and long-term rates to the interest rate on housing loans in France

Dependent variable: Δ (nominal mortgage rate) t	1990:4 to 2016:4		1990:4 to 2016:4		1990:4 to 2016:4	
	Eq. 1		Eq. 2		Eq. 3	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
Constant	1.98	7.61	1.92	7.24	1.84	6.92
(short interest rate spread) t-1	0.11	7.90	0.10	7.32	0.11	7.32
(long interest rate spread) t-1	0.20	8.25	0.17	8.02	0.19	7.53
log (NPL ratio to loan book) t-3	0.20	4.04	0.21	4.11	0.21	4.11
(Euro risk spread) t-1	0.05	3.33	0.06	3.44	0.07	4.48
Smoothed transition dummy (1992-93) t	-0.49	-7.61	-0.50	-7.55	-0.44	-6.81
Δ (long interest rate spread) t-2	0.16	3.76	0.18	4.47	0.16	3.77
Dummy 1993Q1 t-2	-0.45	-3.92	-0.47	-3.95	-0.47	-3.90
Δ8 log (real house prices) t-2	-0.40	-2.48	-	-	-0.43	-2.53
Δ8 log (consumer expenditure deflator) t-2	-4.79	-4.19	-5.80	-5.27	-3.17	-3.04
Δ4 log (real disposable income pc) t-1	-3.30	-2.95	-3.43	-3.00	-	-
Equation standard error	0.107		0.109		0.111	
Adjusted R-squared	0.786		0.775		0.769	
Durbin-Watson	2.00		2.01		1.90	
Breusch/Godfrey LM: AR/MA4	p = [.443]		p = [.546]		p = [.694]	
Chow test	p = [.861]		p = [.532]		p = [.758]	
Breusch-Pagan het. Test	p = [.156]		p = [.100]		p = [.115]	

Notes: Estimation performed in TSP 5.0 of Hall and Cummins.

4.2 The drivers of house prices

4.2.1 Theory background

What determines house prices is of critical importance both for measuring monetary transmission via the housing market and, in the context of macroprudential policy, for examining potential over-valuation of house prices. Two approaches have been used by researchers to explain variations in house prices. One is based on asset market theory, assuming efficient arbitrage, and the second is based on supply and demand principles. As explained in Duca, Muellbauer and Murphy (2021a,b), simple arbitrage theory – in which the value of a home is merely the discounted present value of future rents – is inappropriate for explaining variation in house prices, see also Glaeser and Gyourko (2009). The theory is based on perfect arbitrage between rents and house prices, which, under restrictive assumptions, implies that the price-to-rent ratio moves one-for-one with the inverted user cost of housing, strongly contradicted by the data. Moreover, in many European countries, rent indices include non-market social and regulated rents.

As explained in Duca, Muellbauer and Murphy (2021a), a more general theory of what determines house prices is just a story of supply and demand, where the supply – the

stock of houses – is given in the short run. Then prices are given by the inverted demand curve, that is, by the stock of housing and the factors driving demand.[19] This inverse demand approach is widely used by researchers, including as one way of measuring over-valuation of house prices in the risk assessment used by the ESRB, see section 5.3. We have strong priors regarding the values of the key long run elasticities, corresponding to the "central estimates" set out in Meen (2001) and Meen and Andrew (1998), inter alia. For example, many estimates of the income elasticity of demand suggest that it is in the region of 1, in which case the income and housing stock terms in the house price equation simplify to log income per house. Typical estimates of the long-run elasticity of real house prices w.r.t. income per house are in the range 1.5 to 2.5.

The other demand shifters cover a range of other drivers, crucially including mortgage credit conditions, and nominal as well as real interest rates represented by user cost. The user cost takes into account that durable goods deteriorate, but may appreciate in price and incur an interest cost of financing as well as tax. The usual approximation is that the real user cost is

$$uc = hp\left(r + \delta + t - h\dot{p}^{e} / hp\right) \tag{2}$$

where r is the real after-tax interest rate of borrowing, possibly adjusted for risk, δ is the deterioration rate, t is the property tax rate[20], and $h\dot{p}^{e} / hp$ is the expected real rate of capital appreciation. The formulation for the property tax rate assumes a tax rate fixed in the short-run and continuous revaluation to current prices of the house on which the tax is charged. If this is not the case, it is preferable to make a separate allowance for the tax rate outside the user cost term. The derivation of equation (2) assumes houses are traded every period. However, as DiPasquale and Wheaton (1994) stress, the expected appreciation term should reflect planned holding periods, as transactions costs impede trading, and so should not just refer to very short-run appreciation.

The user cost is not the only channel through which interest rates affect housing demand. Kearl (1979) notes that typical mortgages stabilise nominal payments. For credit-constrained households, cash-flows matter so that the debt-service ratio affects demand. Moreover, the debt-service-to-income ratio (DSTI), along with LTV and DTI ratios, is used by lenders to set loan terms and decide whether or not to lend. Thus, as nominal mortgage rates fall, one of the lending criteria becomes less binding, thereby increasing credit supply.[21] The implication is that nominal, as well as

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19 Inverse demand functions have a long history, particularly in the analysis of markets for natural resources. Theil (1976) refers to a 1909 Danish study as the first empirical study of inverse demand functions.

20 The formulation for the property tax rate assumes a tax rate fixed in the short-run and continuous revaluation to current prices of the house on which the tax is charged. If this is not the case, it is preferable to make a separate allowance for the tax rate outside the user cost term.

21 In France, regulatory DSTI caps strengthen the effect of nominal interest rates (Chauvin and Muellbauer (2018)).

real, mortgage interest rates are likely to affect housing demand, and therefore house prices, in countries where the debt-service ratio is a key lending criterion.

The user cost, first formulated for consumer durable goods by Cramer (1957), regards the durable good only as a consumption item. However, the structure and land components of housing are also major stores of value that compete with other assets. This means that part of the demand for housing comes from its role as part of a wealth portfolio, implying that relative returns and risks for other assets also affect housing demand. The relevance of low returns on other assets versus strong house price appreciation is particularly high in the current period of lower bond yields. It also means that the positive effect of income growth expectations on housing demand—and hence on house prices that comes from thinking of housing purely as a consumption good—could be reversed if a major motive is the saving motive. Indeed, Campbell (1987) highlights how saving could rise in anticipation of future income declines.

The user cost term defined in equation (2) does not account for how leverage affects the relative returns to buyers using mortgages, see Muellbauer and Murphy (1997). Leverage amplifies returns and risks, implying that the coefficient of the user cost term in a house price equation should depend on how much leverage lenders provide to homebuyers, as measured by the LTV, and hence the general state of mortgage credit conditions.

In addition to such portfolio considerations, the availability of home equity withdrawal creates a potential third source of demand for housing, in addition to the standard demand for a durable good and the portfolio demand. In countries, such as the US, the UK, Netherlands and Ireland with easy access to home equity loans, the role of housing as collateral for borrowing gives households with positive housing equity a means of overcoming credit constraints that would otherwise prevent or raise the cost of borrowing.

4.2.2 Multi-country evidence

Recent multi-country empirical evidence based on the inverse demand approach on the determination of house prices comes from Geng (2018) at the IMF and Cavalleri et al. (2019) at the OECD. They apply equilibrium correction models to real house prices in respectively 20 and 23 countries. Geng finds long-run elasticities of response of real house prices to income of around 1.6 but somewhat higher for countries with high levels of tax relief on mortgage interest. The negative response to the housing stock measured in number of units is a little over 1. Taking averages across countries, Cavalleri et al. (2019) find an average elasticity of response in the long-run of real house prices to real income of 1.8 and -1.8 to the housing stock, so that the income per house restriction holds, and an average response to the real mortgage rate of -0.3. Neither study checked for the influence of the nominal mortgage rate and did not attempt to control for variations in credit conditions. Demography is represented only by the log of population in the OECD study. Estimates of the average speeds of

adjustment are not reported, but are probably quite low, given the omissions in the specifications chosen for estimation.

4.2.3 Evidence from central bank models

Next, we turn to central bank models. Many major central banks have semi-structural econometric models several of which include house price equations. For example, the influential FRB-US model adopts the house price/rent approach based on asset pricing theory. However, the weaknesses are that there are no controls for credit conditions and the ECM adjustment coefficient[22] is only 0.012 per quarter, implying almost no role for the adjustment of house prices to rents. A new policy model from the Bank of France, Lemoine at al. (2019) assumes that real house prices are governed by a simple autoregressive process with two lags, to the exclusion of all economic variables.

The new ECB model, ECB-BASE, for the whole Eurozone, adopts the inverse demand approach, unlike the models at the FRB and Bank of France. This model assumes an elasticity w.r.t. income per house of 1, lower than suggested by other studies, and finds a strongly significant user cost effect using the average annual appreciation over the previous 4 years to proxy expectations. There are no controls for the nominal interest rate, credit conditions and demography, and the ECM adjustment coefficient is a relatively low 0.036 per quarter, suggesting omitted variables. One can also question the choice of aggregating data over countries with such diverse credit institutions and house price dynamics, likely to give rise to measurement biases from implausible restrictions.

The Netherlands central bank model DELFI 2.0 is different from most models in assuming a long run solution for log nominal house prices as a linear function of the log nominal mortgage stock. The dynamics includes lagged growth in the mortgage stock and changes in interest rates and the ECM adjustment coefficient is 0.04. For the model as a whole, in which house prices also influence consumption and residential investment, much then depends on the equation for mortgage credit. This includes three proxies for credit conditions amongst the explanatory variables: an S-shaped linear trend (a proxy for the gradual loosening of bank lending standards in the 1990s), the ECB's Bank Lending Survey (available from the end of 2002 onwards), and the banking sector's leverage ratio. It also has a strong nominal interest rate effect.

The Irish model COSMO also follows the inverse demand approach with a house price equation whose long run solution depends on the mortgage stock-to-income ratio, which in turn is driven by credit supply indicators based on LTV and LTI indicators.

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[22] In a simple partial adjustment specification, this coefficient captures the speed of adjustment. This indicates the fraction of the total adjustment to the long-run level completed in one quarter. In more general equilibrium correction specifications, the ECM adjustment coefficient is an indication of the strength of long-run cointegration. Well-specified house price models typically have quarterly ECM adjustment coefficients above 0.1. While adjustment coefficients vary with the persistence of the dependent variable, relatively low coefficients often signal omitted factors, possibly including structural breaks.

The Bundesbank model models real house prices in the long run as a function not of income per house but of income per household and also includes a real mortgage rate term. The ECM adjustment coefficient is a satisfactory 0.11.[23] At the Bank of Italy, BIQM models housing wealth rather than house prices, and in relation to total wealth. At the Bank of Spain, the house price equation includes a nominal interest rate and long-run core inflation. The low ECM adjustment coefficient of 0.018 suggests that the long-run solution is not well formulated.

4.2.4 Evidence from a more general model (for France)

Only the Dutch and Irish models control for credit conditions – and indirectly via the mortgage stock. An alternative approach to incorporating non-price credit conditions in a house price equation, and indeed a set of household sector equations is the 'Latent Interactive Variable Equation System' (LIVES) methodology, see Duca and Muellbauer (2013) and Muellbauer (2018a), p.24-26. Shifts in observed LTVs and LTIs, especially for market averages, are imperfect proxies for shifts in non-price credit conditions as they depend also on interest rates and recent house price changes. We therefore use latent variables[24] to capture the hard to directly observe complex of non-price credit availability, i.e., lending standards. Intuitively, the principle is similar to the 'Sherlock Holmes method' of finding the criminal in a set of possible suspects: eliminate all the innocent individuals to find the guilty one (here non-price credit conditions or lending standards). Some of the credit conditions effects can interact with other economic variables, hence 'interactive', as well as shifting the level of the dependent variable.

The ESRB (2016) noted major data gaps in the monitoring of risks in residential and commercial real estate and issued a series of recommendations, which also influenced the G20 data gaps initiative. The collection of systematic and granular bank by bank information on mortgage credit conditions, including LTVs, LTIs and DSTIs, was one of its recommendations, updated in ESRB (2019). The UK is unusual in having long had information of this type[25]. The latent variable approach was also followed by Fernandez-Corugedo and Muellbauer (2006) to extract a summary non-price credit conditions index for mortgage loans from the proportions of first-time buyers, classified into young and old and by north vs south of the UK, with respectively high LTVs and high LTIs, and from an aggregate mortgage stock equation, after controlling for full range of economic and other factors, including house prices and interest rates. The index proved highly effective in subsequent modelling of consumption and home equity withdrawal, Muellbauer (2007) and Aron et al. (2012).

Without such granular information, it is still possible to make progress as demonstrated in Chauvin and Muellbauer (2018), by extracting the common information in aggregate mortgage, house price and consumption data after

[23] Though with a short sample period 2003-2019, it is not very accurately estimated, t=1.8.

[24] The latent variable is measured in a spline function, consisting of piecewise (non-linear) smooth transition dummies, whose coefficients are estimated. State space methods can also be used to estimate the latent variable.

[25] Though after 2001 and before an improved survey was introduced in 2005, there were changes in methodology which make it hard to interpret movements during this period.

controlling for a full range of economic and demographic factors. The two non-price credit conditions indices (CCIs) for France, one for mortgages and one for the rest of household debt, play a crucial role in explaining variations in consumption, house prices and mortgages, as well as non-mortgage debt. LIVES has been used to model house prices, mortgage debt and other variables in Chauvin and Muellbauer (2018) for France, and in Geiger et al. (2016) for Germany. In each case, a six-equation system was modelled, and the other variables included were consumption, non-mortgage debt, liquid assets and permanent income. France is a particularly good example, as there were major changes in credit conditions with liberalisation in the 1980s, a contraction in the early to mid-1990s, renewed liberalisation from the late 1990s to 2008 and a contraction after the global economic crisis, followed by the European sovereign debt crisis.

We follow the general specifications of Chauvin and Muellbauer (2018). An equilibrium correction framework is adopted, in which adjustment to the long-run solutions implied by theory takes time. Given the theory background set out above, the long-run solution for the house price equation is an inverted log-linear demand function, where real house prices, rhp, are determined by household demand, conditional on the lagged housing stock.

$$\ln rhp_t = h_{0t} + h_{1t} \ln mr_t + h_{2t} \ln user_t + h_3(\ln (y_t/hs_{t-1}) + h_{4t} E_t \ln (y_t^p/y_t)) + h_5\, demog_t + h_6 LA_{t-1}/y_t + h_7 IFA_{t-1}/y_t \quad (3)$$

In this equation, the intercept term, h_{0t}, captures shifts in demand, increasing with mortgage credit conditions, represented by an index MCCI. The nominal mortgage rate is mr, and user cost, measuring interest rates minus expected appreciation, is user. Both effects should be negative, and potentially could vary with the mortgage CCI. The coefficient h_3, for the log ratio of income to the housing stock,[26] is expected to be positive, and from the theory is measuring minus the inverse of the price elasticity of demand for housing, see above. The coefficient h_{4t} captures the relative effect of permanent to current income. The sign is ambiguous as there are offsetting influences. Standard demand for housing as a consumption item would suggest a positive coefficient as in a consumption function. But portfolio and collateral demand for housing, as a way of saving for the future, imply the opposite sign: more optimistic income expectations should reduce the demand for this store of value.[27] In principle, either influence could vary with mortgage credit conditions MCCI. The remaining terms represent the effects of demography and liquid and illiquid financial assets relative to income.

The role of demography is potentially mixed. On the one hand, the proportion of or changes in the proportion of households in the younger, first-time buyer age groups could influence house prices, mainly derived from housing demand as a consumption good. However, the portfolio demand for housing among middle aged and pre-retirement households is likely to be high. This suggests that the proportion of households in this age group could also be a positive factor for house prices. In

[26] This formulation imposes the constraint that the income elasticity of demand for housing is 1.

[27] Note that house price expectations are already embodied in the user cost term.

principle, demography and the income distribution should interact, as the purchasing power of the different demographic groups, as well as their size, should be relevant. In practice, lack of data typically makes this impossible to implement. The different components of portfolio wealth could also have dual roles: other things being equal, higher wealth would increase the consumer good demand for housing. However, higher financial wealth would tend to diminish demand for housing as a store of value.

The house price equation for France has a very strong long-run solution with a quarterly ECM adjustment coefficient of around 0.12 (t=13). Mortgage credit conditions, measured by the latent variable MCCI, are crucial: if MCCI is omitted the ECM adjustment coefficient collapses and few long-run coefficients make sense. The elasticity of real house prices w.r.t. the nominal mortgage rate is -0.38 (t=-12) and seems to be quite stable. In France's fixed mortgage rate market, where lenders focus strongly to keeping the debt-service ratio below a ceiling of around 40 percent (recently reduced to 33 percent), the importance of the nominal mortgage rate makes especial sense. This is a powerful and well-determined part of the monetary policy transmission mechanism in France. For example, it implies that a fall in the mortgage interest rate from 3 to 2 percent, results in a 17 percent rise in real house prices in the long run, other things equal. To this must be added an effect via the user cost term, including the effect on lagged house price appreciation.

This formulation has important implications when nominal mortgage rates fall to low levels because the log formulation amplifies small changes. One question is whether this amplification is more excessive than the data warrant. This is easily checked by reformulating log (nominal mortgage rate) as log (constant + nominal mortgage rate), where, if the mortgage rate is measured as an annual percentage, the constant is a small number such as 2.[28] But even with such an adjustment, there is a genuine issue for financial regulators: have they placed too much weight on the debt-service ratio, to the exclusion of the loan-to-income ratio? This matters when interest rates rise, as is likely in 2022. In France, where the floating rate share of the mortgage market is small, existing borrowers on fixed rate mortgages are protected from interest rate risk. The main effect on house prices will come by discouraging potential new buyers.

A second component of transmission via the mortgage interest rate occurs through the user cost term. User cost uses a weighted average of appreciation in the previous year and the average of the previous 4 years and also incorporates a time varying risk premium that depends on the volatility of recent house price changes. The elasticity w.r.t. user cost varies significantly with MCCI and is around -0.035 at the peak value of MCCI. The implication of this term, which confirms a tendency for French housing market participants to extrapolate past house price appreciation in forming expectations, is that overshooting of house prices is liable to occur in France after a period of positive economic developments, such as easier credit conditions or lower interest rates.

[28] The results are robust to such a reformulation and there is little difference in, for example, the estimated mortgage credit conditions index. The coefficient on the reformulated mortgage rate term increases relatively to the simple log mortgage rate version, but with similar implications for the interest rate sensitivity of house prices.

The elasticity of house prices with respect to income per house is 2 and seems fairly stable. Assuming an income elasticity of demand for housing of 1, which can be accepted, this implies that the price elasticity of housing demand w.r.t. average house prices is -0.5, which is in line with studies surveyed by Meen (2001). The elasticity of real house prices w.r.t. log permanent/current income is around 0.5. There are also significant demographic effects from the ratios of children and pre-retirement adults to the total number of adults.

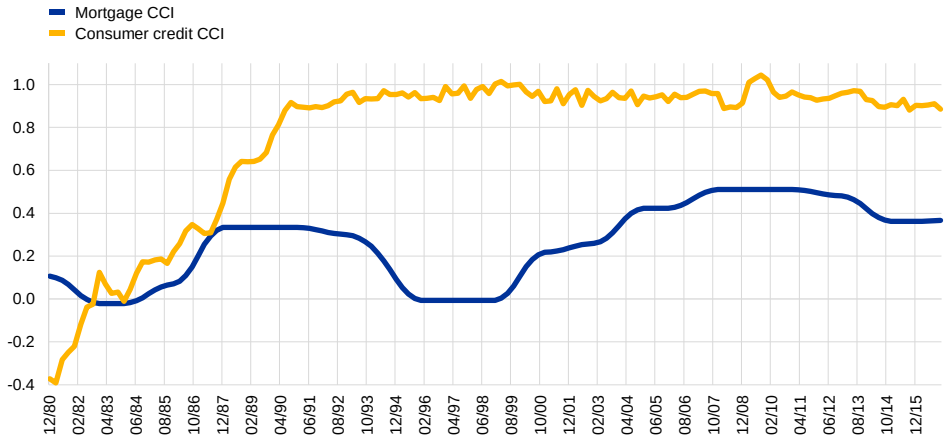
While macro policy models need an equation for a national house price index, there are, of course, great divergences within economies between regions and major cities such as Paris. In Cameron et al. (2006), we pioneered an inverse demand systems approach to model house prices in 10 UK regions. In Muellbauer (2019), the same idea was applied by adding an equation for Paris house prices to the equation system developed with Valerie Chauvin. This suggested that house prices in capital cities are more sensitive to interest rates and credit conditions, and that international investors tend to play a more important role as seen in greater international spill-over effects. Within country differences in house price dynamics are highly relevant for financial stability as any over-valuation may be more extreme in particular cities.

Without the mortgage credit conditions index, as noted above, it is impossible to find a coherent model for house prices in France for the post-1980 period. From the mid-1980s, there were a series of well-documented liberalisations of French credit markets. However, as bad loans built up in the early 1990s, further liberalisation in the mortgage market seems to have stalled and then reversed in the early to mid-1990s. A new wave of liberalisation of mortgage credit began with monetary union, only to reverse after the global financial crisis and the European sovereign debt crisis. The corresponding profile of the mortgage credit conditions index for France is shown in Chart 12, while the close correlation with the NPL ratio after 1990 is shown in Chart 13.[29]

[29] This comes from a regression of the estimated mortgage credit conditions index on a declining weighted moving average of the NPL ratio from t-2 to t-14 and the difference between a smooth transition dummy for 2002 and 2012, where the dummy grows from 0 to 1 over an 8-quarter period. This represents an easing of mortgage credit conditions in the early 2000s and its reversal after 2012, not otherwise captured by the NPL ratio.

Chart 12

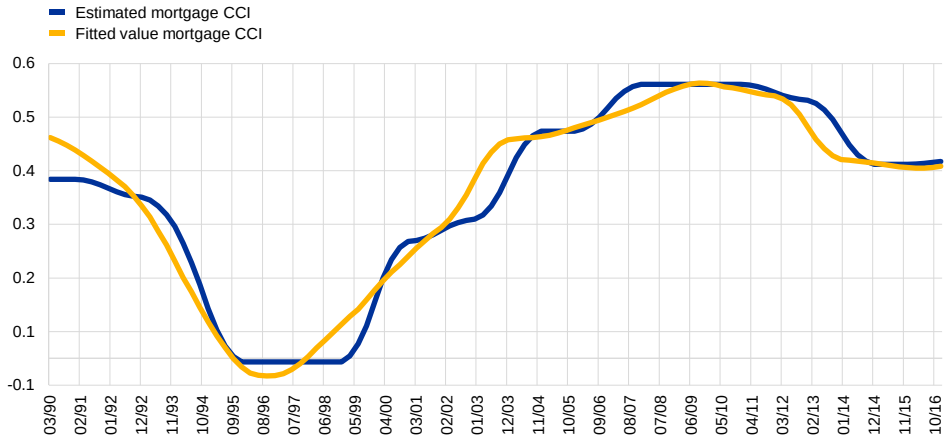
Estimated mortgage and consumer credit conditions indices for France



Source: Chauvin and Muellbauer (2018).

Chart 13

The NPL ratio was a major driver of French mortgage credit conditions from 1990



Source: Chauvin and Muellbauer (2018) for the estimated mortgage credit conditions index. The fitted value comes from a regression for 1990Q1 to 2016Q4 of the estimated mortgage credit conditions index on the weighted moving average, with declining weights, of the previous 3 years NPL ratio and on a smooth transition dummy capturing mortgage credit liberalisation in 2002-3 and its reversal in 2012-13.

The implication of Chart 13 is that since 1990, the NPL ratio for France has played an important part in the credit cycle through its implications for non-price credit conditions in the mortgage market. As we have already seen, it also affected the pricing of mortgage interest rates, and the next section will show that it also affected residential investment through its effect on the willingness of banks to lend to home builders.

Estimates of a similar house price model for Germany for data up to 2012 in Geiger et al. (2016) suggest notable differences. An important difference is that, although once again, the log of the nominal mortgage rate dominates a real mortgage rate, the coefficient is around one third of that in France. This is probably because German financial regulators placed less weight on the debt service ratio and as a result, the fall in nominal mortgage rates had smaller effects on house prices than in France. A second difference is that no user cost effect was detectable, though there is some

evidence of extrapolation of past house price gains. However, this arises measured as the difference between appreciation in Germany and an average of past appreciation in Spain, Italy and France. Higher appreciation in these countries tends to result in lower relative portfolio demand for housing in Germany. This can be interpreted in terms of the strength of the portfolio investment motive for German homebuyers, given that renters make up over half of tenures. A third difference is that there is no evidence that income growth expectations matter. This is also consistent with the saving for acquiring housing assets, which includes the 'saving for a rainy day' motive when saving tends to rise if lower income growth is expected.

The spill-over effect from other countries detected for Germany, raises the question of whether such spill-overs are relevant for other countries. International investors, including the extremely wealthy, find the Mediterranean region and Switzerland desirable locations. If that is so, it is plausible that when housing is relatively expensive in Spain, Italy and Switzerland relatively to France, more portfolio investment from outside flows into the French housing market. There is some evidence that the lagged level of house prices in Italy and Spain relative to France have a significant positive effect in the long-run solution for the French house price index, particularly since the late 1990s. While significant, the effect is not large and makes little difference to the overall conclusions reported in Chauvin and Muellbauer (2018). Preliminary findings for Italy suggest a parallel effect with relative house prices in Italy, Switzerland and to a lesser extent Spain affecting the long-run solution for Italian house prices. In other respects, findings for Italy suggest a far smaller interest rate response than in France and a much smaller role for extrapolative expectations.

For Ireland in the period 1980 to 2012, Lyons and Muellbauer (2013) find an even stronger extrapolative expectations effect on house prices than Chauvin and Muellbauer find in France. Extrapolative expectations in Ireland are measured by the annualised appreciation in the previous 4 years. The implication is that, with easy access to credit and high LTVs available to home buyers from 2000 to 2007, a good deal of the overshooting of house prices that preceded the crisis can be accounted for by a speculative frenzy based on extrapolation of previous gains. Credit conditions also played a key role and were proxied in the model by the ratio, as well as its change, of total mortgage debt to domestic retail deposits. This rose from 75 percent in 1998 to 175 percent in 2008 with the expansion of funding by banks from international money markets before returning to about 80 percent in 2021. The lack of market-price linked property taxes and high levels of tax relief on mortgage interest payments are other features of the institutional framework for Ireland that help explain the Irish house price and credit boom. Preliminary evidence for Spain for the period 1987 to 2012 suggests that Spanish house prices also responded more than in France to a user cost including an average of house price appreciation in the last year and the last 4 years.

To summarise this discussion, the size of extrapolative expectations matters greatly for detecting episodes of overvaluation, an issue to which we return in section 5. Comparative evidence (albeit preliminary for Italy and Spain) suggests that the following ordering of countries in the importance of extrapolative expectations in explaining house price dynamics: Ireland, Spain, France, Germany and Italy. The

evidence from the dynamics of the house price equation in the DELFI model for the Netherlands is for strong effects from lagged house price changes in the previous year, also pointing to a role for extrapolative expectations. As we have seen, there is convincing evidence of strong effects from nominal mortgage rates on house prices – though with considerable differences between different countries. There is also evidence for a crucial role for variations in non-price credit conditions, more important in Ireland, Spain, France and the Netherlands than in Germany and Italy. In the long-run, housing supply matters too and as it depends on the accumulation of residential investment over many years, which itself depends on house prices and interest rates, the nature of monetary transmission to house prices is complex and heterogeneous both in the short-run and the long-run. One of the contributors to heterogeneity is the proportion of fixed vs. floating rate mortgages: where fixed rates predominate, rising rates transmit more slowly into house prices.

4.3 The drivers of residential investment

Residential investment, comprising a significant and volatile part of GDP, is an important channel for monetary policy transmission. As an important part of the transmission mechanism in the financial accelerator, it is also important for financial stability: for example, if construction responds strongly to house prices, as in Ireland and Spain, a strong house price boom can result in overbuilding, which can contribute to the decline in house prices and activity in a subsequent recession.[30] Further to this, an equation for residential investment potentially serves two additional functions in an econometric policy model. First, if housing wealth is one of the drivers of the consumption function, an equation is required for the acquisition of housing assets by households. This acquisition would be captured largely by residential investment since most of such investment is in the form of home improvements or home purchases by households. Second, a residential investment equation is needed to endogenise the housing stock, which is an important driver of house prices, see section 4.2.

The simple theory of a profit-maximising firm in a competitive market suggests that profits of a homebuilder depend on the sales prices of houses built relative to the costs of construction. Given lags in construction, sales occur several quarters after construction begins and this could affect the timing of observations of prices and costs. Homebuilders need capital to build and in some cases, to acquire the land in advance of building,[31] which suggests a role for interest rates as a measure of financing costs and potentially for credit constraints. While house prices are driven by demand, in the short run, house prices tend to adjust to demand with a lag, as we saw in section 4.2. This suggests that short-term demand shocks should affect construction volumes.

[30] A more conventional view is that a high supply elasticity helps prevent excessive appreciation in the first place. However, in the case of the house price boom in Ireland and Spain, the combination of falls in interest rates and much looser lending standards overwhelmed the short-run supply response.

[31] This would apply to ‘speculative builders’, who are effectively buying land and are hoping to profit from a rise in land values plus the profit margin on the value they have added in the form of building materials and labour, see Muellbauer (2018b).

4.3.1 Multi-country evidence

Research on residential investment has been reviewed by Duca et al. (2021a). An important recent study for the OECD, by Cavalleri et al. (2019), covers 25 countries and updates an earlier study by Caldera and Johansson (2013). The key driver in this research is the ratio of house prices to an index of building costs,[32] which for many countries is well proxied by the price deflator for residential investment. Countries vary a great deal in the supply elasticity of residential investment. For example, their estimate for the U.S. is that a 1 percent increase in real house prices leads eventually to a 2.8 percent increase in the volume of residential investment. The figure, see Table 5, is by contrast around 0.5 percent in the Netherlands, France and Italy, 0.67 in Germany, 1.17 in Spain and 1.3 in Ireland. Cavalleri et al. (2019) also find that, in explaining cross-country differences, more habitable land per head, greater ease of construction (proxied by the past expansion of built-up area) and less land-use restrictiveness all boost the price elasticity of housing supply. Hence there may be important structural and procedural/planning differences between countries affecting monetary transmission, realised via housing markets.

It is useful to locate different countries in the international spectrum of the mechanism connecting residential investment with house prices and possibly other drivers. It would establish the magnitude of the transmission channel between monetary policy, house prices and residential investment. The OECD study is an important contribution, but its limited short-term dynamics probably do not fully capture timing differences between the effects of house prices and construction costs. The study also omits interest rate effects and credit conditions, usually thought to be relevant in a study of investment. In particular, since such effects are likely also to be correlated with house prices, their omission is likely to result in an upward bias of the elasticity of residential investment w.r.t. to house prices. Since house prices are sticky, short-term demand shocks also influence residential investment directly without being mediated through prices, as noted above. Proxies for such demand shocks could help capture the short-term dynamics in residential investment. These proxies need to be based on the changes in demand drivers, such as income, interest rates and employment. Note that the long-term demand drivers, apart from the cost of capital and credit availability, are already captured by the level of house prices, which enters the residential investment expressed as a ratio to construction costs.

[32] To be precise, the model is formulated in terms of the log real house price index and the log real construction deflator. For several countries, the coefficients on the two are approximately equal and of opposite sign, so that the two terms can be combined into a single log price ratio of house prices to the construction cost deflator.

Table 5

Housing supply elasticities and speeds of adjustment for Euro area economies

Country	Supply Elasticity	ECM adjustment coefficient
	0.67	-0.21
DEU	0.16	0.07
	1.17	-0.05
ESP	0.16	0.017
	0.49	-0.1
FRA	0.11	0.041
	1.3	-0.37
IRL	0.14	0.13
	0.55	-0.47
ITA	0.12	0.09
	0.4	-0.2
NLD	0.13	0.071

Source: Cavalleri et al. (2019).

Duca et al. (2021a) argue that future research in this area also needs account for a major structural break caused in countries such as the U.S., Ireland and Spain by the GFC. Much productive capacity, all the way down the supply chain, was lost in these countries, particularly in Ireland as noted in section 2, see Charts 9 and 10. The construction industry became more concentrated as many smaller building firms went bankrupt when cash flows and the value of their land banks collapsed. This suggests that post-crisis, monetary transmission via the housing market will have altered in those countries.

4.3.2 Evidence from central bank models

Consider one version of a residential investment equation in its long-run form as follows:

$$\ln inv_t = v_{0t} + v_1 \ln gdp_t + v_2 \ln\left(\frac{hp_t}{hc_t}\right) + v_3 interest\ rate_t + v_4\ credit\ conditions_t + v_5\, demography_t \quad (4)$$

Here $hinv$ is per capita residential investment in constant prices, the intercept term is potentially time-varying to indicate the kind of capacity loss that some countries have suffered in the GFC, gdp is per capita real GDP, hp is the house price index, hc is the deflator for residential construction, and the interest rate and credit conditions terms are self-explanatory. The demography effect could take different forms[33]. Another variant of equation (4) replaces GDP by the residential capital stock. Then if $v_1 = 1$, this becomes a model for the investment rate, and this is adopted in

[33] Demographic data such as the rate of growth of the population or of the working age population, are typically classified as I(1), i.e. integrated of order one, so that such data need to be time-differenced again for stationarity.

ECB-BASE[34]. The dynamic form of the equation is of the equilibrium correction type, with the dependent variable the change in the log of per capita residential investment in constant prices. Apart from changes in the elements of the long-run solution, other potential variables in change form could include the log of real per capita household disposable income and the inflation rate.

The ECB-BASE model includes a negative time trend and estimates the long-run elasticity of investment w.r.t. relative prices, v_2 , to be 1.06[35], and a significant user-cost effect, which incorporates extrapolation of past relative house prices to capture expectations. The short-run dynamics include the growth rate of real GDP. The ECM adjustment coefficient is (not very precisely) estimated at 0.1.

The Bank of France model does not include residential investment. The Bundesbank model assumes that residential investment moves in line with building permits.

4.3.3 New evidence from France

An ECM version of equation (4) was estimated for French data. After reduction from a general lag specification to a parsimonious form, the results shown in Table 6 were found. Here, the relative price appears as the log ratio of the current house price to the construction cost 5 quarters earlier. This corresponds to a 5-quarter delay between the start of building operations and the sale of the dwelling. There is no effect from the level of real GDP. The level of the real short-term interest rate proved significant at a lag of 2 quarters. However, the corresponding inflation rate at a lag of 3 quarters is also very significant and with a negative coefficient, suggesting that nominal effects are important. As a proxy for credit availability, the log of the total NPL ratio for banks enters at a lag of 2 quarters. Quite similar results but slightly worse fits are obtained with the level of the NPL ratio and with the log or level of the NPL ratio defined as NPLs for loans to households divided by the stock of household debt. The ECM adjustment coefficient is estimated at 0.21, twice that found for France in the OECD study, but the estimated elasticity of supply is 0.25, just about half of the estimate from the OECD study. This is consistent with the inclusion of controls for an interest rate, credit conditions, population growth and short-term dynamics, likely to be correlated with house prices. Such a finding points to the estimated supply elasticities from the OECD study being systematically biased up. The short-run implications of the two approaches for the size of adjustment to house prices are similar, as the slower ECM adjustment coefficient in the OECD study approximately compensates for the higher response elasticity. But the long-run implications are rather different.

Short-run dynamics in the estimated equation include the lagged growth rate of real per capita household income, the rate of population growth in the 25 to 64 age group – note that much of this effect is as a deviation from the previous year's population growth, and the lagged 4-quarter change in the short rate minus its 4-quarter change

[34] However, the foundation based on the theory of business investment is weak, as the capital stock of house builders does not consist of the outstanding housing stock, much of it constructed decades earlier.

[35] Preliminary indications from the ECB's new multi-country model are that estimates of this supply elasticity are at around this level and vary much less across countries than the OECD evidence would suggest.

one year earlier. Dummies for outliers in 1982 and in 2018-19 are also included. The latter may be connected with tax changes affecting property. All the diagnostic tests are satisfactory and estimates shown for the pre-GFC period and the period since 1992 are closely in line with full period estimates, confirming parameter stability. This suggests that a downturn in the French housing market after the GFC was not severe enough to cause any structural shift in the drivers of residential investment. As expected, there are large outliers if the estimation period includes the COVID pandemic period (not shown).

Table 6

Residential investment model (example using French data)

Dependent variable: Δ log (residential investment per capita)t	1982:2 to 2008:2		1992:1 to 2019:4		1982:2 to 2019:4	
	Eq. 1		Eq. 2		Eq. 3	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
Constant	-2.042	-6.6	-1.922	-7.1	-1.909	-8.2
log (Residential investment per capita) t-1	-0.227	-6.7	-0.213	-7.1	-0.212	-8.5
log (Nominal house prices) t-1 - log (Residential investment deflator) t-5	0.060	5.2	0.059	5.9	0.055	6.1
(Real short run interest rate) t-2	-0.143	-4.0	-0.148	-3.6	-0.128	-4.2
log (NPL ratio to loan book) t-2	-0.015	-4.5	-0.010	-1.9	-0.013	-5.7
Δ log (Residential investment per capita) t-1	0.211	2.6	0.335	4.2	0.290	4.4
Δ log (Residential investment per capita) t-2	0.393	4.9	0.334	3.9	0.366	5.4
Δ log (Residential investment per capita) t-3	0.286	3.2	0.268	3.0	0.256	3.6
Δ4 log (Consumer expenditure deflator) t-3	-0.198	-2.7	-0.222	-3.4	-0.244	-5.2
Δ4 log (Real disposable income pc) t-1	0.168	2.8	0.227	4.1	0.194	4.6
Δ4 log (Population aged 25-64) t-1	0.757	1.0	1.508	4.6	1.501	6.2
Δ4 Δ4 log (Population aged 25-64) t-1	3.177	3.1	2.612	2.4	3.123	4.2
Δ Dummy 1982Q4 t	-0.018	-4.3	0.000	0.0	-0.018	-4.5
Dummy 2018Q3(4q-ma) t	0.000	0.0	0.041	3.2	0.040	3.0
Δ4 Δ4 (Nominal short run interest rate) t-1	-0.137	-4.9	-0.199	-5.9	-0.150	-5.7
Equation standard error		0.00585		0.00543		0.00574
Adjusted R-squared		0.706		0.741		0.732
Durbin-Watson		1.98		2.08		1.93
Breusch/Godfrey LM: AR/MA4		p = [.602]		p = [.150]		p = [.398]
Chow test		p = [.895]		p = [.292]		p = [.310]
Breusch-Pagan het. Test		p = [.305]		p = [.433]		p = [.185]

Notes: Estimation performed in TSP 5.0 of Hall and Cummins.

4.4 The drivers of consumer expenditure

The theory background for most central bank policy models is the familiar textbook aggregate, life-cycle/permanent income consumption function of Friedman (1953) and of Ando-Modigliani (1963). Here real per capita consumption c is a linear function of real per capita permanent non-property income y_t^p and wealth A. Permanent income, y_t^p, is defined as the constant flow of current income y that corresponds to the present value of expected future income streams. Since consumption and income tend to grow exponentially, formulating the consumption function in logs has advantages. A log approximation of the model is: [36]

$$\ln c_t = \alpha_0 + \ln y_t + \gamma A_{t-1}/y_t + \ln\left(y_t^P/y_t\right) \quad (5)$$

Common versions of the model use the log of wealth but (5) has advantages.[37] The log ratio of permanent to current income $\ln(y_t^p/y_t)$ reflects expectations of income growth. The long-run solution is typically embedded in an ECM.

4.4.1 Evidence from consumption functions in central bank models

In the FRB-US model, permanent income is further disaggregated into labour, transfer and property income, while consumption is split into services, other non-durables and durables. Wealth is given by net worth, defined as liquid plus illiquid financial assets, plus physical wealth (mainly housing), minus debt. Two versions of household expectations are available in the model: model-consistent or generated by satellite VARs. A dynamic adjustment process takes place around the long-run solution. The ECB-BASE model is similar to the FRB-US model, except that it has been developed for aggregate consumption and is estimated for quarterly data for the aggregate Euro area from 2000 to 2017. Both models make the ad hoc assumption that a fraction of households (estimated at 0.36 in ECB-BASE) just spend current income, which makes aggregate consumption much more responsive to current income than implied by the permanent income theory. Moreover, following Muellbauer and Lattimore (1995), the permanent income measures in both models assume far higher discounting of future income than textbook theory, with annualized discount rates of around 20 percent as opposed to around 3 percent on conventional assumptions about the level of real interest rates. The higher discount rates incorporate a risk premium absent in the textbook model. The ECM adjustment coefficient in ECB-BASE is 0.22, indicating a fairly strong long-run solution.

A new policy model from the Bank of France, Lemoine at al. (2019) omits all household balance sheets, even net worth, as well as credit conditions, in the consumption function, which is driven by permanent income, based on aggregate

[36] See Aron et al. (2012).

[37] The log assets formulation employed in most studies of consumption gives a poor approximation of the marginal propensity to consume out of assets when asset levels are low, as they are for many households. It is also a poor approximation when disaggregating net worth into several components since the log function is not additive.

household disposable income, and interest rates and also assumes a fraction of households just spend current income. The low ECM adjustment coefficient of 0.12 is symptomatic of specification problems.

In sharp contrast, the Netherlands central bank policy model DELFI 2.0 model, Berben et al. (2018), incorporates separate effects from housing and financial wealth. The long-run marginal propensity to consume out of financial wealth (excluding pension wealth) is around 0.04, while that on housing wealth is around 0.058, suggesting an important collateral channel for housing wealth in the Netherlands. Pension wealth has a small indirect influence as the funding ratio of pension funds affects consumer confidence whose change enters the short-term dynamics of the consumption function along with changes in the unemployment rate, and in rates of change of real house prices and equity prices. The ECM adjustment coefficient for aggregate consumption is 0.11. A recent unpublished upgrade newly distinguishes household debt[38]. The Irish central bank's COSMO model also distinguishes financial from housing wealth but with a rather smaller effect from the latter. However, in the short-run dynamics, the current rate of change of housing wealth has a very large effect, almost certainly capturing credit effects operating via house prices. The ECM adjustment coefficient is estimated at 0.26 over the period 1997-2015. Indeed, in their house price equation, a credit conditions measure extracted from an equation for the loan-to-income ratio for mortgage debt that attempts to control for other influences, plays an important role. Credit conditions are therefore indirectly represented in the consumption equation. Something similar occurs in the Netherlands DELFI model, where as noted above, dummy variables for credit liberalization enter the mortgage stock equation, which in turn drives house prices. Neither COSMO nor DELFI attempt to control for income expectations as represented by a permanent income term.

The Bundesbank model splits income into labour plus transfer income and other income. Wealth is aggregate net worth and there is a small negative real interest rate effect. The ECM adjustment coefficient is 0.47 and estimated accurately (for 1995-2019) indicating a strong long-run solution. For Italy, BIQM uses a different definition of consumption by adding non-durable spending to a measure of durables services proportional to the stock. As the stock is very persistent, this is part of the reason for an ECM adjustment coefficient of only around 0.07 over a sample from 1972 to 2012. A separate stock adjustment process is used to model the durable stock. Wealth is net financial wealth –excluding housing wealth- and there is a negative real interest rate effect. For Spain, the consumption function includes income and net worth and the rate of change of bank lending to households to capture an aspect of credit conditions and the ECM adjustment coefficient is 0.08. Only the Bank of France and ECB-BASE models include permanent income. The striking difference between the ECM coefficient estimated for Germany and all the other models hints at the possibility of omitted variables in the latter. An obvious candidate is a measure of credit liberalization or of changing lending standards, as Germany seems to have been relatively immune from liberalization trends elsewhere, at least after 1995.

[38] Private communication from Robert-Paul Berben.

4.4.2 Evidence from credit-augmented consumption functions

A more comprehensive approach to modelling aggregate consumer expenditure can be found in the credit-augmented aggregate consumption function applied in a series of my papers with co-authors. To incorporate shifts in credit constraints such as the down-payment constraint for a mortgage, the disaggregation of balance sheets, a role for house prices, income uncertainty, interest rates, and demography, the long-run version of this credit-augmented aggregate consumption function is:

$$\ln c_t/y_t = \alpha_{0t} + \alpha_{1t} r_t + \alpha_{2t}\theta_t + \alpha_{3t} yperm_t/y_t + \gamma_1 LA_{t-1}/y_{t-1} + \gamma_2 DB_{t-1}/y_{t-1} + \gamma_3 IFA_{t-1}/y_{t-1} + \gamma_{4t} HA_{t-1}/y_{t-1} + \gamma_{5t} \ln(hp_{t-1}/y_{t-1}) + \gamma_6 demog_t \quad (6)$$

Here, as in equation (5), c is real consumption, y is real income, r is a real interest rate, θ is an indicator of income uncertainty, yperm/y is the ratio of permanent to current income, LA is household liquid assets and DB is household debt [39], IFA is illiquid financial assets, hp is an index of real house prices, HA is gross housing wealth, and demog captures the possible effect of demography on consumption. Some coefficients can be time varying because of shifts in credit conditions. The four balance sheet variables are delated by the consumption deflator.

The intercept α_{0t} increases with greater availability of non-housing loans and of mortgages, as the need to save for a down-payment is reduced. However, for given level of access to mortgage credit, higher house prices relative to income increase the size of required down-payments, implying that γ_{5t} is negative. This coefficient should become less negative if lenders relax the down-payment constraint. However, if the focus of credit easing by lenders is instead on relaxing debt-to-income or debt service ratios, this reduction in minus γ_{5t}would be absent.[40] If access to home equity loans increases, the coefficient γ_{4t}, measuring the marginal propensity to spend out of housing wealth, should increase. One might also anticipate that expectations of future income growth, captured in α_{3t}, would have a larger effect on consumption when credit constraints ease. It is also possible that α_{1t} , the sensitivity of consumption to the real interest rate, might be affected by credit conditions. However, the direction of the effect is unclear a priori, with greater access to credit and higher levels of debt pulling in opposite directions. The full dynamic specification incorporates partial adjustment, and changes in the unemployment rate or other proxies for income insecurity,

[39] It is possible to disaggregate net worth into three elements if liquid assets and debt can be combined into liquid assets minus debt, which is sometimes an acceptable restriction. Relative to a common alternative restriction- the assumption that mortgage debt can just be netted off gross housing wealth, the restriction that the coefficient on debt is minus that on liquid assets is better supported by the data.

[40] It is plausible that to preserve the overall level of risk, lenders could tighten the loan-to-value constraint to offset a loosening of the debt service or loan-to-income constraint. Evidence of such behaviour in the setting of loan-to-value and loan-to-income constraints by mortgage lenders for UK first-time buyers was found by Fernandez-Corugedo and Muellbauer (2006). One might then observe a paradoxical increase in minus γ_{5t} as loan-to-income constraints are loosened.

changes in income, in inflation, and in nominal interest rates for countries where floating rate debt is prominent.[41]

Estimates for a range of countries including the UK, U.S., France, Germany, Italy, South Africa and Canada suggest ECM adjustment coefficients of 0.3 or more.[42] The coefficient α_{3t} on the ratio of permanent to current income is typically in the range 0.3 to 0.7, sometimes with mild evidence of increases with ease of credit.[43] Estimates of the coefficient γ_1 on liquid assets are mostly in the range 0.07 to 0.16, with estimates of γ_2 on debt in a similar range, but negative.

One implication of these results for several countries is to offer a different perspective on the 'debt-overhang' hypothesis, under which the downturn in consumer spending in the aftermath of a financial crisis is explained as a larger cut in spending by heavily indebted households. Rather than an increase in the negative effect of household debt at this point, our models suggest that the contraction in non-price credit conditions accounts for much of the spending decline. However, this does not rule out distributional effects.

Estimates of the coefficient γ_3 on illiquid financial wealth are typically 0.02 to 0.025. Estimates of the time-varying housing collateral effect for the U.S., UK and South Africa, are around zero in the 1970s, and later positive but fluctuating with credit conditions, reaching peaks in the mid-2000s, e.g. around 0.06 in the U.S. This time variation matters because it tends to amplify the cyclical effect on consumption of house prices both in the upswing and in recessions where credit has tightened. In contrast, in countries where mortgage equity withdrawal is absent or very limited, no time-variation could be found for the effect of housing wealth effect on consumption in France and Italy, and no significant effect at all for Germany. For all three, there are significant negative effects for the log house price to income ratio, consistent with a substantial down-payment constraint encouraging saving.[44]

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41 In the estimated UK version of the equation, see Aron et al. (2012), the change in nominal interest rates is weighted by the debt/income ratio as one would expect larger cash flow effects when debt burdens are higher. However, when credit conditions are easy, households can refinance to ameliorate the strain on cash-flow when nominal rates rise. This explains an offsetting interaction effect with credit conditions of the weighted nominal interest rate change.

42 Most of these models are of the simple partial adjustment form. Then a speed of 0.35 would imply that 82 percent of the adjustment to a shock would be complete within one year and higher speeds imply even higher percentages.

43 Increases in income inequality tend to increase the fraction of households with high MPCs, see e.g. Crawley and Kuchler (2018), reducing the average value of α_{3t}. Rajan (2010) argues that pressure for financial deregulation in the U.S. leading to credit liberalisation came from increasing income inequality and the lack of income growth for the lower half of the distribution. This could explain why empirical evidence for an increase in α_{3t} with credit conditions is not stronger.

44 For Italy, in comparison with France, the positive effect of the housing wealth to income ratio and the negative effect of the log house price to income ratio are both larger. The latter is consistent with far more constraining down-payment requirements in Italy than in France for access to mortgage credit, already noted in Maclennan et al. (1998).

Table 7

Estimates for Germany, France and Italy of a credit-augmented consumption function

Dependent Variable = Δlnc_t	Symbol	1981Q3-2012Q4		1981Q2-2016Q4		1977Q1-2016Q4	
		Germany		France		Italy	
		coefficient	t- ratio	coefficient	t- ratio	coefficient	t- ratio
Long-run coefficients for log c/y							
ECM adjustment coefficient	λ	0.86***	15.9	0.56***	11.1	0.32***	7.4
Constant	α_0	0.647***	3.4	0.08*	1.7	1.6***	3.1
Mortgage credit conditions index: MCCI	α_{0c}	0.092***	7.7	0.064***	5.3	0.13**	2.4
Consumer credit CCI: UCCI	α_{00c}	0.025	1.2	0.058***	5.4	-	-
Real mortgage interest rate	α_{11}	-0.238***	-3.4	-0.72***	-7.5	-0.50***	-5.3
Real unsecured interest rate	α_{12}	-0.474***	-4.6	-	-	-	-
Real deposit rate	α_{13}	0.737***	5.7	-	-	-	-
Forecast future income growth: $E\ ln\ yperm/y$	α_3	0.346***	8.6	0.55***	9.9	0.36***	3.2
Liquid assets/ y	γ_1	0.09***	4.1	0.14***	4.4	0.08***	8.9
Debt /y	γ_2	-0.09***	-4.1	-0.14***	-4.4	-0.17***	3.4
Illiquid financial assets/y	γ_3	0.016**	2.5	0.022***	3.3	0.016**	2.2
Housing wealth/ y	γ_4	0.001	0.1	0.013**	2.2	0.048***	4.3
Log house prices/y	γ_5	-0.070***	-3.4	-0.062**	-2.5	-0.14***	-3.2
Equation s.e.		0.00236		0.00324		0.00450	
Durbin Watson		2.29		1.93		2.02	
R-squared		0.938		0.705		0.729	

Source and notes: Consumption is total expenditure in real terms. All equations also include short-term effects such as the change in the unemployment rate, income volatility and inflation surprises. German estimates from Geiger et al. (2016). Income is household disposable income. The equation also includes controls for pension reform and demographics and short-run effects. French estimates from Chauvin and Muellbauer (2018). Income is an average of total household disposable income and labour plus transfer income. The real interest rate consists of the rates for mortgage and consumer credit, weighted by respective debt/income ratios. Italian estimates from Debonis et al. (2022). Unlike for Germany and France, an equal and opposite coefficient restriction for liquid assets and debt is rejected for Italy. Non-price credit conditions indices for Germany and France are estimated as latent variables from an equation system. For Italy, the measure is based on the ratio for all types of borrowers between the used credit lines and the granted ones based on the Bank of Italy's Central Credit Register.

Since the house price-to-income ratio is correlated with the housing wealth-to-income ratio, omitting the former results in misleadingly downward-biased estimates for the latter. It is clear to that a considerable extent, these two opposite-signed effects represent the behaviour of different households: renters and would-be homeowners for the former and owner-occupiers for the latter. This illustrates that this kind of evidence-based model is not for some mythical 'representative' household but captures, despite the formulation for aggregate data, a good deal of the heterogeneity across households implied by theories of household behaviour in incomplete markets with heterogeneous credit and liquidity constraints. For policy simulations, evidence from microdata could be used to calibrate modifications in aggregate implications of distributional shifts in household portfolios and in incomes, for example, as occurred during the pandemic.

4.5 The drivers of mortgage debt

Higher mortgage debt, other things equal, clearly has a negative effect on consumption. Mortgage debt builds up slowly and therefore is part of a long-run channel from monetary policy via debt to consumption. High household debt levels relative to income can also generate vulnerability across the household sector when falls in income or interest rate rises lead to problems in servicing debt. Understanding the drivers of mortgage debt is therefore of interest not only to standard monetary policy but also for macroprudential policy.

There is no convincing single, simple theoretical model that underlies the demand for housing. Clearly, the demand for mortgages is strongly linked to the demand for housing, which implies that there is also no single, simple theoretical model behind this demand. However, while some homebuyers are cash buyers or buyers with so much wealth that the mortgage represents only a small part of the purchase price, the demand for mortgages tends to be dominated by the subset of potential buyers with less wealth. Younger first-time buyers are likely to be prominent, suggesting that the proportion of the population in this age group is likely to be a factor. Moreover, to model the mortgage stock, or the flow of new mortgage lending, the credit supply side is crucial. All lenders use screening rules, such as limits on leverage as represented by loan-to-value ratios, and affordability criteria as represented by debt-service or debt-income ratios, as well as checks on the credit worthiness of individual households, to allocate credit. This implies that credit conditions, a proxy for shifts in credit availability other than that represented by the standard mortgage interest rate, need to be a key feature of a model of the mortgage stock.

Given the link to demand for housing, a key issue for modelling the demand for mortgages is the average price of housing. For those committed to a home purchase, higher house prices suggest the need to borrow more, though some buyers might be forced into lower quality housing. This would imply a positive effect from house prices onto the mortgage stock. A second reason to expect such an effect is that existing homebuyers, considering trading up in the market, will have more equity in the market and so be able to achieve a cheaper loan at a lower low-to-value ratio or, if previously at an LTV constraint imposed by a lender, be able to buy a more expensive home. However, there is a potential argument pointing in the opposite direction, which comes from a shift in the ‘extensive margin’, i.e., by reducing the pool of potential first-time buyers able to enter the market at all, when lenders demand substantial down-payments to obtain a mortgage. As a result of a rise in average house prices relative to the incomes of potential first-time buyers, fewer of such buyers will have saved enough to offer the (substantial) minimum down-payment necessary and will therefore remain renters in the interim.

Turning to the role of mortgage interest rates, the above discussion of the demand for housing emphasised that, as well as the real rate represented by the user cost of housing, the nominal mortgage rate was likely to be important in countries where lenders focus on the debt-service ratio as a lending criterion. The nominal mortgage interest rate should be even more relevant for mortgages than for house prices as affordability in terms of short-term cash-flows is not only a concern for mortgage

lenders but also one for borrowers: defaulting on a mortgage and losing one's home is damaging both for lenders and borrowers. If the mortgage stock model is partly driven by the level of house prices and that, in turn, is strongly influenced by the user cost of housing, it is quite possible that there is no direct effect from user cost on the demand for mortgages but only the indirect effect via house prices. However, the real mortgage interest rate based on expectations of consumer price inflation may well be relevant for mortgage demand as a measure of the long-term servicing cost of debt.

4.5.1 Mortgage debt in central bank policy models

The central bank models for Ireland, Italy and the Netherlands have an equation for the mortgage stock. In COSMO, the mortgage stock is built up from an equation for new lending driven by the real rate of interest on mortgages, adjusted LTI and LTV ratios to indicate credit conditions, and changes in income and house prices. The mortgage stock is then given by new lending plus repayments proportional to the previous mortgage stock. In Italy's BIQM, bank credit for mortgages is driven, inter alia, by the return on housing relative to the long bond yield, the nominal mortgage interest rate and its spread to the interbank rate. Income is proxied by GDP and the ECM adjustment coefficient is 0.03. In DELFI, the mortgage stock equation includes three proxies for credit conditions, amongst the explanatory variables: an S-shaped linear trend (a proxy for the gradual loosening of bank lending standards in the 1990s), the ECB's Bank Lending Survey (available from the end of 2002 onwards), and the banking sector's leverage ratio. It also includes a strong nominal interest rate effect.

Many central bank models do not cover mortgage debt. For example, neither the FRB-US, nor ECB-BASE or Bundesbank models has an equation for mortgage debt - or indeed for household debt. Because they rely on net worth (or net financial wealth) to drive consumption, these models depend on an equation which updates net worth every quarter by net disposable income minus consumption and minus residential investment, and a revaluation adjustment. This does not permit an explicit role for credit conditions. In the French model of Lemoine et al. (2019), there is no role for household wealth or debt, and therefore no model for these, and hence no role for credit conditions.

4.5.2 A comprehensive model for mortgage debt (for France)

A very general formulation of the long-run solution that corresponds to the economic arguments above is as follows:

$$\ln rmdebt_t = m_0 + m_1 \ln y_t + m_2 MCCI_t + m_{3t} \ln user_t + m_{4t}\, rmr_t + m_{5t} \ln mr_t$$

$$+m_{6t} E_t \ln (y_t^p / y_t) + m_{7t} \ln (hp_t / y_t) + m_8 demog_t + m_{9t} ln(LA_t / y_t)$$

$$+m_{10t} \ln\left(\frac{nmdebt_t}{y_t}\right) + m_{11} \ln\left(\frac{IFA_t}{y_t}\right) \quad (7)$$

Here, $rmdebt$ is per capita mortgage debt in real terms, i.e., nominal debt divided by the consumer expenditure deflator, and y is per capita real household disposable income. If the income elasticity of mortgage debt, m_1, is one, the dependent variable can be reformulated as the log of the mortgage debt to income ratio. $MCCI$ is an indicator of credit conditions in the mortgage market; $user$ measures user costs as previously explained; rmr_t is the real mortgage rate of interest; mr is the nominal mortgage rate of interest; y_t^p / y_t is the ratio of permanent to current per capita real household disposable income; hp/y is the ratio of the real house price index to per capita real household disposable income; $demog$ is a demographic indicator; LA/y is the ratio of liquid assets to income, and $nmdebt/y$ and IFA/y, the corresponding ratios for non-mortgage debt and illiquid financial assets.

Credit market liberalisation could impact in several ways on these long-run relationships as indicated by time subscripts on several parameters. In principle, the strength of the effects of user cost and real interest rates rmr_t is likely to increase with credit liberalisation, making m_{3t} and m_{4t} more negative for example, while nominal interest rates may have less impact, making m_{5t} less negative.[45] The impact of income expectations could also vary with shifts in credit liberalisation, for example causing an upward shift in m_{6t} with increasing MCCI. Higher house prices relative to income should increase demand for mortgages but this could increase further if liberalisation relaxed the down-payment constraint, hence shifting up m_{7t}. Demography and asset to income ratios are represented in the next four terms in equation (7). Generally, a higher ratio of liquid assets may indicate greater availability of liquidity to fund mortgage deposits, but with easier credit access, that could become less relevant. A higher level of non-mortgage debt relative to income reduces the ability of households to take on mortgage debt and may also make lenders more cautious about mortgage lending. It is possible that, when mortgage credit conditions are more relaxed, this negative effect becomes somewhat less pronounced. In practice, in short samples, empirically identifying such interaction effects can be very demanding. Nevertheless, testing for such possibilities is advisable.

[45] This would be the case if mortgage market liberalisation was mainly about easing loan-to-value constraints. However, if it more concerned relaxing debt-to-income or debt service ratio constraints, m_{5t} might become more negative.

A well-determined long-run solution for the mortgage stock but with a moderate ECM adjustment coefficient, to reflect the long-run nature of mortgage debt, are desirable properties for a mortgage stock equation. From Chauvin and Muellbauer (2018), the mortgage stock equation for France has an ECM adjustment coefficient a little under 0.08 (t=16). The mortgage credit conditions index, MCCI, enters both directly (with a t-ratio of 12) and in interaction with the log house price-to-income ratio (with a t-ratio of 6). Given log house prices to income and the other independent variables, the nominal mortgage rate is highly significant, as in the French house price equation. There are no significant direct effects from user cost or from a real interest rate. However, by conditioning on the log house price to income ratio, there is an indirect user cost effect, as well as the indirect effect of nominal interest rates that operates via house prices. Demography has a similar role to that in the house price equation. The hypothesis can be accepted that the income elasticity of the mortgage stock is 1.

Our six-equation model does not endogenise credit conditions, but Chart 13 suggests there would be strong potential in endogenising the NPL ratio of the banking system, data permitting, to quantify the link between the household and banking sectors. Moreover, the lag between the NPL ratio and the mortgage credit conditions index, implies that in real time, early warnings would be flagged up before credit conditions turned down, with negative consequences for house prices and consumption. A top-down macro approach needs to be integrated[46] with micro evidence on potential household vulnerabilities and individual bank stress tests data to better tune macro-prudential policies, see Constâncio (2017a, 2018). Improving the quality of the top-down approach, taking proper account of institutional difference between countries, would make an important contribution to this endeavour, see further discussion in sections 5 and 7.

It is sometimes argued that the global financial crisis was such a rare event that there is little to be gained in more normal times for building mechanisms into models that trace how such a crisis might affect the household sector. However, not only can such risks not be precluded, but better, evidence-based models of the household and housing sectors throw important light on monetary policy transmission in more normal business cycle fluctuations and on potential obstacles to a strong recovery resulting from high levels of debt and changing demography. They also illuminate potential risks for and via the household sector from other sources, such as a rise in global interest rates or in global inflation or substantial fall in equity prices, see Constâncio (2018a). As will be seen in section 7, they are very useful in considering scenarios in the current crisis induced by the war in Ukraine.

4.6 Non-performing loans, credit cycles and real estate

Elevated non-performing loans[47] (NPLs) are a recurrent characteristic of banking crises and recessions. Negative shocks may convert the loans that support household

[46] Constâncio (2017b) says: “Stress tests of the banking and financial system must not be limited to microprudential supervision but need to be embedded in a macro-financial environment and take a macroprudential dimension.”

[47] Some central banks distinguish ’bad loans’ from NPLs. I use the term ‘NPL’ to cover either. What is important is that neither definition changes over time.

and firm investment and spending to NPLs that are in or close to default when debtors fail to meet the contractual obligations of the loan.[48] NPLs ballooned following the Global Financial Crisis (GFC) and the European sovereign debt crisis, see Table 8. As noted in the introduction, there is an important two-way connection between credit conditions and NPLs. Banking crises are typically preceded by poor quality of lending, excessive credit growth and high levels of leverage. The value of non-performing loans, low and stable in boom periods, can rise sharply when the crisis breaks. Rising NPLs raise funding costs for banks, damaging their efficiency and profitability. As banks apply tougher lending criteria for firms and households, a credit crunch may follow, with falling GDP or stagnant economic growth. Even without a major crisis, easy credit conditions resulting in lax lending criteria can create financial vulnerability among borrowers and potentially among lenders, particularly if followed by an economic downturn. Then, rising NPLs will amplify the economic cycle.

Table 8

Recent selected Euro area trends in annual NPLs

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	2.82	4.02	3.76	4.29	4.29	4.50	4.16	4.05	3.70	3.12	2.75	2.47	2.71
Germany	2.85	3.31	3.20	3.03	2.86	2.70	2.34	1.97	1.71	1.50	1.24	1.05	
Greece	4.67	6.95	9.12	14.43	23.27	31.90	33.78	36.65	36.30	45.57	41.99	36.45	26.98
Ireland	1.92	9.80	13.05	16.12	24.99	25.71	20.65	14.93	13.61	11.46	5.73	3.36	3.54
Italy	6.28	9.45	10.03	11.74	13.75	16.54	18.03	18.06	17.12	14.38	8.39	6.75	4.36
Netherlands	1.68	3.20	2.83	2.71	3.10	3.23	2.98	2.71	2.54	2.31	1.96	1.86	1.89
Poland	2.82	4.29	4.91	4.66	5.20	4.98	4.82	4.34	4.05	3.94	3.85	3.80	3.71
Portugal	3.60	5.13	5.31	7.47	9.74	10.62	11.91	17.48	17.18	13.27	9.43	6.18	4.86
Spain	2.81	4.12	4.67	6.01	7.48	9.38	8.45	6.16	5.64	4.46	3.69	3.15	2.85

Source: IMF Financial Soundness Indicators, the ratio of non-performing loans as a percentage of total gross loans. Note, the table draws on charts using different methodologies and definitions across countries, and these may also change over time within countries.

The pandemic era was expected to exacerbate the problem of NPLs worldwide, as government fiscal support and various regulatory forbearance measures, such as rental and mortgage payment moratoria and eviction bans, were withdrawn (Kasinger et al., 2021). Reinhart and Klapper (May, 2022) point to recent business level data from the Mastercard Economics Institute and the World Bank Pulse Enterprise Survey revealing that the withdrawal of debt moratoria appears to have created a severe NPL problem in many countries, even if not yet apparent in official data.

4.6.1 Non-performing loans: a brief literature review

Even recently, Ari et al. (2020, 2021) pronounced that ‘we know little about the patterns of NPL build-up and the factors that affect NPL resolution’. Modelling credit

[48] For example, an NPL can be defined as a loan upon which the debtor has not made scheduled payments for at least 90 days.

risk indicators like NPLs is highly relevant to inform monetary and macro-prudential policy. It should be a priority to clarify the sometimes complex definitional issues concerning NPLs and related proxies like loan-loss provisions, to identify their driver variables, and to design models for early warnings systems for NPLs. Such credit risk indicators are likely to influence credit pricing and credit extension by banks, as we have seen from the evidence for France, and hence this could improve the modelled linkages between the financial sector and the real economy. Further, comparing results for NPL models and loan loss provisions models would illuminate questions about the pro-cyclicality of loan provisioning.

A serious consideration is that the criteria for classifying NPLs across countries vary not only across jurisdictions and lenders, but also within lenders across time (Bholat et al., 2018). Inconsistency of concepts makes it harder to draw firm conclusions from empirical studies, whether using country panels, time series for individual countries or bank-specific panels. Several empirical studies, from surveys (e.g., BCBS, 2017) and from cross-country and cross-bank tabulations of definitions (e.g., Bholat et al. (2018), Baudino et al. (2018) and Barisitz (2011, 2013a, 2013b)), have confirmed that there are considerable differences in NPL definitions both across and within countries, and across systemically important banks. Moreover, many countries have inadequate or missing data, especially on lending quality. The goal of arriving at a harmonised NPL definition across countries has been promoted by guidelines from the IMF (2005), the European Banking Authority (ECB, 2017), and the Basel Committee on Banking Supervision (BCBS, 2017), amongst others.

Reliable and comparable NPL data are crucial for NPL monitoring and evidence-based NPL resolution polices. Since NPL concepts have sometimes been affected by successive regulatory definitional changes, for modelling purposes, caution is needed to check for and adjust for breaks in the data. In principle, the different NPL concepts within a country might be joined to permit an analysis of data on reasonably consistent definitions at least incorporating the period from 2001 to cover the prelude to the GFC, to help draw robust insights.[49]

Two broad reviews of empirical studies[50] of NPLs point to how real economic growth reduces NPLs while higher interest rates, unemployment rates, and worsening public debt can push up NPLs, all controlling for a range of macroeconomic factors as well as bank-specific and non-financial corporate drivers.[51] A recent cross-country paper by Ari et al. (2020, 2021) provides a useful benchmark against which other NPL studies can be compared, though it focuses on specific windows around banking crises.[52] The authors attempted to adjust for NPL definition differences across data sources to ensure consistency within countries; across countries, however, the same concerns about poor comparability of the data for NPLs remain. Their predictor models use

[49] In a study for the South African Reserve Bank, Aron and Muellbauer (2022b) analysed the available data from the banking authority's bank surveys, with recommendations for joining up the data for approximately consistent series from 2001 to the present.

[50] Macháček et al. (2017) cover 37 studies, and Naili and Lahrichi (2020) cover 69 studies, with limited overlap of seven studies.

[51] See analysis in Aron and Muellbauer (2022b).

[52] Their dataset on NPLs for 78 countries from 1990, covers 88 banking crises, and reports NPLs for an 11-year window, three years before and seven after the crisis. Two earlier but related datasets are used by Laeven and Valencia (2013, 2018) and Balgova et al. (2017).

pre-crisis independent predictor variables, measured as averages or cumulative changes over the five years prior to the crisis, with constructed dependent NPL variables, dated on or after the crisis date. Regressions are conducted for five constructs of NPLs (and some variation of these)[53] on three sets of independent variables, sourced from the literature, using a form of general-to-specific selection for the most informative combination of predictors for each NPL metric ("post-r-lasso"; Belloni et al., 2012; Belloni and Chernozhukov, 2013). The first set of potential drivers comprises macro-variables, which in set 2 is appended by banking variables, and in set 3 by non-financial firm/industry variables.

Ari et al. (2020, 2021) also find that if (pre-crisis) GDP growth is higher, this reduces the time to the NPL peak and increases the likelihood of NPL resolution. Similarly, high unemployment reduces the time to the peak NPL and increases the likelihood of resolution - interpreted as due to the pressure to resolve the debt sooner. However, neither the inflation rate nor interest rates were selected by the Lasso statistical model. (Nominal) exchange rate depreciation or abandoning an exchange rate peg prior to the crisis the reduces the time to reach the peak, interpreted as reflecting the facilitating effect of floating exchange rates in adjustment, and by the same token increase the likelihood of resolution. However, the appendix of Ari et al. (2020, 2021) with an alternative specification for the dependent variable suggests that depreciations and floating exchange rates also predict lower peak NPLs. There is also correspondence with the general findings for higher (pre-crisis) government-debt-to-GDP ratio, which increases the time to the peak NPL, reflecting less fiscal space, increases the time to resolve NPLs and reduces the likelihood of resolution. Ari et al. (2020, 2021) use higher GDP per capita to proxy for institutional strength which reduces the probability of elevated NPLs and concurs with related findings in the afore-mentioned surveys.

The Bank of Ireland's COSMO has equations for mortgage arrears and corporate insolvencies. Mortgage arrears in COSMO are assumed to be a function of the repayment capacity measured by unemployment and income gearing, given by the mortgage repayment to income ratio, and the equity position of the household. The aggregate rate of corporate insolvency is driven by the cost of corporate credit, the unemployment rate, commercial property prices, and corporate indebtedness as approximated by the ratio of corporate credit to GDP.

The Bank of Italy's BIQM also has an equation for bad loans. It is focused on firms rather than households as the bad loan ratio for firms rose far more in recent crises than that of households.[54]

For the Netherlands, quite a sophisticated treatment of the banking sector includes impairments for bad loans which affect bank profits, bank capital and the leverage ratio. Moreover, changes in mortgage lending impact net interest income, hence also

[53] The five dependent variables of Ari et al. (2020, 2021) are elevated NPLs, the peak NPLs as a percentage of total loans, the time to reach the NPL peak, the time to resolve NPLs, and the likelihood of resolution within 7 years.

[54] It is driven by the output gap, a real interest rate, and borrowing costs for NFCs relative to the operating surplus of the company sector.

affect bank profits, bank capital and the leverage ratio. And as we saw earlier, the leverage ratio affects the mortgage interest rate and firm lending rates.

None of the above studies considers the housing market and real estate-related drivers such as mortgage debt-to-income and house price-to-income ratios, mortgage debt growth and mortgage debt service, or indicators for commercial real estate as drivers of NPLs. The US is a useful example of an economy where the housing market and associated changes in house prices are likely to be an important NPL determinant. In the US studies of Ghosh (2017), as for Beck et al. (2013), changes in the house price index are included as a potential macro-determinant. Rises in house prices are expected to reduce NPLs, especially for the real estate sub-sector NPL. The mechanism through which this operates is via a wealth channel, since rising house prices raise property wealth, helping borrowers cope with unexpected adverse shocks or to refinance their mortgages by boosting the value of their housing collateral. Ghosh (2015, 2017) confirm the fall in NPLs with higher house prices for both real estate NPLs and individuals' NPLs, capturing the countercyclical nature of these types of loans and the effect of house prices on collateral values.

In principle, the credit-gap (measured as the credit-to-GDP ratio relative to Hodrick-Prescott trend, to proxy 'equilibrium' credit levels), could capture an element of real estate. At least of the household debt component of private sector credit, some 60 to 80 percent is usually accounted for by mortgage debt, and in the Netherlands this proportion is nearly 90 percent. Neither of the reviews by Macháček et al. (2017) and Naili and Lahrichi (2020) consider private credit extension as potential macro-drivers, but instead examine bank-specific loan growth as a banking sector variable.[55] The results concur with those of Ari et al. (2020, 2021), where private credit extension features strongly in most of the models, with the findings that a rise in domestic credit to the private sector elevates NPLs, lengthens the time to the peak NPLs; lengthens the time for NPLs to be resolved; and reduces the likelihood of NPL resolution. However, many factors affect loan growth, and especially in idiosyncratic banking panels, so that the link to the housing market may be tenuous.

There seems to be a surprising lack of connection between the literature on early warning systems of potential financial crises, see Duca et al. (2021a) for a review, and the studies of drivers of NPLs. Few of the latter incorporate the full set of drivers recommended for modelling 'growth at risk' by the IMF in Prasad et al. (2019). These consist of three underlying aggregates and the credit-to-GDP gap. These aggregates attempt to capture respectively household sector vulnerabilities, corporate sector vulnerabilities, and housing market imbalances. The measures capturing household and corporate sector vulnerabilities are aggregated from indicators that capture leverage, debt servicing capacity, and indebtedness. Housing market imbalances are aggregated from indicators that measure imbalances from multiple aspects, including house price dynamics, construction activity, inventory and sales, mortgage activity, and household financial strength. The relevance of such drivers can vary across countries, for example, with rates of owner-occupation, leverage, the structure of the

[55] Rapid loan growth is often linked to riskier lending behaviour (Keeton and Morris, 1987), through adverse selection, inappropriate managerial incentives and reduced screening standards in boom periods, worsening credit quality. The short-term easing of credit quality promotes short-term profits at the expense of heavy future losses.

financial system, and whether home-equity withdrawal is readily available. The growth at risk approach uses quantile regressions which give more weight to periods with probabilities of low or negative growth. NPLs are likely to have a non-linear relationship with growth, with high NPL values particularly associated with recessions, especially ones associated with financial crises. A linear predictive model for NPLs, therefore, is implicitly designed to put more weight on forecasting recessions accurately, than on forecasting variation during periods of more normal economic growth. Therefore, one should expect similar predictive variables to be relevant in forecasting NPLs using conventional methods as in the growth at risk models based on quantile regressions.

A productive approach in this area in Europe has been the domestic Systemic Risk Indicator (d-SRI) system developed in Detken et al. (2018) and Lang et al. (2019), and applied, for example, in ECB (2022), p.91. The d-SRI for each country is based on 6 indicators including credit growth and the 3 –year change in the house price to income ratio, with weights tuned to forecasting past financial crises. Investigating the usefulness of d-SRIs in forecasting NPLs should be on the research agenda.

4.6.2 A new model of non-performing loans in France

For France, quarterly data on NPLs are available back to the 1970s and appear to be on a consistent basis. As France has experienced periods of financial liberalisation and considerable fluctuations in house prices and house price-to-income ratios, it is a particularly good candidate for examining real estate influences on NPLs. NPLs are often considered to be a lagging indicator of banking sector problems. It is therefore very important to discover whether the NPL ratio can be forecast 4 or 8 quarters ahead. If this is possible, the current dated drivers of future NPLs can be used to inform macro-prudential or other policy actions. Chauvin and Muellbauer (2018), as noted above, used a latent variable method to identify non-price credit conditions indices for housing loans and non-housing loans to households. One potential difficulty with our identification strategy is that the latent variables pick up omitted influences on mortgage and non-mortgage debt, house prices and consumption not otherwise controlled for in a rich set of economic and demographic controls. An important test of the credit interpretation is to discover whether these latent variables pick up the loose credit conditions that often precede, by years, problems in the banking sector.

A general forecasting model for the NPL ratio for France was developed incorporating interest rates, the unemployment rate, the growth rate of income, debt and house price to income ratios, credit growth, the inflation rate and long lags in the non-price credit conditions indicators from the study by Chauvin and Muellbauer (2018). To represent long lags parsimoniously, 4-quarter moving averages of the credit conditions indicators are introduced at lags of 1, 5, 9, 13 and 17 quarters. Testing down to a parsimonious specification for data from 1987 to 2016, the results shown in Table 9 were obtained.

The expected effects are found of the NPL ratio increasing with high recent short-term interest rates, a high recent unemployment rate and low recent growth of real income per head. There are highly significant effects from loose credit conditions not in the very recent past but over the 4 years before the current year, combined with a highly significant negative effect of the recent house-price-to income ratio, as in Ghosh (2017) for the U.S. In other words, a perfect storm that would generate extreme levels of NPLs would be the combination of loose credit conditions in recent years, a fall in house prices relative to income, high recent interest rates, weak recent income growth and high recent unemployment. The model also includes the change in a proxy for the euro risk spread. This is measured as the 4-quarter change in the moving average of the spread between Italian and Spanish 10-year bond yields minus the German yield. This exploded during the Euro area sovereign debt crisis. The interpretation is that bank lending in France was more cautious as a result, other things equal, resulting in lower bad debts on private sector loans.

Estimating the equation over the period 1987 to 2007Q4 and to 2010Q4 shows quite stable and significant parameter estimates in line with the full period to 2017Q1.[56] For comparison, the risk indicator for France developed by Lang et al. (2020) was investigated for its forecasting performance for the NPL ratio. Starting with the same general specification incorporating interest rates, the unemployment rate, the growth rate of income, debt and house price to income ratios, credit growth, the inflation rate and long lags in d-SRI for France, the best fitting model has almost twice as large a standard error with only marginal significance for lags in d-SRI beginning 5 quarters ago. The coefficient of over 0.9 on the lagged level of the NPL ratio indicates that the lagged dependent variable is having to compensate for omitted drivers. To put it another way, the d-SRI is more useful for forecasting the 4-quarter change in the French NPL ratio rather than the level, but with quite limited forecasting power. Lang et al. (2019) show, in multi-country panels, that the d-SRIs are useful in predicting financial crises, and Lang and Forletta (2020) show they are also useful for predicting down-side risks to bank profitability. The absence, in the case of France, of a financial crisis,[57] may help account for their more limited usefulness in forecasting NPLs in France.

[56] The parameters are also stable for the samples 1987Q1 to 2006Q4 and 1990Q1 to 2017Q1. Given the overlapping nature of the dependent variable, the residuals are, of course, strongly positively auto-correlated and the t-ratios are overstated by of the order of two. However, even after adjustment they remain highly significant.

[57] The Credit Lyonnais scandal and rescue of the early 1990s had more to do with bank-specific malfeasance than the wide economy.

Table 9

A 4-quarter ahead forecasting model for the NPL ratio (example using French data)

Dependent variable: (NPL ratio to loan book) t+3	1987:1 to 2017:1		1987:1 to 2007:4		1987:1 to 2010:4	
	Eq. 1		Eq. 2		Eq. 3	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
Constant	0.0412	6.5	0.0253	1.4	0.0324	3.7
(NPL ratio to loan book) t-1	0.261	6.1	0.237	3.0	0.222	4.0
(Short interest rate, 4q-ma) t-2	0.00153	14.9	1.59E-03	10.7	0.00150	12.0
(Short interest rate, 4q-ma) t-6	0.000609	5.6	8.25E-04	5.4	0.000881	6.2
(Unemployment rate, 4q-ma) t-2	0.00212	7.4	2.04E-03	5.1	0.00191	5.8
Δ4 log (Real disposable income pc, 4q-ma) t-1	-0.0680	-5.4	-0.073501	-3.4	-0.0719	-4.1
Δ4 log (Real disposable income pc, 4q-ma) t-5	-0.0360	-3.0	-0.0654	-3.4	-0.0706	-4.2
log (House price to income ratio) t-2	-0.0259	-13.7	-0.0210	-3.5	-0.0227	-7.9
Δ4 (Mortgage Credit Conditions Index, 4y-ma) t-5	0.00949	4.1	9.41E-03	3.7	0.00847	3.6
(Mortgage Credit Conditions Index, 4y-ma) t-5	0.0240	13.9	0.0166	2.6	0.0185	6.5
(Unsecured Credit Conditions Index, 4y-ma) t-5	0.0237	14.5	0.0267	13.3	0.0265	14.1
Δ4 (Euro risk spread, 4q-ma) t-2	-0.000570	-3.4	-6.15E-03	-1.6	-0.00212	-1.9
Δ4 log (Consumer expenditure deflator, 4q-ma) t-1	0.0624	2.4	0.0928	1.8	0.0765	2.0
Equation standard error		8.81E-04		8.75E-04		8.56E-04
Adjusted R-squared		0.992		0.993		0.993
Durbin-Watson		0.775		1.02		1.02
Breusch/Godfrey LM: AR/MA4		p = [.000]		p = [.000]		p = [.000]
Chow test		p = [.000]		p = [.046]		p = [.007]
Breusch-Pagan het. Test		p = [.059]		p = [.019]		p = [.056]

Notes: Estimation performed in TSP 5.0 of Hall and Cummins.

Table 10

An 8-quarter ahead forecasting model for the NPL ratio (example using French data)

Dependent variable: (NPL ratio to loan book) t+7	1987:1 to 2017:1		1987:1 to 2007:4	
	Eq. 1		Eq. 2	
	Coefficient	t-Statistic	Coefficient	t-Statistic
constant	0.0594	6.4	0.0443	2.4
(Short interest rate, 4q-ma) t-1	0.00211	15.4	0.00172	11.3
(Short interest rate, 4q-ma) t-5	0.000645	5.0	0.00134	7.4
(Unemployment rate, 4q-ma) t-1	0.00300	12.3	0.00232	8.0
log (House price to income ratio) t-1	-0.0376	-13.3	-0.0308	-5.8
Δ4 (Mortgage Credit Conditions Index, 4q-ma) t-1	0.0118	3.2	0.0114	2.6
Δ4 (Mortgage Credit Conditions Index, 4q-ma) t-5	0.00901	2.7	0.00699	2.0
(Mortgage Credit Conditions Index, 4y-ma) t-5	0.0400	13.2	0.0340	4.5
(Unsecured Credit Conditions Index, 4q-ma) t-1	0.00417	1.3	0.00765	1.9
(Unsecured Credit Conditions Index, 4q-ma) t-5	0.0154	4.0	0.0167	3.6
(Unsecured Credit Conditions Index, 4q-ma) t-9	0.0104	3.8	0.00807	2.3
Δ4 log (Consumer expenditure deflator, 4q-ma) t-1	0.135	4.9	0.0742	1.2
Equation standard error		1.29E-03		1.16E-03
Adjusted R-squared		0.983		0.988
Durbin-Watson		0.414		0.613
Breusch/Godfrey LM: AR/MA4		p = [.000]		p = [.000]
Chow test		p = [.000]		p = [.000]
Breusch-Pagan het. Test		p = [.008]		p = [.003]

Notes: Estimation performed in TSP 5.0 of Hall and Cummins.

Broadly similar results can be found forecasting the NPL ratio 8 quarters ahead. Again, recent short interest rates, the unemployment rate, the credit conditions indicators stretching back over 4 years, and the house price to income ratio all prove highly significant. While parameter estimates are a little less stable forecasting to 2007 compared with 2017, the key parameters are quite stable.

It is noteworthy that NPL data analysed here cover all loans, while the non-price credit conditions indicators and the house price to income ratio refer to the household sector. This suggests that easy lending conditions diagnosed from household data are likely to be correlated with easy lending conditions also applying to the corporate sector. There are several reasons that can explain the wider relevance of the house price to income ratio. One is that many small business loans are collateralised by the home of the owner. Furthermore, cycles in commercial real estate prices tend to be correlated with cycles in residential property, see section 6. This suggests that the house price-to-income ratio may well be picking up variations in commercial real estate price ratios relative to corporate income.

The question arises whether it is possible to obtain plausible forecasting models for NPLs using past credit growth in place of the non-price credit conditions indicators. An attempt to do so proved remarkably unsuccessful. The positive signs one might have expected on long lags of credit growth are absent, with significant negative short-term effects from credit growth, insignificant effects from the unemployment rate and income growth and a sign reversal on the recent house price to income ratio. The

equation fit is far worse and the previous quarter's NPL ratio becomes far more relevant as a substitute for the omitted variables, as in the similar attempt to use the French d-SRI to forecast NPLs. It seems that the methods used by Chauvin and Muellbauer (2018) to extract the underlying dynamics of non-price credit conditions are far superior for forecasting NPLs to the cruder use of credit variables that confuse non-price credit effects with those of income, interest rates and asset prices. Applying the method to a wider range of countries could therefore be quite productive and make aggregate NPL data far more useful for the analysis of risks to financial stability, not to mention for improving econometric policy models used for more general macroeconomic stabilisation.

5 A summary: lessons on residential real estate channels of monetary transmission, and housing and credit cycle-related risks to financial stability

5.1 Key points for monetary policy

The evidence on the six real estate-related transmission mechanisms presented in section 4 gives a new perspective to the long-run transmission of monetary policy - via mortgage and housing markets - to consumer spending. The stimulative effects of lower interest rates may be less than commonly thought and it varies greatly across countries. Evidence from house price models suggests that in addition to real interest rate effects, there are strong nominal interest rate effects, which most of the central bank models ignore. The differential effects from nominal interest rates across countries arise mainly from the operation of debt-service limits on borrowing. In countries where debt service limits are the main criterion for credit allocation, nominal interest rate effects are likely to be especially large (e.g. in France as opposed to Germany). Real interest rate effects operate mainly through the user cost of borrowing, which incorporates householders' extrapolative expectations about several years of house price appreciation. Through this expectations effect, there can be long-lasting durations of interest rate and credit shocks.

Higher house prices increase housing wealth, which in turn affects consumption. Housing wealth has mainly a collateral effect, being able to borrow more with higher collateral, where home equity withdrawal is available. Hence, the collateral effect differs across countries, for instance it is low in Germany where there is no home equity withdrawal. The collateral effects can be time varying, for example are weaker in a credit crunch. While higher house price tend to increase the consumption of house-owners through raised housing wealth, they worsen affordability for non-owners.[58] The aggregate impact of house prices on consumer spending can thus be muted. This points to important distributional consequence of monetary policy, though estimated on aggregate data.

[58] These effects are most negative in countries with less easy access to credit.

Lower interest rates and credit liberalisation increase mortgage debt, which is very persistent; once acquired it is hard to reduce quickly, and has a persistent negative effect on consumption. Even in countries with home equity withdrawal, where the short-run effects of lower interest rates on consumer expenditure can be strong, a build-up of debt very significantly weakens the long-run effects on consumption. The empirical evidence, other things being equal, suggests that for aggregate spending, the negative effect of an extra 100 euros of debt is about five times the effect of a 100 euro increase in illiquid financial wealth and perhaps a two to five times the effect of 100 euros increase in housing wealth. Moreover, if an extended period of low interest rates has induced an overshooting of house prices and of mortgage debt, more likely in countries with liberal access to credit, a subsequent reversal can lead to a credit crunch and, in more extreme cases, a financial crisis. The resulting fall in consumer spending and aggregate demand can be extreme. Even in France, where there was no banking crisis in the GFC, the sharp credit contraction after the GFC which caused consumption to fall, illustrates the relevance of the credit cycle.

The credit-augmented consumption models discussed in section 4.4 relax several unrealistic restrictions found in most policy models, and illuminate monetary transmission to consumer spending.

The net worth restriction on wealth and omitting lending standards results in a critical mis-specification of the equations with distorted estimates of the interest rate effects and the consumption dynamics. One implication is that monetary policy should not be considered in isolation from regulatory and macroprudential policy. For example, for Germany, given household portfolio stocks, house prices, and permanent income, higher interest rates tend to have a positive effect on consumer spending (Geiger et al., 2016). Since a high fraction of household assets are held in liquid deposit form, higher deposit rates increase the income, particularly of older households, from such saving deposits.[59] In Germany, this 'perverse' sign is compounded by the unusual negative effect of higher house prices on aggregate consumption, see section 4.4. By contrast, for France and Italy, a positive housing wealth effect outweighs a negative housing affordability effect in aggregate, so that higher house prices have a small overall positive effect on consumption, given debt. The direct effect of interest rates on consumption is negative, and the indirect effect via lower house prices is marginally negative, leading to an overall negative effect. In all three countries, there is also a strong negative effect of higher interest rates on permanent income. The overall implication is that higher interest rates reduce consumer spending by rather more in France and Italy than in Germany.

Non-price credit conditions, i.e. lending standards, are likely to affect every one of the six housing related channels of monetary transmission. For example, the evidence from France for each of the channels of transmission shows that non-price credit conditions, or their key driver, the NPL ratio, enter every equation: transmission from policy rates to mortgage rates, house prices, residential investment, consumption and mortgage debt. Hence, the measurement of lending conditions over time becomes an important issue, which is discussed further below.

[59] See Aron et al. (2012) for what consumer theory says about the ambiguous sign of the interest rate effect.

This paper has shown explicitly the degree to which current central bank policy models incorporate the six channels of transmission via housing and credit markets (section 4, and summarised in Table 3). Failure to fully incorporate the six channels potentially has serious implications. One implication is that where the models are deficient in this respect, they should not be used to construct macro-scenarios relevant for stress testing exercises. For example, half the models in Table 3 have no connection between bank balance sheets and the real economy. Italy's BIQM, Ireland's COSMO and the Netherlands DELFI 2, are the exceptions, and hence can be used for macroprudential purposes (on Italy see also Bulligan et al., 2017).

A recommendation of the 2021 strategic review of macroeconomic modelling in the Eurosystem, ECB (2021a) is this: "the burgeoning literature on a new generation of macrofinancial models should inspire the development of small-scale structural models that generate a role for banks, feature non-linear amplification effects from financial distortions, provide a structural role for macroprudential regulation… and permit analysis of optimal monetary policy strategies in the presence of financial frictions." Developing a fully-fledged model of the banking system is desirable, but a simple improvement for a tractable semi-structural policy model for linking with the banking sector is to include a model for NPLs. The French evidence from section 4 suggests adding an equation for the NPL ratio, and incorporating NPL effects in other equations, would be a large step forward. This would enable far better tracking of the credit cycle and also warn of potential financial stability risks.

Table 3 from our review of central bank policy models also highlighted the degree to which there has been an omission of income and house price expectations effects. Indeed, the ECB strategic review ECB (2021a) raised the omission of various expectations effects, other than in ECB-BASE and the Bank of France model, in the current generation of central bank policy models. For aggregate demand, probably the most significant expectations effect is for income growth, as long emphasised in the permanent income hypothesis. We have developed a practical method for controlling for income expectations and incorporating an important element of realism regarding unanticipated major shifts and shocks to the income process (Chauvin and Muellbauer (2018) and Debonis et al. (2022)).[60] Our work suggests that income expectations are a major channel for the transmission of interest rate effects, real oil prices, competitiveness, demography and stock market prices. The inclusion of equity prices to model expectations allows a cleaner interpretation of illiquid financial wealth effects. These findings also have practical implications for assessing the effects of the war on Ukraine on consumer expenditure. The evidence from France, Germany and Italy is that house prices do not appear to be very relevant in forecasting models for future income.

Thus, I argue for the following four crucial improvements in central bank policy models. First, to ensure that all six channels of real estate-related transmission are represented, with equations for mortgage rates, house prices, residential investment, consumption, mortgage debt and the NPL ratio. Secondly, to include for all six

[60] The GFC, the Covid pandemic and Russia's war on Ukraine were not anticipated. Mechanically using either 'model-consistent' expectations or a VAR system to proxy what could have been in the minds of economic agents without allowing for learning about such unanticipated structural breaks seems scarcely satisfactory.

channels a measure of evolving lending standards or more crudely, to include the closely-related the NPL ratio as a proxy. Thirdly, to disaggregate household net worth into its components to allow them to differentially impact consumption (liquid assets, debt, illiquid financial assets and housing wealth). Finally, control for income and house price expectations.

To illustrate just one of these issues in the context of current policy, it is plausible that central banks guided by their policy models under-estimated the post-pandemic surge in household demand[61] and therefore underestimated its inflationary implications. In the pandemic, partly as a result of the inability to spend, while incomes were strongly supported by fiscal measures, households accumulated record levels of liquid assets. The evidence from a range of countries from models that disaggregate assets is that the marginal propensity to consume out of liquid assets is around five times as high as out of illiquid financial assets. Such models would have better predicted the post-pandemic surge in household demand.

5.2 Key points for risks to financial stability and macroprudential policy making

The evidence from section 4 on the real estate-related transmission mechanisms also clarifies the potential amplification mechanisms from house price shocks in the financial accelerator, and hence implications for risks to financial stability. A major component of the transmission and amplification mechanism from house price shocks operates via consumption and residential investment. Institutional heterogeneity across countries turns out to have a large impact on the size of these effects (section 5.1). The potential amplification mechanisms in the financial accelerator involving housing are relatively weak in France, Italy and Germany, in contrast to the historical experience of Ireland and Spain (though post GFC regulatory reforms likely have reduced the overall scope for such amplification in the latter countries). Despite higher house prices, France, and Italy did not experience an Anglo-Saxon-style consumption boom in which the financial accelerator via home equity loans proved powerful and destabilising. In the French house price boom, 1996-2008, the combined positive effects of higher housing wealth and looser mortgage credit conditions on consumption, was largely offset by the combined negative effect of higher house prices and higher debt (section 5.1). The substantial rise in German house prices since 2013, similarly, has not generated a consumption boom, and since 2013 the household saving rate has risen significantly. Similarly, the ratio to GDP of residential investment rose quite moderately in the 1998-2008 French house price boom, probably because of the low supply elasticity (see section 4.3), and the same is true in Germany in the post-2013 house price boom.

Householders' extrapolative expectations of capital gains, which enter 'user cost', which is a driver of demand for housing and hence of house prices, are potentially a powerful endogenous source of house price over-valuations. Higher debt leverage

[61] An additional reason for disaggregating household portfolios is that mis-specifying the long-run solution for consumption results in estimated speeds of adjustment that are far too low, e.g. often not much over 10 percent per quarter, when well specified models yield speeds three times or more higher.

amplifies returns from house price appreciation. Thus, country differences in leverage imply differences in the risks of house price over-valuation. Extrapolative expectations were important in the US boom of the 2000s, see Duca et al. (2011, 2016), and in Ireland, see Lyons and Muellbauer (2013), and probably contributed to excess credit growth in those countries. By comparison, the scale of extrapolative expectations was moderate even at the height of the French boom (see the estimated user cost contribution in Chauvin and Muellbauer (2018)). The evidence for Germany, and preliminary indications for Italy, suggest a relatively small role for extrapolative expectations of capital appreciation and therefore limited scope for overvaluation of house prices from this source.[62]

There is an important two-way connection between credit conditions and NPLs. NPLs are an important component of banking crises and the credit cycle. Modelling the drivers of NPLs, and the consequences of higher NPLs for the economy through their impact on lending standards, should be highly informative for macro-prudential policy. The French NPL ratio helps explain variations in mortgage spreads and residential investment, and has a close correlation after the 1980s financial liberalisation with non-price credit conditions (lending standards) in the mortgage market. The latter are important drivers of house prices, consumption and mortgage debt. This covers one direction of the NPL ratio in affecting the dynamics of the credit cycle. The French NPL ratio is quite predictable, even at 8 quarters ahead, driven by loose lending conditions in the past (+) (measured by non-price credit conditions in both consumer credit and mortgage markets), the recent level of short-term interest rates (+), the house price-to-income ratio (-), the unemployment rate (+) and economic growth (-), section 4.6. This covers the reverse direction of dynamics in the credit cycle, with a clear role for real estate drivers. Quantitative evidence for the two-way interaction of NPLs with the credit cycle could establish the different relevance of real estate in various countries. Such evidence would go a long way to articulating links between the banking system and the real economy, missing in most policy models. This could also help close the gap between the economic ideas behind the semi-structural policy models and the monetary policy influenced by such models, and that of the financial stability sections of central banks and the ESRB.

Stress tests of the financial system have now been adopted almost universally by financial regulators, see Anderson (2016). However, many countries' macroprudential stress tests do not incorporate macro-financial linkages, given the weakness of the current generation of macro policy models which still neglect real estate and debt, except in relatively trivial ways. Appropriate stress tests need to capture not only the 'bottom-up' approach - the adequacy of capital and liquidity, and of resolution arrangements at the level of individual institutions, but within-financial sector amplification of shocks and contagion, transmission from the financial sector to the real economy (often involving real estate) and feedbacks from the real economy to the financial sector.

[62] Information from central bank models for Spain and the Netherlands points to important effects from house price appreciation in the previous year; we lack information on the relevance of longer memories of appreciation.

There is a welcome exception, however. The ECB's BEAST, the 'Banking Euro Area Stress Test' model, see Budnik et al. (2020), is a significant step forward.[63] It takes heterogeneity amongst systemically important banks seriously and it incorporates dynamic adjustments by banks. The bank responses feed back to the macroeconomic environment affecting credit supply conditions. In the other direction, an adverse macro scenario lowers bank profitability and increases the risk weighted exposure amounts. The banking block models the evolution of exposures to NFCs, housing loans to households, consumer credit, and exposures to sovereigns and the financial sector.

5.3 Implications for monitoring financial risks via lending standards and measures of over-valuation.

The analysis in section 4 suggests a potentially important addition to the toolbox of indicators of lending standards and house price over-valuation. The ESRB currently uses a risk scoreboard of residential real estate data divided into three groups: collateral stretch, funding stretch and household stretch. Respectively, the indicators linked with these three groups number four, three and three, totalling ten indicators. Collateral stretch is intended to warn of unwarranted price developments and potential price misalignments to provide early warning of the timing and the intensity of financial crises and housing downturns.[64] Funding stretch is intended to detect too lax or 'exuberant' lending conditions.[65] Household stretch is intended to detect fragilities in household balance sheets.[66] Further recent information that is valuable for evaluating risk arising from real estate comes from Lang et al. (2020) in the ECB Financial Stability Review who examine a survey of 145 country-specific mortgage loan portfolios for systemically important institutions covering around 75 percent of the residential mortgage market across the Euro area on lending standards in mortgage markets. The survey, from ECB Banking Supervision, covers the period 2016-18 and includes data on loan-to-value (LTV), loan-to-income (LTI) and debt-service to income (DSTI) ratios, loan maturities and loan pricing spreads.

However, drawing overall implications from the risk scoreboard or from the survey, on whether country-specific lending standards have weakened, and if so, whether the

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63 On the macro side, for each of the 19 Euro area economies, a structural VAR incorporating 11 variables, was developed with an identification strategy for credit shocks linking the banking sector model with the real economy. Data are for 2002–2016 and cover real gross domestic product, the unemployment rate, consumer price index, nominal residential property prices, long-term nominal interest rates, equity price index, import volumes and export prices, bank lending rates, bank loan volumes, and short-term money market rates.

64 The four ingredients are the average percentage growth in real house prices in the previous 3 years, the deviation of real house prices from trend, the deviation of the house price/income ratio from its historical average and measures of overvaluation from a Bayesian-estimated inverse demand house price model for each country, a simplified version of equation (3) above.

65 The three indicators are the average percentage rate of growth of housing loans to households in the previous 3 years, real housing loans relative to trend, and the loan spread measured as the difference in the interest rate on new housing loans and a weighted average rate on new deposits from households and NFCs. A low spread could indicate that lending conditions had become very competitive and that profit margins for the lenders had become uncomfortably stretched.

66 It is measured by three indicators: household debt as a percentage of income, household financial assets relative to debt and the debt service ratio. The debt service ratio is intended to include both the annual interest charge on an instalment loan and the debt repayment element and is measured relative to disposable income, Drehmann et al. (2015).

change poses serious concerns for financial stability, for example for deteriorating NPL ratios, is far from easy. Average values of the five characteristics above, or indeed of the even richer set of criteria in the ESRB's risk scoreboard, may move in different directions and changes in the fraction of loans at the riskier end of the spectrum are likely to be particularly important.

Moreover, local institutional characteristics have a large bearing on how to interpret the above indicators, see detailed examples in section 7.1. Valuation practices and fees differ between countries, handicapping cross-country comparisons and interpretations of reported LTVs. Further, the reported survey includes only the larger banks and the data may be different for smaller, especially regional banks. Lack of historical information also makes it harder to put these data into context.

The analysis in this paper suggests that the latent variable approach, as exemplified by the French study, could extract a highly-informative summary indicator of the evolution of mortgage lending standards. With controls for other factors including nominal mortgage interest rates, inflation, income[67], and demography, the latent variable is interpretable as a measure of lending standards. This approach is quite different from a factor analysis of a set of credit indicators which extracts the common information without controlling for the influence of other drivers. The French study showed that, together with macro controls, this summary measure of lending standards proved highly effective in forecasting the NPL ratio not just one, but two years ahead. The availability of good quality quarterly data for France back to 1980 on household balance sheets, NPLs, interest rates and other data, made it possible to apply the latent variable method to a five-equation system, plus an equation for permanent income. However, fairly similar estimates of the mortgage lending standards indicator can be achieved with only a two-equation system – for house prices and mortgage debt. Thus, simplified versions of equations (3) and (7) could be run for many of the countries in the Euro area to this end. Further, using panels for groups of economies with common characteristics could compensate for the absence of longer time series of data for some economies.

Another benefit of the latent variable approach is to improve on the specification of the house price equation currently used to derive an estimate of over-valuation. With appropriate user cost measures incorporating extrapolative expectations of house price appreciation to capture over-shooting in house price dynamics, together with the time path of the latent variable measure of lending standards, a more accurate indicator of house price over-valuation could be achieved.

The 'house prices at risk' approach to monitoring housing-related risks developed at the IMF (IMF, 2019, ch. 2) should also benefit from this method of improving the measurement of previous lending standards and of obtaining better estimates of over-valuation.

A third benefit of the latent variable approach is to assess the impact of shifts in macro-prudential measures such as the tightening of LTV or LTI ratios, which should

[67] Whether income growth expectations are relevant or not in these equations is an empirical question. A simplified version of the approach used by Chauvin and Muellbauer (2018) and Debonis et al. (2022) could replace the 10-year horizon with a 3-year horizon in the forecast measure of income growth.

be reflected in a negative effect on the latent variable measure of lending standards at the point of application of the policy. This method offers a way of greatly reducing the endogeneity biases handicapping attempts to estimate the impact of macro-prudential measures.

Another avenue that should be explored in this context, is a granular analysis of data on lending conditions in mortgage markets from the ECB's bank lending survey, which began at the end of 2002. One of the survey questions deals with the tightening or loosening credit conditions relative to three months prior. By cumulating these changes in credit conditions, a level indicator of mortgage credit conditions can be extracted, see Aron et al. (2012) and Duca and Muellbauer (2013) for an application to consumer credit.[68] A naïve application of the method is probably misleading. Circumstantial evidence from our work on France suggests that, compared with our latent variable estimate of non-price mortgage credit conditions, the indicator derived from the bank landing survey does better in capturing tightening than loosening. It is plausible that respondents to the survey may be interpreting an increase in the risk spread as tightening, or may be interpreting changes coming from the demand side as a credit supply response. Bassett et al. (2014) used bank-specific panel data from the Federal Reserve's Senior Loan Officer survey to adjust the tightening indicator for lending to NFCs to try to separate out demand side from credit supply influences. The Bassett technique could be a fruitful avenue for research on the ECB lending survey of conditions in mortgage markets, with the benefit of panel data for several countries to compensate for the shorter length of historical data. Continuous data back to 2003 on a plausible indicator of non-price credit conditions at the country level would benefit both macroprudential and monetary policy.

6 Commercial vs. residential real estate markets in affecting monetary transmission and financial stability

As the 2015 ESRB report on commercial real estate (CRE) cogently puts it: "CRE markets affect financial stability through various channels. A direct channel is through lenders providing CRE loans. Since commercial premises are operated for purely economic purposes, and given that it tends to be on a non-recourse basis, CRE lending typically exhibits higher default rates than residential real estate (RRE) lending. In addition, there is a collateral channel, whereby CRE prices and lending increase in tandem in cyclical upswings and fall in downswings, which may result in higher loan-to-value ratios (LTV) and ultimately higher losses given default (LGD). Indirect links may also pose threats to financial stability. In most EU countries, CRE and the construction sector account for a significant proportion of gross domestic product (GDP). Negative developments in these two sectors can have a material impact on economic growth and on financial resilience in general. A third channel through which CRE can affect financial stability is the scale of investment made by institutional investors." Dierick et al. (2017) point out that according to ECB data for

[68] In Aron et al. (2012) and Duca and Muellbauer (2013), we used the Senior Loan Officer survey data from 1967 on non-mortgage consumer credit, corrected for cyclical factors, to construct an index of consumer credit conditions. This proved highly significant in a US consumption function.

2016, in most EU countries, lending to the construction sector and real estate related activities (a proxy for commercial real estate lending) makes up between 20 percent and 50 percent of total lending to firms. However, as their risk profile is likely to be rather different, one should probably make a distinction between loans to firms building housing and infrastructure, and holding companies and funds invested in CRE, whose main cash flow is the rent they receive.

ESRB (2015) reports that in the EBA 2014 stress test of EU banks, around 60 percent of CRE exposure by banks in Ireland was non-performing, around 40 percent in Spain, around 20 percent in Italy, 10 percent in the Netherlands, and around 6 percent in France and Germany. Moreover, after the 2007-8 crisis, in a few countries, CRE prices fell substantially further than house prices, though of the six countries covered, Chart 14 suggests that was true only in Ireland. As the report argues, one reason for cyclicality of CRE prices, is the long gestation period for many CRE development projects compared with house building, so that projects begun in the upswing of the business cycle may come on the market just as the economy turns down. Another is the even closer linkage to current economic conditions, especially the rate of return, than for housing. In a downturn, the demand for commercial space to rent drops and as space becomes vacant, this adds to downward pressure on rents. CRE also tends to be more exposed to international CRE trends and capital markets as credit provision tends to be more international than for housing. This international dimension has implications for monetary policy transmission. The effect of Euro area monetary policy on CRE may be more through effects on cash-flows than through lending rates or local credit provision.

Of course, one can overstate these differences between CRE and housing: the Irish house price boom was largely financed from international money markets and had a clear speculative element. However, in Ireland, where CRE loans as a share of total lending to non-financial corporations grew from 40 percent pre-boom to 60 percent in 2006, CRE credit was growing by more than 60 percent on a year-on-year basis at the peak of the cycle in 2006. In contrast, in Ireland, annual growth of household mortgage debt peaked at 35 percent in 2004, and the boom built up earlier and more slowly. In the US, the CRE boom and bust proved especially severe, see Duca and Ling (2020), with the defaults in CRE proving especially damaging to the financial sector. This introduced another reason for the correlation of CRE and housing prices: negative shocks generated from the CRE crisis affected the ability of the financial system to extend credit, which had a spill-over effect on housing markets in the US.

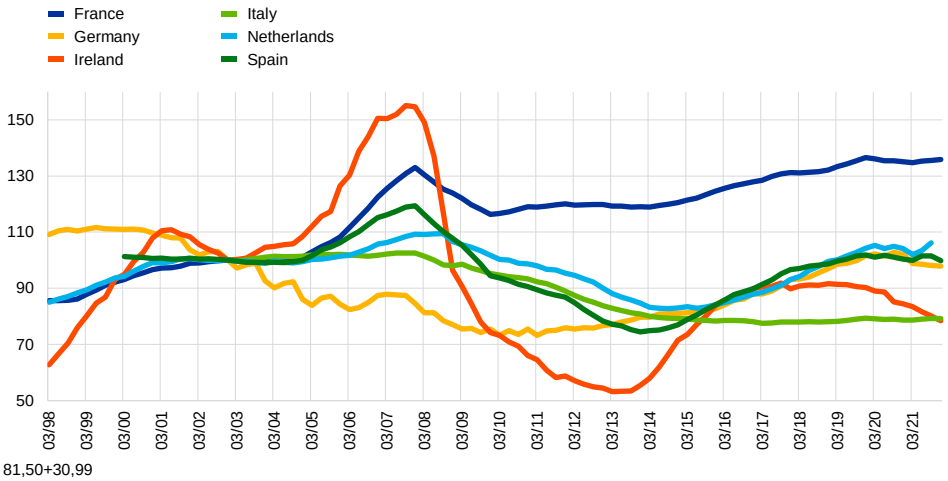
Comparing real CRE price indices for six Euro area economies in Chart 14 with real house price indices in Chart 1, illustrates both the correlation between the two – at least since around 2000, and some differences. For example, the boom-bust cycle for CRE in Ireland is a little more extreme than for residential real estate. However, for Spain, the downturn in the GFC was rather less sharp than for house prices and only a little sharper than downturns in CRE prices in the Netherlands and Italy. For France, real CRE prices rose less than real house prices in the boom preceding the GFC, suggesting that factors particular to households were at work in the French housing market (e.g. the widespread use of DSTI limits in lending). The German picture for real CRE closely resembles that for real house prices, with recovery beginning in 2010 and

gathering pace in later years. While quality issues with CRE data suggest caution about such comparisons, these general tendencies suggest a different pattern of institutional differences for housing and CRE finance across Euro area countries.

Dierick et al. (2017) (see table, p.20) examined differences between commercial and residential real estate. The conclusion that CRE was necessarily more cyclical was probably influenced by US experience and the above comparisons suggest that a generalisation to all or even most Euro area countries may not be appropriate. CRE markets tend to be more complex and opaque, suggesting risk management issues connected with particular properties or property types. In many countries, as noted above, significant CRE financing comes from nonbanks and foreign investors, so that international spill-overs tend to be more important than for residential real estate. In Europe, bank exposures tend to be lower for CRE than for residential real estate and the link with consumer spending is weak and indirect, in contrast to residential real estate, especially in countries with easy access to home equity loans.

Chart 14

Real CRE indices for six Euro area economies



Source: Data for Germany from VDP, data for remaining countries from MSC-IPD.
Notes: Missing index data for Germany and Italy are interpolated from data on quarterly growth rates. All CRE price indices are deflated by country level consumer expenditure deflators.

As Dierick et al. (2017) show, while there are substantial data gaps for monitoring risks to financial stability in residential real estate – for example in granular data on characteristics such as loan-to-value ratios, loan-to-income ratios and debt service ratios – these gaps are more extreme for the financing of CRE. Moreover, while there has been much effort expended to improve the measurement of house price indices and put these into the public domain, including at the regional level (see the OECD database) much of CRE data is compiled by private providers with only partial coverage and is subject to comparability problems. Partly because of scarce and incomplete data, there is little experience in the use of macroprudential instruments for CRE.

7 Residential and commercial real estate and the associated risks to financial stability.

7.1 Financial stability in the policy agenda.

The consideration of risks to financial stability involving real estate has become a high priority for the ESRB, the ECB, the European Commission and the financial and macroprudential regulators. Large panels of experts at the European Systemic Risk Board, the ECB and the Commission produce regular reports demonstrating a high level of appreciation of the issues and a strong commitment to assess the evidence from the available data. Even before Russia's invasion of Ukraine, the ECB's November 2021 Financial Stability Review, (ECB, 2021b), and the ESRB's February 2022 review of 'Vulnerabilities in the residential real estate sectors of the EEA countries', ESRB (2022a), had warned of exuberance and rapid growth of house prices and of mortgage credit in 2021. The ESRB can issue warnings to the macroprudential authorities in each country of risks to financial stability that may be building up. In 2019 it issued country-specific warnings on medium-term vulnerabilities in real estate to the Czech Republic, Germany, France, Iceland and Norway. It can also go one step further and issue recommendations, with later compliance reports on how adequate it judges the response of each country's macroprudential authority to have been. In 2019 it issued such recommendations to Belgium, Denmark, Luxembourg, the Netherlands, Finland and Sweden and the compliance report was published in March 2021. In November 2021, a recommendation was added for Germany, followed up by increasing the cyclical capital buffer for loans secured on housing.[69]

Along with the ESRB risk dashboard, the bank survey data analysed in the ECB Financial Stability Review, Lang et al. (2020) have enhanced information on housing loans standards across the Euro area, see section 5.3. The findings make clear that countries with recently high NPL ratios (Italy, Spain Greece and Cyprus) applied significantly tighter mortgage lending standards in 2016-18. However, as noted in section 5.3, drawing overall implications on whether country-specific lending standards have weakened, and if so, whether the change poses serious concerns for financial stability, for example for deteriorating NPL ratios, is far from easy.

There are also problems interpreting data difference between countries. For example, in the Lang et al. data, France, followed by the Netherlands, has the highest average LTV and the highest share of LTVs over 80 percent for new loans in 2018. However, over half of French residential housing loans are not strictly speaking 'mortgages' as they are guaranteed through a collective insurance scheme rather than by the housing collateral. In the Netherlands, in recent years a large fraction of mortgages is insured through the National Mortgage Guarantee Scheme, backed by the government. In the event of a foreclosure, the lender is responsible for the first 10 percent of the loss,

[69] With effect from 1 April 2022, see BaFin - Verfügungen - Anhörung zur Anordnung eines Kapitalpuffers für systemische Risiken. This was in the context of the Bundesbank's November 2021 financial stability report suggesting over-valuations of RRE of 10 to 30%, depending on location.

while the guarantee scheme covers the residual loss. This reduces the lenders' risk, and together with high levels of interest deductibility and high pension coverage, helps account for high LTVs in the Netherlands. There are other complications. Measures of income relevant for defining the LTI can differ in the treatment of the income of spouses and of less regular income. Bank-reported LTVs could be based on the market value of the property or the value assessed by the bank's own valuer and prices can change between the valuation date for mortgage approval and completion. If transactions costs in tax and lawyer's fees paid by the buyer, which can be as high as 10 percent of the price, are taken into account, a substantial part of the down-payment is swallowed up by these costs, increasing the buyer's effective leverage.[70]

Differences in institutions between countries and differences in measurement methods which complicate cross-country comparisons are one reason why a one-size-fits all method for setting macroprudential policy is problematic, implying decentralisation of at least part of the policy process.

One of the credit risk indicators in the ESRB dashboard, comes from data from the bank lending survey carried out since 2003 on the percentage of banks respectively tightening or easing credit conditions. Chart 15 shows percentage net tightening and for the six economies under consideration. It shows a massive tightening of mortgage credit conditions in Spain and Ireland in 2007-8 and slightly later in the Netherlands. In Italy, there was substantial tightening of mortgage credit conditions in 2007-8 and then massive tightening when the sovereign debt crisis erupted in 2010, followed by a relaxation after the crisis eased in 2013-14 and subsequently. In Germany, the changes in credit conditions are small in comparison[71], while France is in an intermediate position, but closer to Germany than to Italy or Spain. There was a general tightening in the pandemic. The most recent data suggest that this has not been generally reversed since the end of the pandemic (though the Netherlands and Italy are exceptions), with the net balance of banks roughly zero. This could suggest a general lack of exuberance in mortgage credit markets in recent years, though with exceptions, and point to lower interest rates, demand shifts induced by the pandemic and yield-search by investors in a low yield environment, as the main factors driving strong growth in house prices. However, as noted in section 5.3, one needs to be cautious in interpreting raw indicators from the bank lending survey as robust measures of lending standards.

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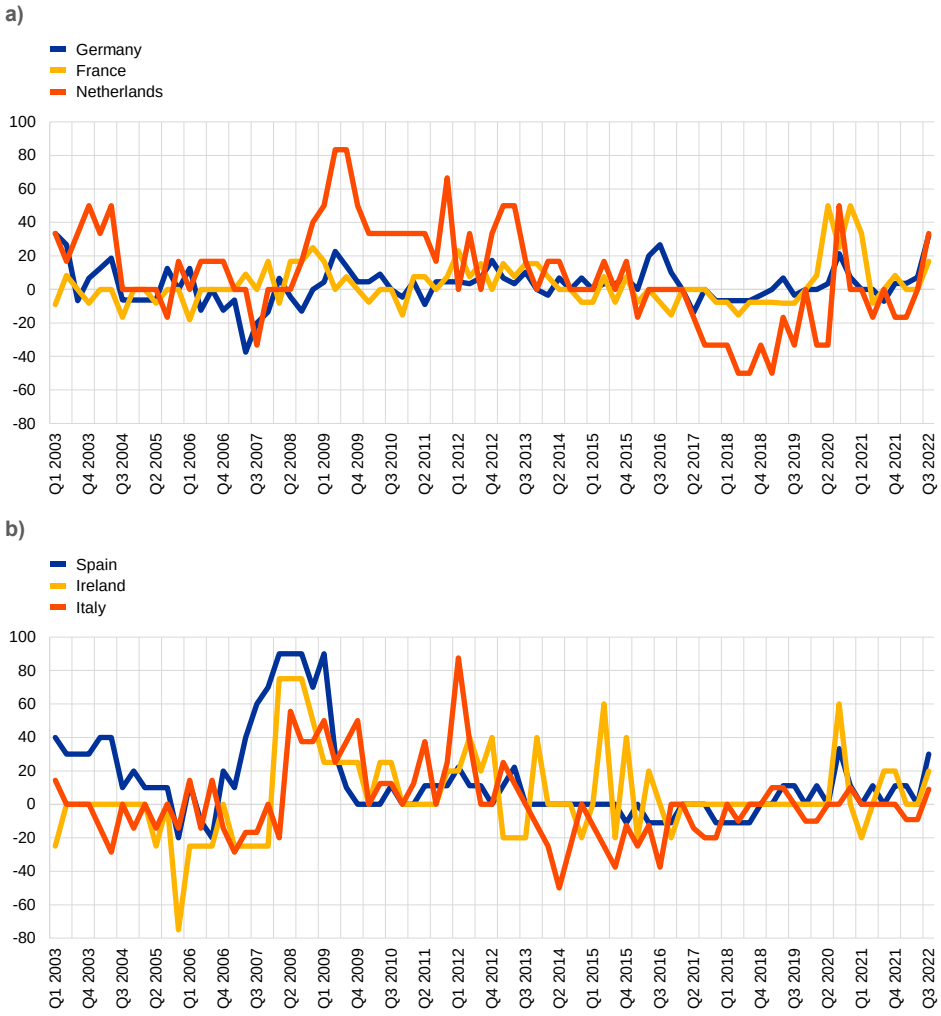
70 It remains to be seen whether the new AnaCredit database which effectively extends credit registers across the EU with harmonized definitions will provide more comparable granular data on housing loans conditions. The initial roll-out in 2018 of data assembly did not include loans to natural persons, but this is expected to be added in future. It may then become possible for the ESRB dashboard to include data on LTIs, LTVs and DSTIs.

71 However, data from Europace suggests a substantial increase in the share of German mortgages with LTV ratios above respectively 90 and 100% after 2018, though these are based on a conservative 'sustainable' valuation measure. It is also not clear whether some borrowers in this tail group might have been able to offer additional security, for example, in the case of buy-to-let investors in the form of other properties.

Chart 15

Change in credit standards for loans to households (for house purchase)



Source: ECB statistical warehouse, July 2022.

7.2 How well have macro-prudential policies operated in Euro area countries?

The macroprudential toolkit, broadly defined, includes setting countercyclical total and, more recently, sectoral capital buffers, specifying minimum liquidity ratios, stress-testing systemically important parts of the financial sector, setting capital flow or foreign exchange reserve requirements in small open economies, and using several real estate-related tools. The last set of tools include capping LTV and DSTI ratios, limiting non-standard amortizing or interest-only mortgages, and increasing capital requirements on riskier mortgages. In Duca et al. (2021a) p.833- 839 we review the international literature, mostly in the form of panel studies, on real estate-linked macroprudential tools and their effectiveness. One issue with such studies is that macroprudential policies are endogenous, and that credit and house price growth also depend on other factors. For example, if tightening occurs amid high credit growth

owing to optimism about future income, this could underestimate the effect of tighter LTV or DSTI caps on credit growth in empirical models excluding income expectations. Researchers have used rich sets of controls and lags or creative application of instrumental variable estimation techniques to circumvent this problem. However, it is important to be aware that there may be a tendency to understate policy effectiveness. A second problem lies in lack of data in many countries on the voluntary lending criteria banks were using before regulatory limits were introduced. Depending on the distributions of LTVs, LTIs and DSTIs just before new limits were announced, their effects could be large or small. Nevertheless, we concluded that the international evidence suggests that tighter LTV limits curb household leverage and credit growth in most countries, especially those with more volatile house prices. However, the effects on house price growth of tighter LTV and DSTI limits are more heterogeneous. The evidence is that leakage can be an issue. For example, tighter limits on banks may be partially circumvented by non-bank financial institutions. This is prevented by many European regulatory authorities applying limits to all mortgage lenders and not just banks. Tighter LTV caps could be offset by lenders relaxing DSTI criteria, so effectiveness would be enhanced by joint action on both, as is indeed often the case, see ESRB (2022a).

In the Euro area, while the ECB shares responsibility for policies on financial stability with national regulators, it lacks authority to set many of the specific real estate-linked instruments, which are largely under the control of national regulators, see Hartmann (2015), section 4, though there have since been improvements. As countries and circumstances are so heterogeneous, such settings would, in any case, need to be country-specific. The ESRB lacks authority to intervene in individual country settings of borrower-based measures such as limits on LTVs, LTIs or DSTIs. However, its system of issuing warnings and recommendations explained above, followed up by its later compliance reports has worked reasonably well in that most national regulators have followed the recommendations to some degree. France and Germany, for example, tightened policy in 2021. The ESRB's assessments on the effectiveness of the use of these policies generally look plausible. In its concept note, ESRB (2022b), the ESRB calls for minimum standards for borrower-based measures to be introduced as complements to capital-based measures. At present, for example, LTI or DSTI limits are not available in national legislation in Germany and Finland.

The lack of historical, country-specific data on distributions of LTVs, LTIs and DSTIs, ideally split into first-time buyers, repeat buyers for owner occupation, buy-to-let investors and, where relevant, refinancing of existing loans, is a handicap to the application of caps on these lending criteria and the assessment of their effectiveness. Given the current state of the data and some of the comparability issues discussed earlier, it is probably wise at present to leave such policies to national regulators, who may also be able to access confidential national bank regulatory data not otherwise currently available. However, the ESRB (2022b) call for minimum standards for the regulatory perimeter for borrower-based measures across countries is surely correct.

The lack of recent distributional information is a related handicap to assessing household vulnerability, as tail risk may not always be closely related to averages of balance sheet and income data. Bankowska et al. (2017) examine data from the

Household Finance and Consumption Survey to assess household vulnerability. The pandemic and the shocks induced by the invasion of Ukraine, may, for example, have disproportionately affected households with weak balance sheets.

Bank of England experience with borrower-based macroprudential instruments is useful. The Bank has used an 'LTI flow limit' which limits the number of mortgages or proportions of housing loans that can be extended at loan to income (LTI) ratios at or greater than 4.5; and the 'affordability test' which requires lenders to check that borrowers could cope with say, a 3 percent rise in the mortgage interest rate when whatever term the rate is fixed for expires.[72] An advantage of these kinds of instrument is that they gives lenders discretion to use the information they have on particular borrowers to evaluate riskiness. This is preferable to a blanket ban on all loans over some particular LTV or LTI ceiling that could be insufficient for some customers and too restrictive for others. In a number of countries, 'flow limit' measures have been applied, with flow limits and LTV, LTI or DSTI limits applied differently for BTL investors and FTBs, see ESRB (2022b).

Promising new instruments, sectoral systemic risk buffers, sSyRBs have been enabled since January 2021[73] , with Belgium, Germany, Lithuania and Slovenia the first to raise the buffer for RRE loans and the Netherlands introducing an LTV-related risk weight. The guidelines in EBA 2020 do not specifically distinguish types of RRE borrowers, such as first-time and buy-to-let buyers, and new loans for purchase vs. refinancings, though such distinctions may be in the spirit of the guidelines. Since real interest rates are currently at record negative levels, reducing leverage for investors driven by speculative considerations should be a high priority and raising the sSyRB on such loans would be wise.

Controversies remain however. An argument often made against macroprudential instruments, especially borrower-based ones, is that they can generate inefficiencies and undesirable distributional effects, see Svensson (2020) and the debate with Filardo and Rungcharoenkitkul (2016, updated 2018) and IMF-FSB-BIS (2016), amongst many others. Macroprudential policies should not be singled out in this respect, however, because similar arguments can also be made against conventional monetary policy and Quantitative Easing (QE). The unemployed may be helped by such policies to the extent that aggregate demand is stimulated, but owners of housing and illiquid financial wealth and borrowers benefit disproportionately, while savers are hurt by low rates of return. While some macroprudential instruments can be quite blunt, for example, ceilings on LTVs or DSTIs, irrespective of individual credit scores or other information lenders may have on potential borrowers, there are softer alternatives as pointed out above. Moreover, the application of borrower-based measures in many countries has been in the context of escape clauses, such as allowing a fraction of loans to be exempt from some limits, subject to others.

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[72] Since risk pricing is likely to be borrower-specific this is preferable to a blanket ceiling on the stress interest rate. The Bank has recently been consulting on the continuation or revision of this policy. Estonia is among countries using similar criteria by adding a 2 percent margin to the mortgage interest rate used to calculate the DSTI, which is subject to a 50 percent ceiling. Since 2012, Ireland requires that lenders assess that borrowers can still afford their mortgage with a 2 percent higher than offered rate.

[73] Under Capital Requirements Directive V and Capital Requirements Regulation II (2019), with EBA (2020) setting out guidelines for the appropriate subsets of sectoral exposures to which this buffer may be applied.

7.3 Leaning against the wind

Given heterogeneity in institutions, mainly decentralised banking regulation and macroprudential policy settings, one can ask if the ECB should ever 'lean against the wind' to protect financial stability by tightening monetary policy? The generic case for LAW has been articulated most strongly by researchers at the BIS, affirming the position taken by Borio and Lowe (2002). The low interest rate policies pursued by the advanced economy central banks since 2009 are a particular concern, neglecting the associated financial stability risks. Macroprudential policy is viewed as insufficient on its own to deliver financial stability, and should be supported by monetary policy, which 'gets in all the cracks' (Stein, 2013). Others opt for the 'middle ground'. Dell'Ariccia et al. (2017), IMF (2015)) and Smets (2014), for example, argue that monetary authorities should generally not lean against the wind, but leave the door open for this provided a primary focus on price stability is maintained over the medium term. If there were currently evidence for a common tendency across the Euro area for overvaluation of house prices or of over-indebtedness of households, one could make a case for such tightening in addition to addressing the problem of rising inflation. At a global level, one could argue that after the global financial crisis, leaning against the wind would have been less damaging than policies followed - provided that fiscal policy could have been more expansionary - since low interest rate policies and QE caused high real estate valuations with negative consequences for financial stability as well as for sustainable growth.

While there is not a strict consensus in the literature nor among practitioners regarding LAW, the ECB strategic review of monetary policy, see ECB (2021c), suggests caution on interpreting the evidence on the costs and benefits and argues that other central banks have generally not adopted LAW as a strategy. Svensson, in a series of papers, most recently Svensson (2018a,b), has argued forcefully that monetary and macroprudential policies are very different (in terms of goals, instruments and authorities), that they do affect each other but not systematically, and that each is more effective in achieving its own goals. He argues that each is best conducted separately, informed about and taking cognisance of the conduct of the other. Monetary policy should only ever "lean against the wind" if supported by a convincing country-specific cost-benefit analysis, a view supported by central bank practitioners (e.g. Constâncio (2018)). Svensson (2020) argues that the raising of interest rates by the Riksbank to 2 percent between mid-2010 and mid-2011, because of worries about rising household debt, was unwarranted -especially as macroprudential policy was also tightened with a 85 percent LTV cap on new loans, tougher capital adequacy requirements on large banks and higher risk weights for mortgage loans from October 2010. Counterfactual simulations with the Riksbank's DSGE model suggest that the cost in higher unemployment and below-target inflation outweighed the trivial reduction in the stability risk from the slight lowering of the household debt to income ratio. However, the kind of DSGE model used by Svensson to examine counterfactuals for a cost-benefit comparison is inappropriate as such models singularly fail to capture the amplifications and endogenous dynamic processes of the financial accelerator, as explained in this paper. Moreover, the DSGE model used by

Svensson is a generic model which does not take into account the particular credit, tax, and housing market circumstances of Sweden[74].

Svensson (2020) returns to his critique of LAW by examining empirical evidence, mainly microeconomic, bearing on the amplification of house price shocks via the housing collateral channel. He argues that this channel is weak in Sweden, and this supports the argument that monetary policy was too tight in 2010-11. He also argues from this evidence that subsequent macroprudential policy, tightened in June 2016 (after the policy rate reached minus 0.5 percent in February 2016), and further in March 2018, has been too tight. Svensson focuses on the negative consequences, particularly the exclusion of many poorer and younger households from access to owner-occupied housing. He points to serious distortions in the Swedish housing market including rent controls, planning restrictions and the ill-advised removal of property taxes, and convincingly argues that macroprudential controls are a third-best response in that context. This points to the need to reduce distortions, and hence to coordination between different groups of policy makers.

At the very least, within central banks, monetary policy and macroprudential decision processes need to be coordinated, rather than the separation proposed by Svensson. Moreover, as argued by IMF (2019, p.77): "if the macroprudential toolkit is incomplete, or the decision-making process is imperfect, monetary policy might still have to take downside risks to house prices into consideration, even when it is not the preferred policy tool from a theoretical perspective". One of the key points of the present paper is that there are strong interactions between interest rates and lending standards and their effects on the economy. This needs to be reflected in common policy models used to inform both decisions.

7.4 The current risk outlook

The most recent IMF April 2022 Global Financial Stability Report followed by the ECB's May 2022 Financial Stability Review make sobering reading on the global situation and how different European countries and the financial sectors in each could be affected by the war in Ukraine, the disruptions to global supply chains and increasing commodity price inflation, already high before the war.

Some observers consider that central banks, especially the world trend setter – the US Federal Reserve -were considerably 'behind the curve' before the war erupted in Ukraine. Arguably, global supply chain problems, the withdrawal of many of those over 50 years of age from the labour market – in some cases due to the incidence of long-Covid, and of labour market mismatch with high levels of job vacancies in some sectors, have resulted in an aggregate supply shock. In many respects, these elements of the supply shock could not have been anticipated, but perhaps were also not quickly enough appreciated by central banks focused on the conventionally measured output gap. Moreover, as noted above, policy models with mis-specified

[74] Adrian and Liang (2016) and BIS researchers (e.g., Filardo and Rungcharoenkitkul, 2016) take issue with Svensson's methodology for related reasons. Nevertheless Svensson was surely right to argue that the 2010-11 interest rate rise in Sweden was a mistake. As if to confirm his view, in 2014 the Riksbank abruptly switched to easing after unemployment rose and inflation came close to zero.

consumption functions that grossly underestimated both the ECM adjustment coefficient of consumption and the marginal propensity to consume out of liquid assets, the level of which experienced an unprecedented jump in the pandemic, likely led to under-estimates of the strength of the consumer demand rebound in 2021.

Uncertainty at the time of writing is extreme, with some military strategists anticipating a war lasting a year or more and others anticipating an earlier end. There is also great uncertainty about the ability and time for Euro area countries to detach themselves from energy dependence on Russia. For Germany, recent reports from the ESRB and the ECB have noted increasing risks building in German mortgage markets. For example, Lang et al. (2020) note that shares of loans with LTVs above 80 percent and LTIs above 5 have increased in 2016-18 in Germany and now notably exceed the EA average. Further rises in the fraction of high-leverage loans appear to have occurred since 2018 according to Europace. Germany also has high energy dependence on Russia and an export sector sensitive to a global recession. However, with owner occupation under 50 percent according to census data (slightly higher from household survey data), little access to home equity loans and a relatively low ownership of illiquid financial assets, the risks posed by asset price declines for German households are relatively moderate.[75] This contrasts with the Dutch situation where households are, on average, heavily in debt and heavily exposed both to declines in equity prices--which already have been substantial—and to potential falls in house prices.

Table 3.12 in the most recent risk dashboard includes estimates of the degree of overvaluation in each EU country's housing market, with bands covered by the four indicators. It suggests that in 17 countries, there is the possibility that, in 2021Q3, overvaluation was 20 percent or more, in the sense that the bands exceeded or overlapped the 20 percent threshold. However, it is noteworthy that the estimates of overvaluation from the inverse demand model of house prices are at the bottom end of the bands in most cases. In other words, econometric models that control for demand factors and interest rates relative to the housing stock tend to give lower estimates of the degree of overvaluation than cruder indicators such as the house price-to-income ratio or the deviation of house prices from trend, with only five countries above the 20 percent level of overvaluation. However, Germany and the Netherlands sit at around 20 percent. The Netherlands is also near the top end of the distribution of household debt relative to household income, while Germany is in the middle of the EU distribution.

What then are the prospects for house prices? Downside risks are likely to stem more from macro-shocks, the fall in real household incomes resulting from inflation, especially of food and energy, the recession likely soon to appear in many countries' data, the jump in income uncertainty and a shift in inflation expectations. The consumption functions we have for France, Germany and Italy incorporate very significant permanent income effects. Permanent income is estimated from a long horizon income forecasting model in which real oil prices and interest rates play a

[75] However, the stress test of the German mortgage market by Barasinska et al. (2019) suggests that a fall in house prices and a rise in the unemployment rate would generate significant credit losses at German banks.

major role in all three countries and equity real price indices also appear. This suggests, not surprisingly, that income expectations will have fallen sharply. The model for France, and especially for Italy, implies a large negative effect from the inflation surprise on consumption, on top of the large fall already implied by the sharp drop in real household income. However, given still unusually high levels of liquid assets among more affluent households, the decline in aggregate spending could be delayed in some countries by a quarter or two. With consumption accounting for well over half of final demand in each country, the contraction in consumption will have further multiplier effects on employment and on income, which are likely to feed into house prices.

A second consideration comes from inflation expectations –especially the expected duration of high inflation- and the belief that residential real estate is an inflation hedge. Problems in supply chains for building materials and their rising prices are another factor pushing up house prices. With real interest rates incorporating cost of living expectations likely to be at record lows, borrowing up to the hilt looks attractive if incomes kept pace with the cost of living, though the latter is questionable for many. For investors, investing in an inflation hedge compared to negative real returns in bonds or cash, could look very attractive. However, the illiquidity of residential real estate and transactions delays are likely to limit this source of demand. Much depends on house price expectations, suggesting the possibility of multiple equilibria, but generating a high degree of uncertainty about house prices to add to the jump in income uncertainty. In this situation relatively small changes in the environment, for example, for interest rates or for the war outlook, could shift the equilibrium. For financial stability, particularly for banks with a high fraction of the loan book committed to fixed-rate mortgages financed at ultra-low rates, the outlook for profits over the next few years suggests problems for the supply of bank credit. To the extent these are priced into bank equity valuations, these problems could affect capital ratios and therefore be brought forward. Of course, much depends on the cost of funds and on returns for alternative assets in which banks could invest.

In many Euro area countries, real interest rates measured with a one or two year horizon for inflation expectations, are likely currently to be at record negative levels. Then there seems little alternative, to put it bluntly, to ‘financial repression’. Macroprudential instruments, including buyer-based and capital based measures provide a more sophisticated framework than was available in the 1970s following the oil price shocks. They should prevent excess leverage leading to a further real estate price rise, with increased financial risk and negative distributional consequences. It seems particularly appropriate that the investor sector, especially BTL in residential real estate, and commercial real estate, should face seriously tighter constraints under current conditions: macro prudential policy needs to be relatively tight for these sectors to prevent high-leverage speculation.

Risks spreads have widened sharply and commercial banks will surely be more cautious. Hidden NPLs that have resulted from the pandemic, unless governments come to the rescue of households that previously benefitted from debt moratoria and forbearance, are likely to come to the surface in some countries, constraining banks’ ability to lend. The NPL forecasting model for France pointed to a ‘perfect storm’ that

would push up the NPL ratio: a rise in interest rates, a rise in the unemployment rate, a fall in economic growth, a fall in the house price to income ratio and loose credit conditions in the previous 4 to 5 years. Clearly what happens to interest rates is crucial as they have not only a direct effect, but indirect effects via the unemployment rate, economic growth and the house price to income ratio. There are few signs yet of house prices turning down in Euro area countries, though in real terms this should soon be the case, given high consumer price inflation.

As far as risks from commercial real estate are concerned, CRE prices and rental flows were far more affected by the pandemic than was the case of residential real estate. The macro shocks of 2022 and the impending recession are likely to feed more strongly into cash flows and valuations in CRE than for residential. Governments relying on electoral support have a strong incentive to try to shield households from recent energy and food price shocks and other symptoms of economic disruption. The May 2022 ECB FSR pointed out that little reaction had taken place so far in prime CRE and in REITs. However, conditions outside prime markets are more precarious, with the after-effects of the pandemic still playing out and repricing due to climate concerns and changes needed to meet net zero targets. Moreover, as CRE prices are more affected by international factors, the recent sharp re-setting of monetary policy at the US Federal Reserve is likely to have a more pronounced effect in the Euro area on CRE than on housing.

8 Conclusions

The credit cycle, with real estate involvement which varies by country, has important implications both for monetary transmission and financial stability. A period of easy credit conditions, resulting in lax lending standards, tends to create financial vulnerability among borrowers and potentially among lenders, particularly if followed by an economic downturn. Then, rising non-performing loans (NPLs) and other credit risk measures, result in a reduced ability and willingness of banks to extend credit, resulting in tighter credit conditions that amplify the downturn in the economy. Further negative feedbacks onto the economy may stem from the spending constraints of the indebted households and firms. This paper has illuminated – indeed quantified- the two-way connection between lending standards and NPLs with empirical evidence from France. Financial sector interconnectedness in the economy may be large enough to cause systemic risk, though France has been fortunate not to experience a major banking crisis, unlike Ireland and Spain. Even without a banking crisis, tracking the credit cycle is important both for monetary and macroprudential policy.

The paper has focused on six channels of monetary transmission involving housing and associated credit markets. The evidence from France is that lending standards – non-price credit conditions – or NPLs have an important influence in every single channel. Concerning transmission from policy rates to the mortgage interest rate, there is clear evidence that a higher NPL ratio raises the risk premium embedded in the mortgage rate. The evidence is that, in addition to strongly significant effects of interest rates on house prices, consumer spending and mortgage debt, lending standards in France had a major effect on each. Moreover, a new model for residential

investment finds an important role for the NPL ratio, in addition to interest rates and the ratio of house prices to construction costs. Credit availability for the building industry, is clearly affected by the NPL ratio, in addition to the indirect effects of lending standards embedded in house prices. Beyond these five channels of transmission of interest rates and lending standards, in one and two year ahead forecasting models, the NPL ratio for France is driven by interest rates, economic growth, an important real estate channel, and by lending standards up to five years earlier. This has the immediate implication that the processes of transmission of monetary policy, and indeed of macroprudential policy and of changes in microprudential regulation, are complex and long-lasting. A further reason why this is the case arises from the fact that residential investment, which is affected by both, cumulates into the housing stock, which, in turn, is one of the determinants of house prices and of housing wealth, with consequences for consumer spending. Similarly, both monetary and macroprudential policies affect mortgage debt, which has important and long-lasting effects on consumer spending, as such debt, once taken on, is hard to reduce quickly. An obvious implication is to deny, even in the long-run, the classical dichotomy, in which monetary policy supposedly affects only the price level and not real variables.

The concept of lending standards and most of these real estate-connected channels of transmission of monetary policy were absent in New Keynesian thinking and in the associated DSGE models, popular among central banks before the global financial crisis. However, the new generation of semi-structural policy models at central banks remains quite deficient in their coverage of the six channels outlined above. The coverage of the real estate channels in six central bank country models and in the Euro area ECB-BASE model, summarised in Table 3, shows that in France, the only channel that appears is to a lending rate for households of which mortgage interest rates are an element. In the remaining central bank models, all include house prices, residential investment and consumption channels. While two (Ireland and the Netherlands) include an indirect role for lending standards on house prices via mortgage debt, none control for lending standards in the residential investment and consumption equations, and only Ireland and the Netherlands split housing from financial wealth. In most models, the potential effect on house prices on consumer spending is highly constrained and this is true also for the new ECB multi-country model that generally follows the ECB-BASE structure. Mortgage debt is included in four country models but only Ireland and the Netherlands include controls for lending standards or proxies for financial liberalisation. Only the Netherlands, Ireland and Italy have equations for NPLs or related measures of bad loans. In these three country models, serious effort has gone into articulating links between the banking system and the real economy which makes their models the only ones potentially useful for macroprudential policy making. Finally, while ECB-BASE and the Bank of France model include an important role for income expectations through a permanent income variable, none of the other country models do so, though income expectations are a potentially important channel for monetary transmissions. This highlights the gap in most central banks between teams concerned with financial stability and macroprudential issues, showing a sophisticated appreciation of the role of real estate and the credit cycle in generating potential risks, and those developing policy models that too often ignore the resulting links between the financial sector and the real

economy. I argue, and the French empirical evidence demonstrates, that these links are important both for macroprudential and for monetary policy.

A general conclusion from the present analysis of the housing channel is that the increase in aggregate demand from households resulting from monetary easing, varies a good deal by country, tends to be overstated and can come with seriously negative side-effects. Because housing wealth has mainly a collateral effect where home equity withdrawal is available, the housing wealth effect is different for different countries, for example low in Germany, and can be time varying – for example, weaker in a credit crunch. Because of the negative longer-term effects of higher debt levels encouraged by monetary easing and negative affordability effects of higher house prices on non-owners, the aggregate effect of house prices on consumer spending can be muted. There are also consequences for the distribution of wealth. Because housing wealth tends to be less unequally distributed than financial wealth, it can be argued that higher house prices reduce overall wealth inequality as measured by the Gini coefficient, OECD (2021) and Dossche et al. (2021). However, they have widened the gap between owners and non-owners, between older and younger generations, and inequality within younger cohorts, within which the rate of owner-occupation has recently been falling in countries with the highest increases in house price to income ratios.

Recent research points to other negative aspects of house price booms. The evidence from Müller and Verner (2021) suggests crowding out of more productive investment in credit-fuelled real estate booms with negative consequences for sustainable growth.[76] More evidence for a negative relationship between rising real estate values and productivity comes from a study of US firms by Doerr (2020).[77] Chakraborty et al. (2018) show that for US data, bank lending for housing crowds out commercial lending, lowering investment by firms borrowing from these banks, especially small credit constrained firms. Basco et al (2022) find a similar result for Spain and document the negative impact on TFP in the manufacturing sector. For China, Hau and Ouyang (2021) show that real estate price rises caused by a restrictive land supply reduce bank credit to small firms, increase their borrowing costs, diminish their investment rate and compromise their output and productivity growth. Of course, house price booms occur not just because of lower interest rates but also because of financial liberalisation inducing lax lending standards. When such booms end in a financial crisis the negative long-term side-effects of easier monetary policy can be large.

Since the GFC, Europe has seen a remarkable transformation of the frameworks for financial regulation, macroprudential policy formulation and implementation, and risk

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76 They study the sectoral allocation of credit in 116 countries since 1940 and inter alia find that show that credit to non-tradable sectors, including construction and real estate, is associated with a boom-bust pattern in output, similar to household credit booms. Such lending booms also predict elevated financial crisis risk and productivity slowdowns.

77 He finds that rising real estate values relax collateral constraints for companies that own real estate and allow them to expand production. Consequently, an increase in house prices reallocates capital and labour towards inefficient firms, with negative consequences for aggregate industry productivity. Industries with a stronger relative increase in real estate values see a significant decline in total factor productivity.

monitoring. Stellar work, though subject to data constraints, has been done at the ESRB, the EBA, the ECB, at country central banks and at other regulators, backed by the BIS and the IMF. The ESRB risk dashboard contains a large set of indicators. Ten indicators for the real estate risk dashboard cover 'collateral stretch' in which house price over-valuation is important, 'funding stretch' concerned with too lax lending standards and 'household stretch' concerned with over –indebtedness of households and risks to their ability to service debt. Furthermore, detailed cross-country studies have been done (e.g. Lang et al. 2020) of mortgage loan characteristics including loan-to-value and loan-to-income ratios, but regular historical data at the country level of such loan conditions have not yet been assembled for most countries, though the developing AnaCredit database should eventually fill that gap. Summarising the information content from multiple sources into a single lending standards indicator with valuable forecasting information for developing risks is hard.

In this regard, the paper makes a concrete proposal towards developing a new indicator. The French evidence showed that the latent variable approach used in Chauvin and Muellbauer (2018) to measure such indicators of lending standards or non-price credit conditions was highly effective: the indicators for consumer credit and housing loan markets have remarkable forecasting power, jointly with some macro variables, for NPL ratios 1 and 2 years ahead. While the effort and data requirements for developing our six-equation system for France will be too much for many countries, a stripped down two-equation version consisting of house price and mortgage debt equation, with a possible ancillary equation to check for the relevance of income expectations, is far more feasible. Another benefit from such work would be the development of better measures of house price over-valuation than those currently used in the risk dashboard, taking account of extrapolative expectations of house price appreciation, which can often lead to such over-valuations. A third benefit is that the latent variable method provides an innovative technique for testing for the effects on lending standards of changes in macroprudential instrument settings.

One of the key features of the paper is to examine the effects of institutional heterogeneity across countries not only for monetary transmission but for financial stability. Table 1 summarises the key ways in which these differences affect the transmission and amplification of house price changes in the financial system and the real economy. Easy access to home equity loans increases transmission and amplification via consumer spending. Liberal lending standards that permit high levels of leverage at households tend to amplify house price swings in part because they make more salient extrapolative expectations of appreciations. Differences in legal systems affect how easy it is for lenders to have recourse to housing collateral in the event of default, affecting how much household risk lenders are prepared to tolerate. Differences in financial system regulation and macro prudential setting obviously also affect leverage and risk taking. Generous mortgage interest tax relief increases the desire for high leverage at households. Property taxes based on recent market prices tend to dampen house price swings and tax regimes differ greatly. Differences in land use and planning policies affect the supply elasticity and speed of response of the building industry, affecting the house price channel on residential investment. Countries differ in the presence of public or other collective insurance schemes that underwrite mortgage risks taken on by lenders. Higher volatility in house prices can

better tolerated without too adverse effects on individual bank risk where such insurance schemes are present.

The reality of such differences implies that a ‘one size fits all’ approach to macroprudential policy settings would be most inappropriate. Quite apart from principles of democratic control and subsidiarity, this suggests that for financial stability, the current mix of supra-national bodies such as the ESRB, the ECB, the EBA and national central banks and other national regulators, co-ordinating with each other, is a functional necessity. However, the push from the supra-national bodies for greatly improved data monitoring across residential and commercial real estate, new instruments in the form of sectoral systemic risk buffers and minimum standards regarding the legal perimeter for borrower based macroprudential measures is very welcome. Given the data constraints, the current system under which the ESRB issues warnings of risk build-up, recommendations for macroprudential tightening and follow-ups to check on implementation appears to be working quite well. Local inaction bias and legal obstacles to the form of policies and data transparency can sometimes be a problem. The high reputation of the financial stability teams at the supra-national bodies underlies the effectiveness of a system broadly based on principles of ‘advice and consent’, backed by a common legislative EU framework. The scale of the current economic crisis in Europe confirms that macroprudential policy advice from the ESRB in recent years has not been overly cautious.

The paper discusses current risks to financial stability involving real estate. One important uncertainty arises from hidden NPLs in the aftermath of the pandemic with the withdrawal of forbearance that had to be exercised on many loan contracts. However, the most important comes from global supply shocks, the size of which have not been experienced since the 1970s, threatening drastic cuts in household living standards and a dramatic shift in inflation expectations. Given global debt levels, central banks are clearly constrained in how far monetary policy can be tightened. But, with real estate considered a potential inflation hedge, the desire by buy-to-let and commercial real estate investors to leverage up in the context of negative real interest rates not seen since the 1970s, poses risks to their lenders and of a further spurt to already unprecedented levels of real estate prices, also with adverse distributional consequences. This suggests the need to raise the sectoral systemic risk buffers for these sectors and to tighten borrower-based measures that apply to BTL investors. Failure to act could also risk worsening a high inflation mind-set whose development would affect the ability of central banks to meet their inflation objective.

While space limitations precluded a discussion of real estate links to financial risks stemming from climate change, it is impossible not to highlight the issue. The ‘global climate accelerator’ describes the phenomenon whereby an accumulation of greenhouse gases, in raising global temperatures, in turn leads to the release of more carbon and even higher temperatures, ultimately making much of the planet uninhabitable. We face a climate crisis as the world is dangerously close to the tipping points at which irreversible changes would occur. This is the reason why the target has been set of reaching global net zero carbon emissions by 2050. The global climate accelerator, and the financial accelerator that operated in the Global Financial Crisis, are both characterised by highly non-linear feedback loops. In Aron and Muellbauer

(2022a) we explore the parallels and differences between these two accelerators, and the further threats posed for climate risk by Russia's war on Ukraine. Housing is an energy-intensive sector, with the residential sector accounting for about 17 percent of global CO2 emissions (OECD 2021) but far higher in Europe. According to the European Commission (2020), it accounts for around 40 percent of emissions in continental Europe (compared to 3-4 percent for aviation). Around three quarters of the EU's building stock is considered energy inefficient as these homes were built when there were minimal or no energy-related building codes. The majority of these buildings will still be in use in 2050, according to the Commission. Quite apart from physical risk (from floods, droughts, heatwaves and wildfires), the transition risk of carbon taxes, regulation and higher insurance premia will affect many real estate values, particularly for energy-inefficient buildings. Banks, lending to the affected real estate sector, could be made vulnerable and regulators should ensure that these risks are appropriately recognised and incorporated in risk premia and lending practices. Indeed, such regulation would enhance the demand for green mortgages and incentivise a more rapid roll-out of retrofitting buildings with, for example, improved insulation.

Finally, as OECD (2021) points out, housing and other real estate have many other critical interactions with the economy as well as those highlighted in this paper. These include the impact on the environment, on inequality between people and regions, labour mobility, location and travel patterns and productivity, as well as housing affordability and financial stability. Moreover, many aspects of policy across different government departments affect housing choices and hence these impacts. The OECD therefore calls for holistic policy, see OECD (2021). Co-operation is needed between governments and central banks to reduce housing market distortions, see Svensson (2020), and stabilise housing markets with reforms to mortgage interest tax relief, property taxes, regulation of rental markets and to constraints on land use and land release. Central banks should not have to carry the entire burden of trying to stabilise housing markets.

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Appendix

A1 A bird’s eye view of the change in macroeconomic thinking

The information economics revolution of the 1970s, in which the work of Joseph Stiglitz played a central role, highlighted the pervasiveness of asymmetric information and uncertainty. The impossibility of complete markets and the widespread relevance of credit constraints and liquidity issues was an important implication. Buffer-stock saving theory (Deaton, 1991 and Carroll, 1992) explained how rational behaviour under income uncertainty and liquidity constraints radically undermined the simple textbook permanent income model of consumption which underlay the DSGE approach. The textbook model implied that the multiplier is weak and fiscal policy is of doubtful efficacy.[78] The New Keynesian DSGE view of monetary transmission is that it works mainly through the real interest rate and the inter-temporal substitution channel: a higher real interest rate reduces current consumption by raising planned future consumption. As far as the financial sector in NK-DSGE is concerned, credit flows and asset prices were a side-show –effectively ‘memo items’ which just proxy expectations of future growth but play no role in system dynamics or the long-run. The GFC has put paid to these last implications. The aggregate consumption Euler equation, which underlies the consumption smoothing implication (hence low MPC) of the permanent income hypothesis and the inter-temporal substitution channel of monetary policy transmission is, as Larry Christiano has admitted, “the most rejected equation in economics”.[79] A spate of micro-evidence, reviewed in Muellbauer (2020), that the marginal propensity to consume out of transitory income is far higher than implied by the simple textbook model, and heterogeneous across households, has shifted standard views on fiscal policy effectiveness and monetary transmission, including via the redistribution and cash-flow channels.

Advances in economic theory have contributed to this shift in understanding. An early extension of the buffer-stock model to introduce an illiquid asset with a higher return but subject to trading costs alongside a liquid asset was by Otsuka (2004). Trading costs are also a key feature in Kaplan and Violante (2014) and Kaplan et al. (2014) who present theory and evidence on ‘hand-to-mouth’ consumption, corresponding to

[78] Some ad hoc extensions, not micro-founded, tried to address this problem by assuming that a fraction of households just spend current income, rather than being guided by the life-cycle/permanent income hypothesis.

[79] Christiano’s comment was made at the third Oxford–New York Federal Reserve Monetary Economics Conference, 27 September 2017. The Euler equation implies that consumption growth is driven by news about future income, which, under rational expectations, should be unpredictable. This is strongly rejected on aggregate data, see Campbell and Mankiw (1989, 1991), and for further powerful evidence from the UK, US and Japan, Muellbauer (2010). Deaton (1987) reviews evidence against the life-cycle/permanent income hypothesis.

short-horizon behaviour by asset-rich consumers who face trading costs in the illiquid asset and a credit constraint. This household behaviour was integrated by Kaplan et al. (2018) into a general equilibrium model with an otherwise conventional New Keynesian production and pricing side of the economy. Kaplan et al. (2018), see Kaplan and Violante (2018) for a non-technical overview, show that monetary policy conclusions are radically transformed in their 'heterogeneous agent New Keynesian' (HANK) model compared to the standard representative agent rational expectations life-cycle/permanent income version of the NK-DSGE model. Their model, however, does not incorporate endogenous asset prices, e.g. of equities and real estate, through which, in reality, monetary policy also operates.

An extension of an optimising behaviour of household to incorporate housing is due to Berger et al. (2018). They present an optimising model of a household facing collateral constraints and lumpy transactions costs, with a collateral effect of house prices on consumption, and where the size of the effect increases as the down payment constraint is relaxed. This implies that the house price effect on consumption varies with credit conditions. While their theoretical framework is simplified, for example, not distinguishing the down-payment constraint lenders impose on first-time buyers from possible constraints on home equity withdrawal by existing home-owners, the variation of the house price effect on consumption with credit conditions remains a robust conclusion.[80]

Heterogeneous agent models, in an incomplete market setting, have shifted the conventional wisdom about monetary transmission with a new focus on disaggregated balance sheet effects, distributional effects with macro consequences and more generally on the credit channel of transmission. Given that housing wealth is, for most European households, their single largest asset, while housing loans account for well over half of household debt, evidence-based research on the size of their effects on aggregate consumption is particularly relevant. More generally, research on variations in bank lending standards or non-price credit conditions, has established their important role in the business cycle, see for example Basset et al. (2012) and Chen et al. (2021).

A2 Rents, inflation and real estate

Monetary transmission via real estate prices has consequences not only for aggregate demand and for financial stability but also for inflation. In the US, the CPI core index has a weight of nearly 40 percent on an index of rents which proxies owner-occupied equivalent rent, OER for housing costs, as well as the rents paid by around 40 percent of families. In recent research, Bolhuis, Cramer and Summers (2022), Brescia (2021) and Dolmas and Zhou (2021) examine prospects for inflation in rents and the wider cost of living in the US, linked to years of rising house price especially in the last 3

[80] Garriga and Hedlund (2020) present an incomplete markets model with other housing features. These include tenure choice between renting and owning, portfolio choice between liquid assets, housing, and long-term mortgage debt with a default option, and a frictional housing market. Specifically, directed search in the housing market makes liquidity endogenous by creating a tension between trading at a desirable price, low for buyers, high for sellers, versus trading quickly. This liquidity responds to changing macroeconomic conditions, including to shifts in credit conditions, resulting in time-varying selling delays.

years. Aron and Muellbauer (2013) showed that, in an inflation forecasting model for the US, there was a robust and large effect on the consumer expenditure deflator from lagged house prices as well as from unit labour costs and international prices.

For Euro area economies, the HICP has long excluded OER though, after the strategic policy review's discussion of price measurement, ECB (2021d), the Governing Council recognised that: "the inclusion of the costs related to owner-occupied housing in the HICP would better represent the inflation relevant for households and that the inclusion of owner-occupied housing in the HICP is a multi-year project". The favoured measure for owner-occupied housing costs is the 'net acquisitions' basis, see Astin (2020) and ECB (2021d), p.48-65, and Whelan (2021) for a contrary view. Be that as it may, there has been little research in Euro area economies on possible transmission of housing cost to the HICP or to the consumer expenditure deflator, possibly in part via wage growth. However, as ECB (2021d) p.50-51, points out, there is strong evidence that house price rises feed into perceived inflation.

Bolhuis et al. use lags in rent and house price inflation to forecast future rents, while Dolmas and Zhou (2021) use lags in house price inflation to forecast a coming rise in residential rents. Since the HICP does include rents paid by those in the rental sector, it is of some interest to examine the feed-through from house prices to rents in Euro area countries since that will illuminate part of the transmission from monetary policy to inflation – which is neglected by those who focus on just the output gap or the unemployment rate.

Taking the case of France, a model was developed from an equilibrium correction specification with long lags explaining changes in the log rent index in terms of lags in the consumer expenditure deflator, house prices and short and long interest rates, see Table A2.1. The latter enter as the spread defined as the 10-year bond yield minus the 3-month T-bill yield.

The model suggests that (in logs) rents adjust to the consumer expenditure deflator and to the aggregate house price index with an adjustment speed of 0.08 per quarter, implying that around 27 percent of the effect is felt after one year. The slow speed of adjustment is likely to be due to two reasons. The first is that rent adjustment for existing contracts is typically lower than for new contracts[81], and the rent index is dominated by the former. The second is that, like many other European countries, France's rent index includes controlled rents in the social sector, which are more detached from market rents. The long-run coefficient on the house price index is about 0.14 and 0.86 on the consumer expenditure deflator. The long-short spread in interest rates is very significant with a positive coefficient (coming in as a moving average) and could be interpreted as inflation expectations. There is some persistence in short run dynamics with real rent rises in the previous 3 quarters having positive coefficients. And rises in real house prices in the previous year also have a positive effect, a kind of delayed transmission or a proxy for factors driving up the general demand for housing, rented or owner-occupied. There is a small positive effect from the inflation shock of 4 quarters ago. Three impulse dummies make up the rest of the equation. Estimating to

[81] Like Germany, France has a system of flexible rent controls in which rent rises on existing leases should not exceed inflation, see https://www.insee.fr/en/information/2489482.

2021:4 we need a pandemic dummy with a negative coefficient as rents rose less than predicted by the model, in the face of faster house price inflation and, in the last year, higher general inflation. The re-introduction of some rent controls in the pandemic probably helps account for this.

With such a slow ECM adjustment coefficient, it is clear that there should be forecasting power for the rent index four quarters ahead from the key drivers, and so it proves. The relative weights of 0.14 and 0.86 on house prices and the consumer expenditure inflator are confirmed in the results in Table A2.2, as is the role of the long-short interest rate spread. Short-term persistence from recent rises in real rents and in real house prices can still be detected 4 quarters ahead.

Table A2.1

A model for rent determination (example using French data)

Dependent variable: Δ (log of nominal rents) t	1992:1 to 2019:4	
	Eq. 1	
	Coefficient	t-Statistic
constant	-0.0459	-9.7
log (Nominal house price to rent ratio) t-1	0.00993	10.1
log (Consumer expenditure deflator to rent ratio) t-1	0.0660	14.9
(Spread between long and short interest rates, 4q-ma) t-2	0.0610	4.7
Δ log (Consumer expenditure deflator to rent ratio) t-1	-0.168	-5.5
Δ log (Consumer expenditure deflator to rent ratio) t-2	-0.124	-3.6
Δ log (Consumer expenditure deflator to rent ratio) t-2	-0.0734	-2.5
Δ Δ log (Consumer expenditure deflator) t-4	0.0774	2.3
Δ4 log (Real house prices) t-5	0.00971	3.7
Dummy 2001Q1 t	-0.0102	-8.9
Dummy 2001Q1 t-4	-0.00729	-6.4
Dummy 2018Q3 t	-0.00806	-7.2
Equation standard error		1.09E-03
Adjusted R-squared		0.906
Durbin-Watson		2.01
Breusch/Godfrey LM: AR/MA4		p = [.053]
Chow test		p = [.946]
Breusch-Pagan het. Test		p = [.083]

Notes: Estimation performed in TSP 5.0 of Hall and Cummins.

Table A2.2

A forecasting model for rents (example using French data)

Dependent variable: Δ4 (log of nominal rents) t+3	1992:1 to 2019:1	
	Eq. 1	
	Coefficient	t-Statistic
constant	-0.262	-19.8
log (Nominal house price to rent ratio) t-1	0.0560	20.5
log (Consumer expenditure deflator to rent ratio) t-1	0.333	25.4
(Spread between long and short interest rates, 4q-ma) t-1	0.354	8.0
Δ log (Consumer expenditure deflator to rent ratio) t-1	-0.602	-6.0
Δ log (Consumer expenditure deflator to rent ratio) t-2	-0.268	-2.7
Δ4 log (Real house prices) t-1	0.0170	2.3
Dummy 2018Q3 t+3	-0.0122	-3.3
Equation standard error		3.63E-03
Adjusted R-squared		0.914
Durbin-Watson		0.745
Breusch/Godfrey LM: AR/MA4		p = [.000]
Chow test		p = [.290]
Breusch-Pagan het. Test		p = [.596]

Notes: Estimation performed in TSP 5.0 of Hall and Cummins.

Clearly, lower interest rates, as well as easier non-price credit conditions, which feed into house prices, eventually drive rents up too, but transmission takes a long time. If the interest rate spread is a proxy for inflation expectations, the interpretation of this potential element of monetary transmission is tricky. In recent months, the delay in raising short rates when long rates signal that they will rise soon, can be interpreted as increasing rents in the near future. In simple terms, this suggests that the delay in raising policy rates will make inflation higher than it would be otherwise, an intuitive result. It may suggest that hints from policy makers that rates will rise in the future are not effective on this particular piece of the inflation process. When short rates rise to close or reverse the long-short gap, that is when rent inflation, other things equal, can be expected to fall.

As far as understanding the potential implications of which method to adopt to include owner-occupied housing costs in the harmonised CPI, the findings for France provide some insights into the possible scale and speed with which house prices would feed into such a HICP based on the rental equivalence approach. However, as housing rent indices typically include subsidised social housing, which are likely to respond more slowly to market conditions, the above empirical results for France surely understate the ECM adjustment coefficient to free market housing rents. The free rental market is more relevant as the alternative to owner-occupation. For some countries, the limited size of free market rental possibilities is a major objection to the use of the rental equivalent approach, ECB (2021d), p. 52. However, for forecasting the rent component of the current measure of the HICP, the above approach remains useful.

By itself, it almost certainly results in underestimating the importance of real estate in the inflation process. Commercial rents are a cost ingredient for companies, making the nature of policy transmission to commercial rents relevant for understanding

inflation dynamics. It is also possible that quite apart from the role of housing rents in the CPI, wage bargainers may take some account of house prices. Tight housing markets in particular places can make it harder to find employees in those locations leading to upward wage pressure. High house prices in particular regions can discourage migration to those regions and increase regional labour market mismatch, see Muellbauer and Murphy (1991). The potential role of housing in wage determination is an under-researched area.

A3 Data appendix.

Table A3.1

Data definitions and summary statistics

Variable	Definition	Mean	Std. deviation	Minimum	Maximum
Mortgage rate equation					
DEPENDENT VARIABLE					
Δ (Nominal mortgage rate)	Quarterly change in the nominal mortgage rate.	-0.0814	0.231	-1.08	0.450
INDEPENDENT VARIABLES					
Short interest rate spread	The 3-month Treasury Bill rate minus the mortgage rate.	-2.88	1.08	-4.99	-0.00547
Long interest rate spread	The 10-year sovereign treasury bond minus the mortgage rate.	-1.78	0.822	-4.22	-0.420
Log NPL ratio to loan book	Log ratio of total non-performing loans over the total loan book (including the public sector).	-3.71	0.349	-4.18	-3.01
Euro risk spread	The average of the Italian long interest rate and the Spanish long interest rate, minus the German long interest rate.	0.685	1.06	-0.0113	4.60
Smoothed transition dummy (1992-93)	Zero until 1991Q4; a smooth rise to 1 in 1993Q4; then 1.	0.919	0.256	0	1
Δ (Long interest rate spread)	Quarterly change in the above spread.	-0.0903	0.332	-0.833	1.06
Dummy 1993Q1	Impulse dummy.	-	-	-	-
Δ8 log (Real house prices)	Two-year change in the log of the real house price index (i.e., divided by the consumer expenditure deflator).	0.0677	0.107	-0.0816	0.290
Δ8 log (Consumer expenditure deflator)	Two-year change in the log of the consumer expenditure deflator.	0.0298	0.0157	-0.00379	0.0666
Δ4 log (Real disposable income pc)	Annual change in the log of per capita real household disposable income.	0.00986	0.0126	-0.01819	0.0383
Residential investment equation					
DEPENDENT VARIABLE					
Δ log (residential investment per capita)	Quarterly change in the log of residential investment (in constant prices) divided by population.	0.000517	0.0112	-0.0402	0.0237
INDEPENDENT VARIABLES					
log (Residential investment per capita)	Log of residential investment (in constant prices) divided by population.	-7.58	0.0767	-7.72	-7.40
log (Nominal house prices) t - log (Residential investment deflator)	Relative price term: log of nominal house prices minus the log of the residential investment deflator four	4.47	0.209	4.17	4.83

Variable	Definition	Mean	Std. deviation	Minimum	Maximum
t-4	quarters earlier.				
Real short run interest rate	The 3-month Treasury Bill rate divided by the consumer expenditure deflator.	0.0247	0.0269	-0.0236	0.0997
log (NPL ratio to loan book)	The log of the ratio of total non-performing loans over the total loan book (including the public sector).	-3.91	0.443	-4.77	-3.01
Δ4 log (Consumer expenditure deflator)	Annual change in the log of the consumer expenditure deflator.	0.0215	0.0236	-0.0216	0.125
Δ4 log (Real disposable income pc)	Annual change in the log of per capita real household disposable income.	0.0118	0.0143	-0.0214	0.0444
Δ4 log (Population aged 25-64)	Annual change in the log of the population aged 25-64.	0.00598	0.00454	-0.00209	0.0157
Δ4 Δ4 log (Population aged 25-64)	Annual acceleration in the log of the population aged 25-64.	-0.00043	0.000937	-0.00466	0.00159
Δ Dummy 1982Q4	Quarterly change in impulse dummy.	-	-	-	-
Dummy 2018Q3(4q-ma)	Impulse dummy (moving average).	-	-	-	-
Δ4 Δ4 (Nominal short run interest rate)	Annual acceleration in the 3-month Treasury Bill rate.	-0.00108	0.0219	-0.0881	0.0584
Non-performing loan equation/s					
DEPENDENT VARIABLE/S					
NPL ratio to loan book	Ratio of total non-performing loans over the total loan book (including the public sector).	0.0248	0.0101	0.0128	0.0495
INDEPENDENT VARIABLES					
Short interest rate, 4q-ma	The 3-month Treasury Bill rate (expressed as a 4q-ma).	4.20	3.17	-0.264	10.7
Unemployment rate, 4q-ma	The unemployment rate based on the Labour Force survey (expressed as a 4q-ma).	9.15	0.969	7.35	10.68
Δ4 log (Real disposable income pc, 4q-ma)	Annual change in the log of per capita real household disposable income.	0.0105	0.0108	-0.0129	0.0282
log (Nominal house price to income ratio)	The log of the nominal house price index relative to per capita household disposable income.	3.02	0.197	2.74	3.32
Δ4 (Mortgage Credit Conditions Index, 4y-ma)	Change in the below variable (expressed as a 4y-ma).	0.008904	0.0611	-0.151	0.165
Mortgage Credit Conditions Index, 4y-ma	The mortgage credit conditions index from Chauvin and Muellbauer (2018) (expressed as a 4y-ma).	0.296	0.162	-0.00679	0.511
Unsecured Credit Conditions Index, 4y-ma	The unsecured credit conditions index from Chauvin and Muellbauer (2018) (expressed as a 4y-ma).	0.866	0.179	0.228	0.975
Δ4 (Euro risk spread, 4q-ma)	Annual change in the Euro risk spread as defined above (expressed as a 4q-ma).	0.0359	0.528	-1.54	2.06
Δ4 log (Consumer expenditure deflator, 4q-ma)	Annual change in the log of the consumer expenditure deflator (expressed as a 4q-ma).	0.0165	0.00929	-0.000634	0.0350
Rent equation/s					
DEPENDENT VARIABLE/S					
Δ (log of nominal rents)	Quarterly change in the log of the nominal rent index.	0.000517	0.0112	-0.0402	0.0237
Δ4 (log of nominal rents)	Annual change in the log of the	-7.58	0.0767	-7.72	-7.40

Variable	Definition	Mean	Std. deviation	Minimum	Maximum
	nominal rent index.				
INDEPENDENT VARIABLES					
log (Nominal house price to rent ratio)	The log of the nominal house price index relative to the rent index.	4.47	0.209	4.17	4.83
log (Consumer expenditure deflator to rent ratio)	The log of consumer expenditure deflator relative to the rent index.	0.0247	0.0269	-0.0236	0.0997
(Spread between long and short interest rates, 4q-ma)	The spread between the 10-year Treasury Bond rate minus the 3-month Treasury Bill rate (expressed as a 4q-ma).	-3.91	0.443	-4.77	-3.01
Δ log (Consumer expenditure deflator to rent ratio)	Quarterly change in the log of the consumer expenditure deflator relative to the rent index.	0.0215	0.0236	-0.0216	0.125
Δ Δ log (Consumer expenditure deflator)	Quarterly acceleration in the log of the consumer expenditure deflator.	0.0118	0.0143	-0.0214	0.0444
Δ4 log (Real house prices)	Annual change in the log of nominal house prices relative to the consumer expenditure deflator.	0.00598	0.00454	-0.00209	0.0157
Dummy 2001Q1	Impulse dummy.	-	-	-	-
Dummy 2018Q3	Impulse dummy.	-	-	-	-

Sources: All underlying data stem from the Banque de France and the OECD.

Discussion of Real Estate Booms and Busts: Implications for Monetary and Macroprudential Policy in Europe by John Muellbauer

By Giovanni Dell'Ariccia[1]

1 Introduction

I enjoyed reading this paper by John Muellbauer. It represents a comprehensive compendium of what we know and what we do not know about the relationship between monetary policy and real-estate market dynamics. I recommend it to anybody interested in these issues, whether a student, an academic, or a policy maker.

The paper emphasizes the key role real estate can play in the transmission of monetary policy and its potential to be the origin or a fundamental multiplier of financial crises. Muellbauer identifies six main elements that affect the shape and strength of monetary policy 's transmission to and through the real-estate sector. And it uses them to emphasize what I see as one of the main messages in the paper: the complexity of the links involved and how they critically depend on country-specific institutions, norms, and customs.

The first element is the pass-through of policy rate changes to mortgage rates. Competitive conditions in the banking industry and the model of bank funding, both local factors, will contribute to shape this element. The second is how sensitive to changes in lending rates house prices are. The factors behind this relationship are also likely local in nature, such as the duration of mortgage contracts, fixed vs. variable rates, the percentage of households holding mortgages and loan size relative to home values. The third and fourth elements relate to the transmission from house prices and interest rates to residential investment, and transmission from house prices and interest rates to consumer spending. The fifth pertains to how monetary policy contributes to the determination of mortgage debt, important both for its consumption implications and for financial stability. The sixth element focuses on non-price credit conditions which are a determinant (but over time also a product) of non-performing loans and the credit cycle.

Against this framework, the paper recognizes the progress the economic profession and in particular central banks have made in modelling the real-estate sector and its role in macroeconomic fluctuations since the GFC. But it also presents a frank discussion of the shortcomings stemming from the still limited fashion in which the

[1] Giovanni Dell'Ariccia is Deputy Director of the IMF Research Department. The views expressed in this discussion are those of the author and do not necessarily represent the views of the IMF, its Executive Board, or IMF Management.

real-estate sector is incorporated in most of the macroeconomic models employed to support monetary policy decisions. In particular, the paper correctly points to the need to improve the way we model the relationship between interest rates and lending standards and how they interact in determining economic outcomes. Lack of attention to specific institutional elements is another highlighted shortcoming: for instance: the role of nominal interest rates and their impact on lending through debt-service limits.

Finally, the paper contributes to our understanding of the complexity of monetary policy transmission through real estate by presenting innovative quantitative assessments of some the channels for the case of France.

There is much I like and agree with in Muellbauer's paper. As a consequence, I structured this discussion more as a complement to than as a critique of the paper. In what follows, I focus on three of the elements that the paper identifies as critical in shaping the effect of monetary policy on and through the real-estate sector: the level and structure of mortgage debt, the role of lending standards (non-price credit conditions), and the role of residential investment. The aim is to highlight, through a few notable examples, the importance of some of the elements identified in Muellbauer's paper, while at the same time discussing briefly how this evidence informs our understanding of the current conjuncture.

I chose to focus on these three factors are as these are the elements of transmission that are more closely interlinked with financial fragility and the potential for disruptive market adjustment. As such, they sit at the core of the debate on whether monetary policy should play a prudential role in the context of real-estate and mortgage-booms and on what other policy levers are available to deal with these risks.

2 Real-Estate and Credit Boom-Bust Cycles

Before the Global Financial Crisis, monetary policy in most advanced economies adopted a "benign neglect" approach to real-estate dynamics (Sweden and Australia were notable exceptions). Housing prices mattered to the extent that they contributed to inflation dynamics. But central bank models almost invariably ignored the complex role of the real-estate sector as a channel of monetary policy transmission and more critically as a potential source of financial vulnerabilities. As Muellbauer's paper documents, this changed (at least in part) after the GFC.

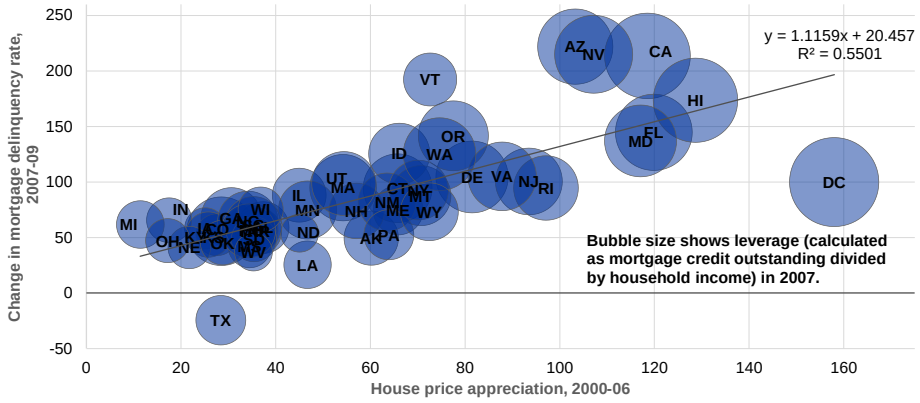
Housing represents the lion share of wealth for most households. And in most countries credit institutions are willing to lend to households against the purchase of a home at leverage ratios multiples of what they allow for other forms of investment. Because of this, house-price fluctuations can have a major impact on household wealth and consumption and can be a source of financial distress. Indeed, there is by now abundant evidence that asset-price cycles when supported through leverage can be harbinger of financial crises. Jorda et al. (2016) show that, as mortgage markets grew relative to the size of economies, real estate cycles have been playing an increasingly more important role in determining household financial conditions and financial stability more generally. Note that the crucial element is the increase in

lending that accompanies the upswing in prices rather than the price fluctuations themselves.

Claessens et al. (2010) and Crowe et al. (2013) show how the GFC provides several examples of these risks. In the United States, there was a clear correlation across states between the increase in delinquency rates during the crisis and house-price appreciation and in mortgage lending during the boom years (see Chart 1).

Chart 1

House-price and credit booms and delinquencies

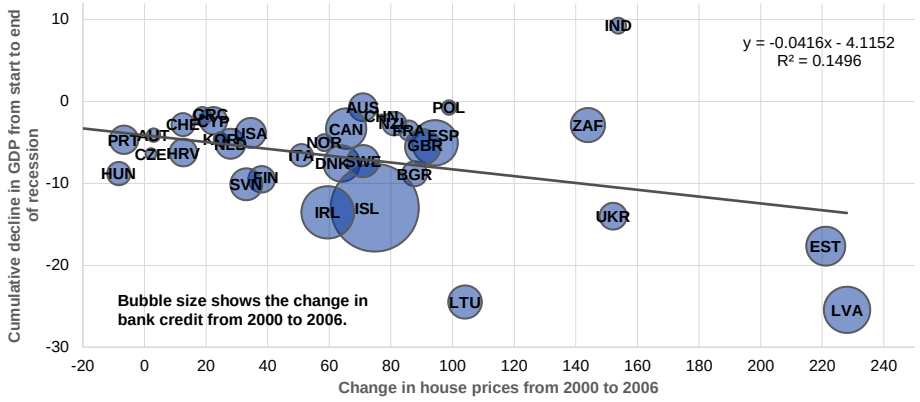


Source: Crowe et al. (2013).

A similar (albeit weaker) pattern holds across countries. There is a cross-country positive correlation between the contraction in GDP post-GFC and house-price and bank credit growth pre-crisis (Chart 2).

Chart 2

House-price and credit booms and the Great Recession



Source: Claessens et al. 2010.

Mian et al. (2017) further document the relationship between household debt (typically associated with real-estate purchases) and macroeconomic performance and link it to the monetary policy stance. In their sample, lower mortgage spreads are associated with an increase in household debt and a subsequent decline in GDP growth (this is also consistent with evidence in Jorda et al. (2016)).

An immediate corollary of this evidence is one of the main messages of Muellbauer's paper: the strength and shape of the monetary policy transmission to (and through) real-estate dynamics depends on the characteristics of mortgage markets. These go beyond the sheer size of the market relative to the economy and include details such as the percentage of mortgages with fixed versus flexible rates, prepayment penalties, the availability of home equity withdrawals, portability of contracts etc. In fairness to the economic profession, some of the difficulties in developing macro models incorporating the real-estate sector in a realistic and comprehensive fashion probably stem from the institution-specific nature of these relationships.

Turning to the current conjuncture, as the paper documents, mortgage credit increased sharply in several advanced economies over the past few years and there is at least cursory evidence that this was at least partly correlated with low mortgage rates. However, somewhat reassuringly, the cross-country correlation between house-price increases and changes in mortgage debt has decreased relative to previous episodes.

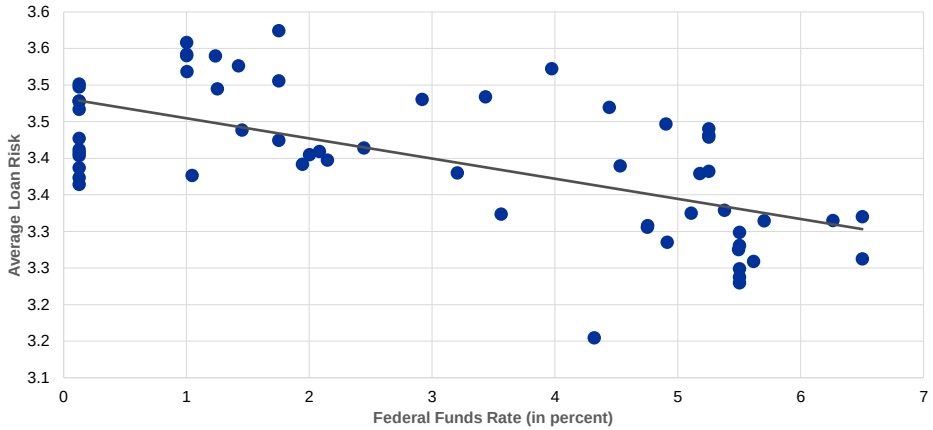
3 Cyclical Lending Standards

Credit and house-price booms are also often associated with a deterioration in lending standards (non-price credit conditions in the words of the paper). These include the degree of borrower screening, LTV and DTI ratios, etc. These lower standards are part of the mechanism that amplifies boom-bust cycles. They increase the probability of financial distress and, even in the absence of an open crisis, they lead to higher NPLs with negative consequences on future bank lending.

To an extent, lower standards are a desirable side effect of monetary expansion. Lower rates have less productive projects become viable and reduce the debt service burden allowing for poorer households to qualify for credit. This extensive margin is part of the normal monetary policy transmission mechanism. Indeed, there is evidence of this effect both from Europe and the US. Using regulatory data from Spain, Jimenez et al. (2014) find that lower policy rates induce banks to lend to riskier borrower, which later results in an increase in delinquent loans. Dell'Ariccia et al. (2016) find similar results using US data. Chart 3 plots a US banks' internal assessment of the riskiness of new loans against the real Federal Funds rate and show a clear negative correlation between the policy rate and risk taking. (See Angeloni et al., 2015 and Gambacorta et al., 2014, for similar evidence).

Chart 3

Policy rate and bank risk taking

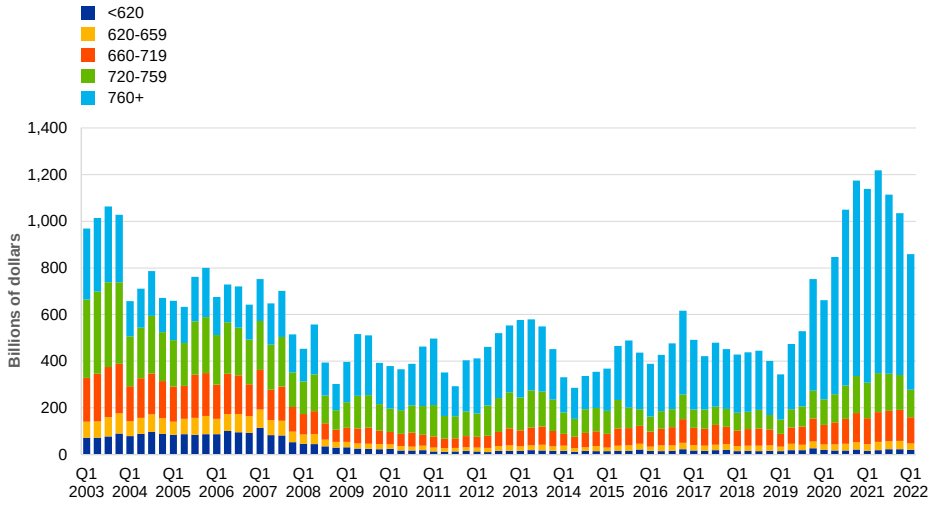


Source: Dell'Ariccia, Laeven, and Suarez (2016).

However, during asset-price booms, competition may lead lenders to "ride the bubble" because of reduced adverse selection and/or the perception that the "ever-increasing" value of the underlying asset (housing) will make borrower quality less relevant (See for instance Dell'Ariccia et al., 2012, and Feng, 2018). Against this evidence, it is again somewhat reassuring that, at least for the US, the recent expansion in mortgage lending did not rely on the extension of loans to risky borrowers that had characterized the pre-GFC boom. At the height of the subprime mortgage boom, one in four new mortgages were extended to borrowers with credit scores below 659. By contrast, in 2020, the share of these risky borrowers was just about 5 percent while roughly 70 percent had a credit score above 760. Importantly, the share of risky borrowers has been low since the GFC (See Chart 4).

Chart 4

Mortgage originations by credit score



Source: Federal Reserve Bank of New York.

4 The Role of the Construction Sector

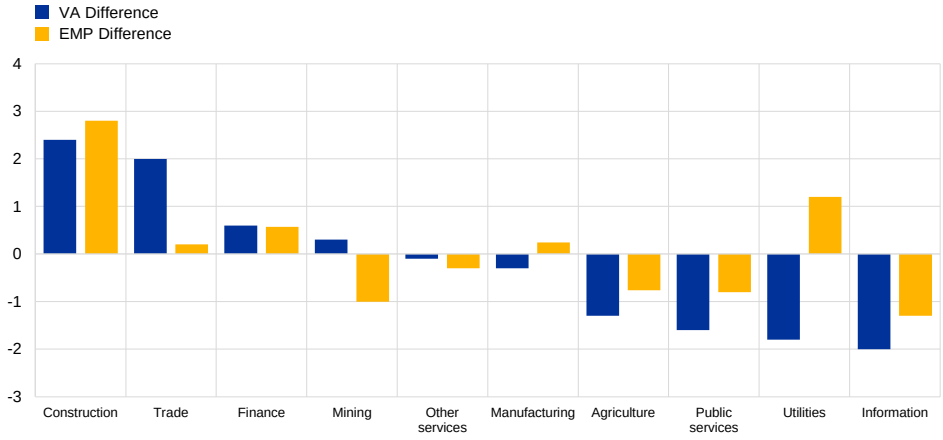
Finally, I want to spend a few words on the construction sector, an often-overlooked element of macroeconomic cycles that Muellbauer's paper rightly identifies as an important channel of monetary policy transmission and an amplifier of boom-bust cycles. Recent evidence suggests that the construction sector is particularly susceptible to boom-bust cycles and that monitoring its activity can be helpful in shaping the response to credit booms (Dell'Ariccia et al., 2020).

Since the pioneering work of Gourinchas et al. (2001) and Borio and Lowe (2002), the literature has recognized that while several booms end up with crises, not all do. Hence, beyond the well documented practical difficulties in stopping a boom, policy-makers have to deal with a trade-off between the cost of curbing economic activity and the risk of increasing financial fragility. Indicators that improve our ability to distinguish between benign and disruptive booms can improve that trade-off.

House-price and credit booms are associated with faster GDP and employment growth. But this aggregate picture hides significant heterogeneity across industries. Booms tend to favour sectors that are less tradable, more labour-intensive, and more dependent on external finance. In that context, construction sticks out (Chart 5). First, it displays the strongest acceleration (deceleration) in both value-added and employment growth during booms (busts). Second, construction is the only sector that consistently overperforms during booms that end up with financial crises relative those that do not. As such, it could be the "canary in the coal mine".

Chart 5

Difference in VA and Employment between "Good" and "Bad" Credit booms



Source: Dell'Ariccia et al. (2020).

Indeed, in Dell'Ariccia et al. (2020), we find that, conditionally on the presence of a credit boom, construction activity helps predict both the likelihood that said boom ends up with a financial crisis, and the magnitude of the associated costs. This estimated effect survives when controlling for other warning signals, such as size and duration of the boom and the rise of household debt or an increase in house prices. If confirmed, this evidence would suggest that monitoring the construction sector may provide a useful warning indicator on the nature of a credit boom.

5 Policy Implications

The paper takes a very careful (almost too cautious, if I am allowed a criticism) stand when it comes to policy recommendations. It discusses the debate on leaning against the wind and seems to leave the door open to a role for monetary policy in curbing credit and house-price booms. But it rightly (and consistently with the main message in the paper) argues that since house dynamics are inherently local, monetary policy is unlikely the best instrument; especially in the context of a currency union or, I would argue, a similarly heterogeneous jurisdiction such as the United States.

The burden then falls on macroprudential policies. There is growing evidence that macroprudential measures can help curbing the excesses stemming from credit booms. However, there is also evidence suggesting that there are limits to their effectiveness (Arajuo et al., 2020). In addition to the thorny governance issues and political economy concerns stemming from their obvious distributional effects, one has to worry about circumvention, including through cross border flows. As for their close relative, CFMs, the effectiveness of macroprudential policies is likely to erode over time as market participants device instruments to get around them. Then, in the case of long-lasting booms, regulators may find themselves in a game of cat and mouse (or whack the mole) with financial markets.

I conclude by again recommending this comprehensive and very informative paper to anybody interested in the relationship between real-estate markets, economic fluctuations, and monetary policy.

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Global Supply Chain Pressures, International Trade, and Inflation[1]

By Julian di Giovanni, Şebnem Kalemli-Özcan, Alvaro Silva, Muhammed A. Yıldırım[2]

Abstract

We study the impact of the Covid-19 pandemic on Euro Area inflation and how it compares to the experiences of other countries, such as the United States, over the two-year period 2020-21. Our model-based calibration exercises deliver four key results: 1) Compositional effects -- the switch from services to goods consumption -- are amplified through global input-output linkages, affecting both trade and inflation. 2) Inflation can be higher under sector-specific labor shortages relative to a scenario with no such supply shocks. 3) Foreign shocks and global supply chain bottlenecks played an outsized role relative to domestic aggregate demand shocks in explaining Euro Area inflation over 2020-21. 4) International trade did not respond to changes in GDP as strongly as it did during the 2008-09 crisis despite strong demand for goods. These lower trade elasticities in part reflect supply chain bottlenecks. These four results imply that policies aimed at stimulating aggregate demand would not have produced as high an inflation as the one observed in the data without the negative sectoral supply shocks.

1 Introduction

Covid-19 has been a historically unique shock to the global economy. While all countries have been impacted by the virus, the effects have not been synchronized across borders like the 2008-09 global financial crisis. The Covid-19 shock impacted economies' sectors heterogeneously and countries were affected repeatedly at different points in time. These uneven impacts were due to several factors. First, responses to the pandemic by governments differed, both in terms of health policies and the degree of monetary and fiscal stimuli. Second, Covid-19 encompassed a combination of sectoral demand and supply shocks, which propagated within and across countries via input-output networks, creating demand-supply imbalances on a global scale, resulting in the so-called supply chain bottleneck problem.[3]

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[2] The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Banks of New York or any other person affiliated with the Federal Reserve System.

[3] The ECB Blog by Philip Lane, February 2022. Accessed here.

This pandemic cycle has captured the world economy since early 2020. In the initial "lockdown phase" of the pandemic, there was a large decline in global economic activity with trade and GDP both collapsing. The roll-out of vaccines combined with unprecedented monetary and fiscal stimulus since late 2020/early 2021 has led to a fast but asymmetric recovery across countries and sectors.[4] The service sectors that rely on face-to-face interactions were slow to recover given the repeated nature of the health shock from different variants, on-and-off lockdowns and labor shortages, whereas manufacturing sectors, especially durables, rebounded quickly as consumption was tilted to these sectors, driving the quick recovery in global trade -- for example, global demand skewed towards stationary-bicycles when gyms remained closed.

The goal of this paper is to quantify how the distinct aspects of the Covid-19 shock have impacted both the flow of goods across countries as well as their prices. To accomplish this goal, we provide three distinct model-based quantitative exercises. First, we build on the theoretical work of Baqaee and Farhi (2022) and Guerrieri, Lorenzoni, Straub, and Werning (2022) to quantify the effects of the pandemic on inflation over the period spanning both the collapse and recovery phases of the economy. This framework not only allows us to examine the cumulative impact of the pandemic from 2019Q4 to 2021Q4 on inflation, but also decomposes the contribution of demand- and supply-side factors underlying the observed inflation. Second, following Çakmaklı, Demiralp, Kalemli-Ozcan, Yesiltas, and Yildirim (2022), we extend the Baqaee and Farhi (2022) approach to a multi-country framework to capture the importance of international spillovers in generating inflation. Finally, we examine how observed cross-country and cross-sectoral consumption changes spilled-over across countries via the global production network, thereby rationalizing observed trade flows. To do so, we follow the methodology of Bems, Johnson, and Yi (2010) and examine how the Covid-19 crisis differed, in terms of the trade response, from the 2008-09 global financial crisis.

The evolution of the pandemic and inflation. The early phase of the pandemic witnessed a negative supply shock, creating the initial supply chain disruption, and combined with uncertainty, created insufficient demand, ending with a large collapse in GDP. During the recovery phase, pent-up demand created further pressure on supply chains, leading to inflation. The initial phase of the pandemic can be thought of as a series of sectoral negative supply and demand shocks in lockdown/contact intensive sectors and a positive sectoral demand shock in others (e.g., online deliveries versus restaurants). The recovery phase involved a positive aggregate demand shock, in part due to stimulative government policies. Note that during this recovery phase, the negative sectoral supply shocks were still in place as the

[4] See Gourinchas, Kalemli-Özcan, Penciakova, and Sander (2021) on uneven recovery across emerging markets and advanced economies due to co-existence of demand and supply constrained sectors and inequality in fiscal space across countries. See Çakmaklı, Demiralp, Kalemli-Ozcan, Yesiltas, and Yildirim (2022), who developed an open economy multi-sector network model that predicts country-sector asymmetry in recovery under unequal global vaccinations as sectoral supply shocks in unvaccinated countries travel through global production network, affecting vaccinated countries.

pandemic were in place globally.[5] The compositional shifts in demand between services and goods sectors, combined with supply-constrained sectors are important to consider in our analysis.

In our framework, like Baqaee and Farhi (2022), domestic inflation is driven by aggregate demand shocks as well as sectoral demand and labor supply shocks. We therefore argue that while some economists warned of looming inflation, few anticipated the prolonged and drastic shift in spending from services to goods and the effects of such a shift under an economy where labor shortages in certain sectors led economy-wide supply constraints that are persistent.[6] Indeed, in the US, as early as March 2021, the FOMC expected CPI inflation to be 2.4 percent in 2021. While in Europe, as of the October 2021 meeting of the ECB, inflation was not even a concern.[7]

Our analysis lays bare how the inherent pandemic-driven labor dislocations were bound to show up as inflation when combined with aggregate demand stimulus. While the increase in consumer spending barely brought economies back to pre-pandemic levels, this rebound in economic activity coincided with supply chains problems that were slow to dissipate. This mismatch in demand and supply led to inflation being less transitory, broad based and higher than 2021Q1 expectations. For example, Chart 1 shows that even though employment and real GDP surged during recovery, employment (blue line) was still substantially below its pre-pandemic level in 2020Q4 when inflation (yellow line) started increasing in the US and Europe, indicating the potential importance of supply constraints and limits to the production capacity of the economy in driving inflation.[8]

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5 We do not formally model the differential impact of health-related labor shortages, the so-called “Great Resignation,” and a slow return of labor given search-match frictions, but instead treat them all as sectoral labor supply shortages/constraints. Çakmaklı, Demiralp, Kalemli-Ozcan, Yesiltas, and Yildirim (2022) open economy global model justifies never disappearing negative sectoral supply shocks under the pandemic.

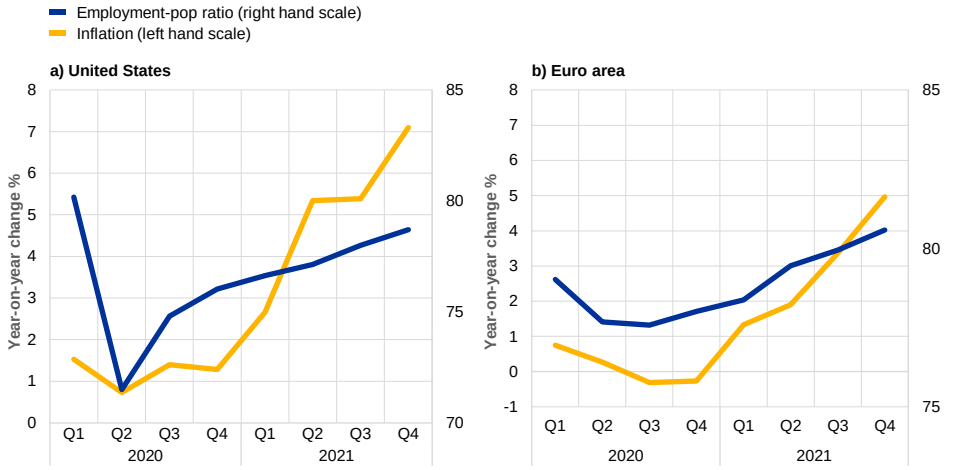
6 See Lawrence Summers arguments outlined here.

7 Link here and here.

8 See Krugman’s New York Times article for a similar argument here. Relatedly, Gourinchas, Kalemli-Ozcan, Penciakova, Sander (2021) estimate a low fiscal (output) multiplier, but a higher `employment’ multiplier of fiscal transfers under supply constraints.

Chart 1

Inflation and Unemployment in the United States and Euro Area

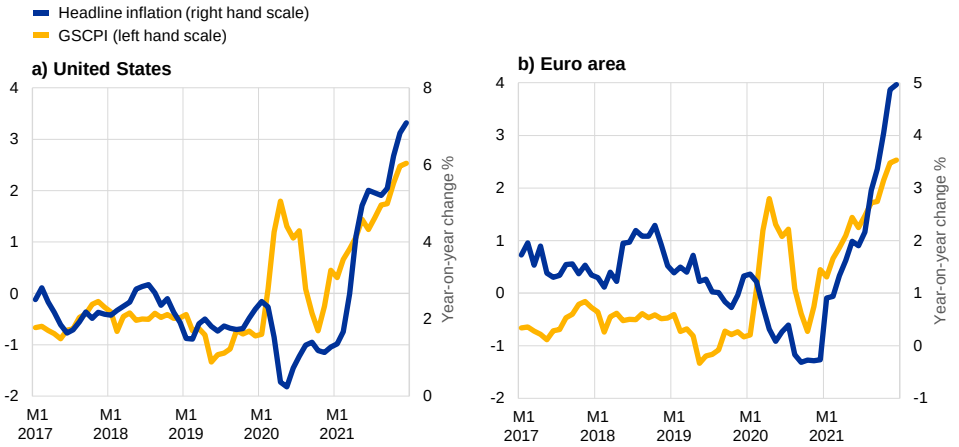


Notes: Both panels plot headline inflation (year-on-year change) on the left axis and employment to population rate (25-54 years, total) on the right axis. All data comes from the Federal Reserve Economic Data (FRED) maintained by the Federal Reserve of St. Louis.

The evolution of the pandemic and international trade. As supply chains are global, the compositional change in consumption is important in understanding the developments of not only inflation but also of international trade. The co-existence of a rapid recovery in trade together with slow-to-dissipate supply chain disruptions and resulting inflation in many countries can in part be explained by such compositional effects. The tilting of consumption from services to goods exasperated the impact of supply-driven constraints on global supply chains, so while trade flows appeared to have recovered quickly, the excessive demand for manufactured goods eventually fed through to prices.

Chart 2

Supply Chain Pressure Index and Headline Inflation



Notes: This chart plots the FRBNY global supply chain index (GSCPI) on the right-hand axis of panels (a) and (b), along with US inflation in panel (a) and Euro Area inflation in panel (b). GSCPI comes from the Federal Reserve Bank of New York and inflation numbers comes from the Federal Reserve Economic Data (FRED) maintained by the Federal Reserve of St. Louis.

Chart 2 shows that the Federal Reserve Bank of New York's global supply chain pressure index (Benigno, di Giovanni, Groen, and Noble, 2022), which measures a common factor of several cross-country and global indicators of supply chain pressures (e.g., delays in shipments and delivery times and shipping costs after purging these from demand measured by new orders), moves together with inflation both in the US and in the Euro Area, where both started their ascent in early 2021.[9]

The time series depicted in Chart 2 reveals an issue with focusing solely on trade data as a metric to gauge global supply chain problems as both the supply pressure index and inflation rose with trade flows in the recent period. Trade is an equilibrium outcome, whereas supply chain disruptions are about mismatch between demand and supply indicating disequilibrium. However, examining trade flows can still be informative on how shocks, such as sectoral demand changes, are transmitted across borders via global supply chains. One key channel through which these shocks are transmitted arise from "demand spillovers," whereby changes in domestic demand for final goods lead to changes in exports and imports of both foreign intermediate and final goods. In fact, the Great Trade Collapse (GTC) of 2008-09 led economists to study the role of such spillovers via intermediate goods trade and cross-border supply chains to help explain why during the GTC trade fell so much more than GDP worldwide.

Model-based exercises. How do these global patterns relate to inflation in each country? In standard models, an increase in demand for certain sectors' output or a decline in the production capacity in other sectors will be smoothed out through relative price adjustments. Sectors with higher demand will attract factors from other sectors via higher prices. Sectors with limited production capacity due to negative supply shocks will also face higher wages when attracting workers. Relative price adjustments ensure the necessary factor reallocation to solve these issues, rendering a response from monetary policy to cool down these sectoral price pressures unnecessary. In a world where such factor mobility is limited, factors are complements in production, and where some of those factors are imported, the drivers of a country's inflation can be imported and broad-based due to both domestic and global sector specific factor shortages.[10]

Limited factor mobility and complementarities in production arose in the short run due to the pandemic. Since everyone was exposed to the same health-related shock at a global level, it was difficult for firms to reallocate labor between sectors and/or switch and substitute suppliers in the short run -- either domestically or internationally. The importance of cross-border production linkages amplified the impact of the inability for firms to substitute between different factors on a global scale,[11] leading to supply chain bottlenecks and a rise in prices that ultimately became persistent. We want to be careful with the use of the word "persistent." Our calibration exercise is based on a

---

9 Note that the increase of the index in early 2020 is due to the initial Chinese lockdown. The fall is in the second half of 2020 is then in part explained by re-opening of China and Europe, particularly in Europe during the summer 2020.

10 See, for example, here.

11 This narrative of complementarities in trade and production is consistent with the evidence, see Atalay (2017), Boehm, Flaaen, and Pandalai-Nayar (2019) and Boehm, Levchenko, and Pandalai-Nayar (2020) who all estimate such degree of high complementarity with elasticity less than one in the short run.

cumulative two-year window, end-of-period 2019Q4 to 2021Q4, where we do not model dynamics. We are thus limited from doing out-of-sample forecasts. Rather, our exercise is meant to provide a decomposition of what demand and supply shocks drove observed inflation, where we highlight the potentially important role of sectoral labor shortages in driving aggregate inflation given higher aggregate demand and compositional imbalances in consumption.

Our first quantitative exercise contrasts the response of global trade to the changes in domestic demand in the GTC and Covid-19 crisis. We base our analysis on the framework of Bems, Johnson, and Yi (2010), who show that the elasticity of world trade to world GDP can be much larger than one, and as high as three, given the amplification of demand shocks via cross-border input-output linkages. Using a simple model of global input-output linkages to map the observed changes in sectoral consumption demand across countries to production and trade flows, they show that the observed collapse in demand could account for 70 percent of the observed collapse in trade during the 2008-09 crisis. While the collapse in demand during the GTC was biased towards the consumption of goods relative to services (reverse is true for Covid-19 though in the early phase demand for goods and services both collapsed), GDP did not fall as much relative to trade given that services make up the majority of most countries' GDP. However, the global trade network still played an important amplification role as the initial change in demand in real value terms (as GDP is measured) was multiplied in gross output terms (as trade is measured) along the global production of the final consumption good. For example, the final consumption of an automobile in the domestic economy requires parts sourced – both directly and indirectly – from countries around the world, which generates production and trade flows at different stages of the production process.

Our closed-economy exercise shows that aggregate demand and sectoral labor shortages contributed to inflation in the Euro Area and in the US. In terms of relative importance, sectoral labor shortages (supply-chain "bottlenecks") explain around *one half* of observed inflation in the Euro Area, while these shocks explain only around *one third* of inflation in the US. The remaining part of inflation is explained by the demand side, with aggregate demand playing a larger role than sectoral demand shifts. The model structure also allows us to decompose the factor price sources of inflation. The decomposition shows that nominal wage increases contribute more than capital price changes in explaining aggregate inflation. Given that the model ignores other potential sources of price pressures, such as changes in firms' mark-ups, we take this result along with the importance of sectoral labor supply shocks as evidence of the overall importance of "cost push shocks" in driving inflation in the Euro Area. Finally, when we extend the model to the multi-country setting, we find that Euro Area-only shocks can only explain roughly one half of observed inflation. This result confirms the importance of international spillovers in driving the observed 2019Q4-2021Q4 inflation episode and in particular the role of foreign cost shocks in driving Euro Area inflation.

Finally, we perform a quantitative exercise that contrasts the response of global trade to the changes in domestic demand in the GTC and Covid-19 crisis. We base our analysis on the framework of Bems, Johnson, and Yi (2010), who show that the elasticity of world trade to world GDP can be much larger than one, and as high as

three, given the amplification of demand shocks via cross-border input-output linkages. Using a simple model of global input-output linkages to map the observed changes in sectoral consumption demand across countries to production and trade flows, they show that the observed collapse in demand could account for 70 percent of the observed collapse in trade during the 2008-09 crisis. While the collapse in demand during the GTC was biased towards the consumption of goods relative to services, GDP did not fall as much relative to trade given that services make up the majority of most countries' GDP. However, the global trade network still played an important amplification role as the initial change in demand in real value terms (as GDP is measured) was multiplied in gross output terms (as trade is measured) along the global production of the final consumption good. For example, the final consumption of an automobile in the domestic economy requires parts sourced -– both directly and indirectly -– from countries around the world, which generates production and trade flows at different stages of the production process.

We apply the Bems, Johnson, and Yi (2010) framework to the recent episode to show how Covid-19's specific compositional demand changes, that were much starker and unique relative to any other crisis episode, spilled-over through the global production network. We find lower trade elasticities relative to the 2008-09 episode; that is given the decline in GDP during the early phase of Covid-19, trade declined less relative to the 2008-09 crisis given the same fall in GDP. Perhaps more surprisingly, when GDP rebounded during the pandemic recovery phase, trade also recovered but by much less relative to GDP compared to the response of trade to the collapse and recovery in GDP during the 2008-09 episode. Our interpretation of these results hinges on the importance of supply bottlenecks that arose due to the unique nature of Covid-19, and which led to the shutting down of the service sector.

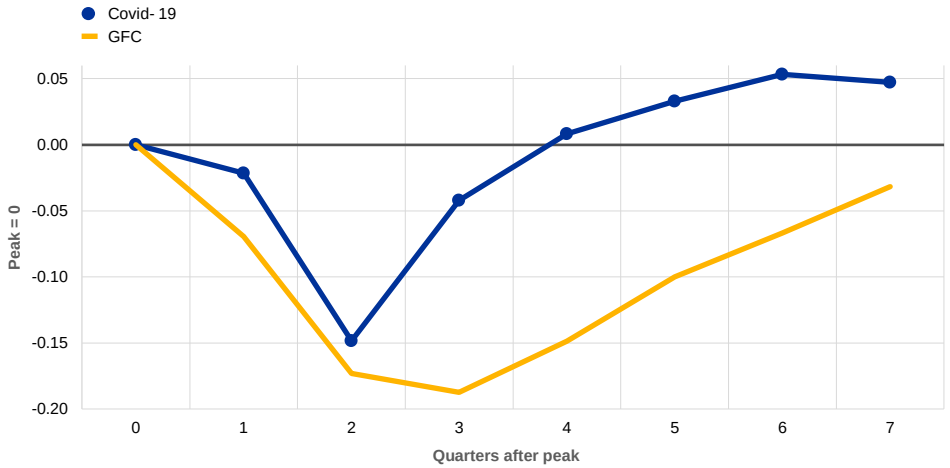
Outline of the paper. Section 2 summarizes descriptive patterns in trade, consumption, output, and prices for several countries since early 2020 and compares these patterns to those of the 2008-09 financial crisis. Section 3 undertakes a calibration exercise based on the multi-sector input-output network macro model of Baqaee and Farhi (2022) to decompose the drivers of inflation in the US vs Euro Area into demand and supply factors in a closed economy setting with a single monetary policy authority. Section 4 revisits these results considering the international linkages of the Euro Area to the rest of the world. Section 5 uses a multi-sector trade model with input-output linkages to calculate trade flows given the observed cross-country quarterly sectoral consumption patterns over 2020-21 and compares the implied trade elasticities to those of the 2008-09 crisis episode. Section 6 concludes.

2 Descriptive Data Patterns

The early phase of the pandemic witnessed a steep disruption in world trade. Chart 3 plots this drop in world real imports (which is equivalent to world real exports) together with the same drop observed during the Global Financial Crisis (GFC) of 2008 – the so-called Great Trade Collapse (GTC). As one can observe, the original drop in trade was worse during the GTC but trade rebounded much more quickly during the Covid-19 period than during the trade rebound after the Great Financial Crisis (GFC).

Chart 3

World Imports for the GFC and Covid-19: WTO Quantity Index

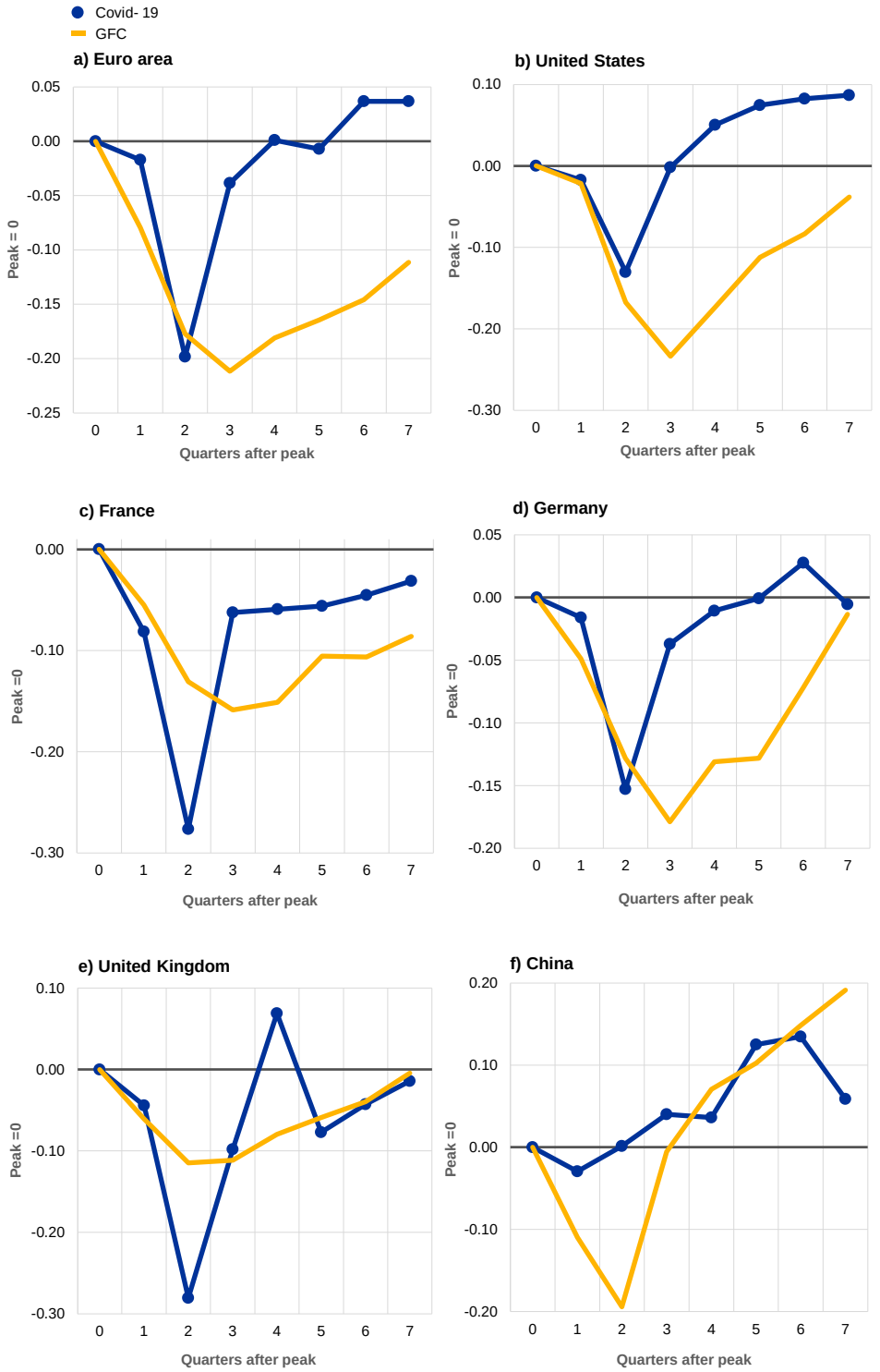


Notes: This chart compares the behavior of world imports quantity during the great financial crisis (GFC) to the Covid-19 pandemic. We compute log- deviations (percentage points) from the pre-crisis peaks that correspond to 2008Q3 for GFC and 2019Q4 for Covid-19. Data refers to merchandise trade (goods trade) and comes from the World Trade Organization (WTO) Trade database. Series are seasonally adjusted.

This aggregate narrative hides a large degree of country heterogeneity as shown in Chart 4. While Covid-19 led to a steeper drop in real imports for Euro Area countries and the U.K. relative to the GFC, the opposite held for the US and China. Chart 5 plots real exports and shows that the Covid-19 period is worse than the GFC for all countries except for China and the Euro Area (where in the Euro Area the drop was as large as the one observed during the GFC). Arguably, these differences reflect the consumption composition change that begin early during the pandemic, particularly in the US, where consumers' consumption of goods remained robust during the initial lockdown period as they substituted away from services. This consumption was in turn in part driven by imports from China. It is also interesting how exports are much slower to recover, indicating possibly both lower demand for these goods (e.g., capital goods from Germany) from the rest of the world and limits to production capacity.

Chart 4

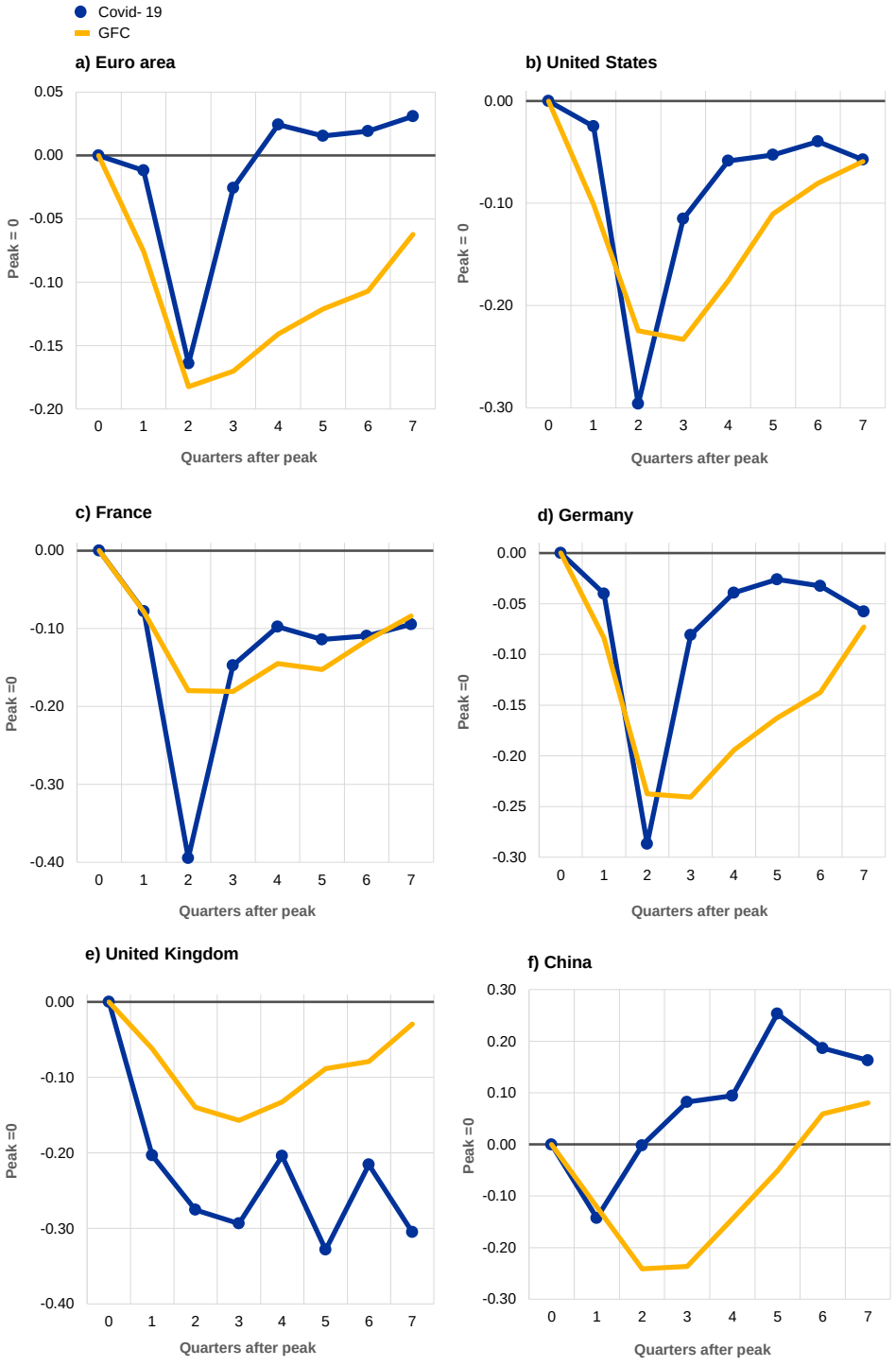
Import Quantity in Selected Countries during the GFC and Covid-19



Notes: This chart provides a cross-country comparison of the behaviour of imports quantities for a set of countries. We compute log-deviations (percentage points) from the pre-crisis peaks in the import quantities series. We pick the same pre-crisis dates for all countries in both crises. We set 2008Q3 for the pre-crisis date in the GFC and 2019Q4 for the pre-crisis date in the Covid-19 crisis. Data refer to merchandise trade (goods trade) and comes from the World Trade Organization (WTO) for all countries except China, for which data comes from the CPB World Trade Monitor. All series are seasonally adjusted.

Chart 5

Export Quantity in Selected Countries during the GFC and Covid-19



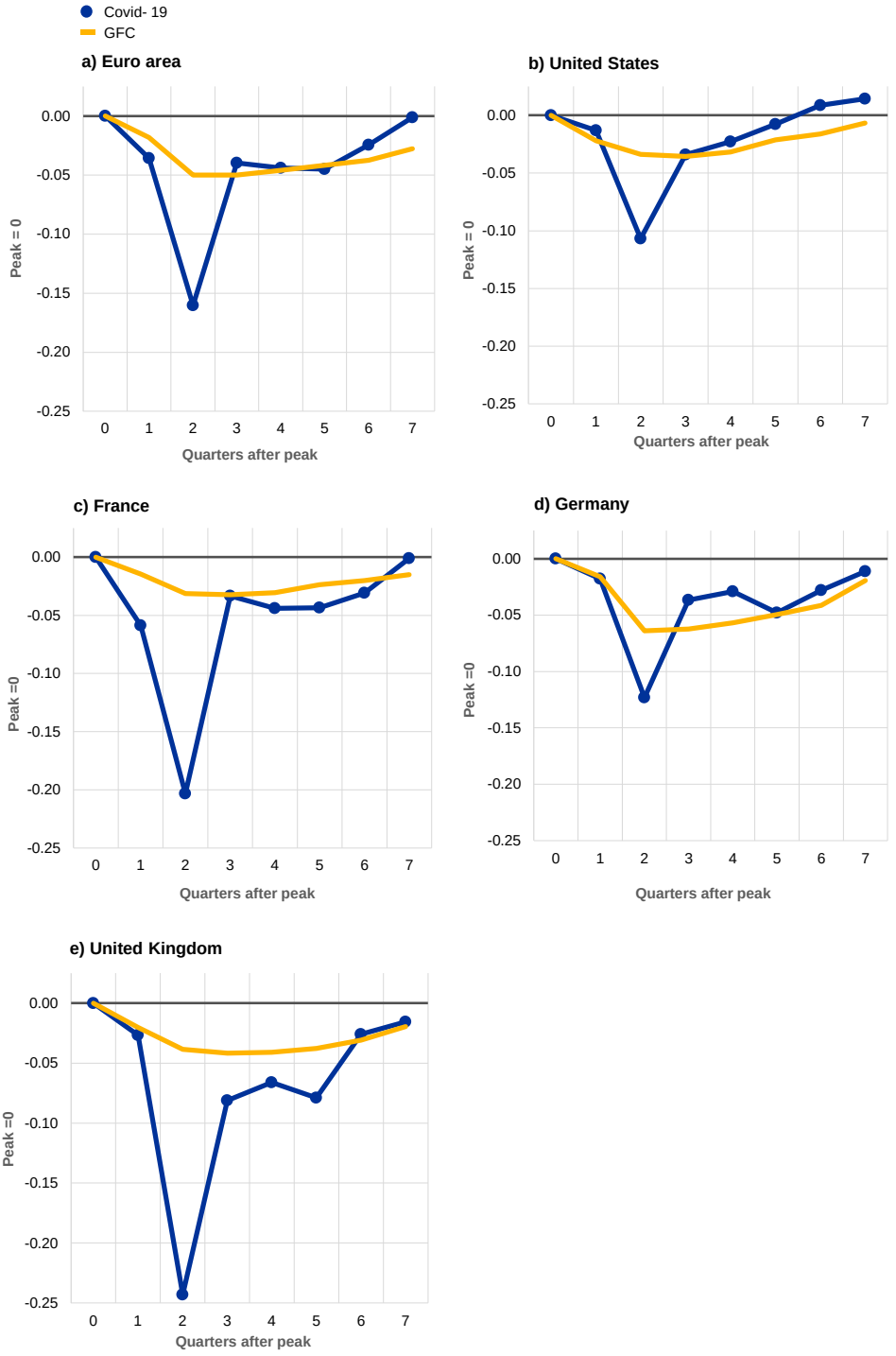
Notes: This chart provides a cross-country comparison of the behaviour of exports quantities for a set of countries. We compute log-deviations (percentage points) from the pre-crisis peaks in the export quantities series. We pick the same pre-crisis dates for all countries in both crises. We set 2008Q3 for the pre-crisis date in the GFC and 2019Q4 for the pre-crisis date in the Covid-19 crisis. Data refer to merchandise trade (goods trade) and comes from the World Trade Organization (WTO) for all countries except China, for which data comes from the CPB World Trade Monitor. All series are seasonally adjusted.

Charts 6 and 7 show that the drops in real GDP and real private consumption were both much larger during Covid-19 relative to the GFC in the US and Europe, making

the early phase of Covid-19 the worst recession since the Great Depression. What is unique about Covid-19 is that during the early phase, even though total consumption expenditures dropped, there were large compositional shifts from services to goods.

Chart 6

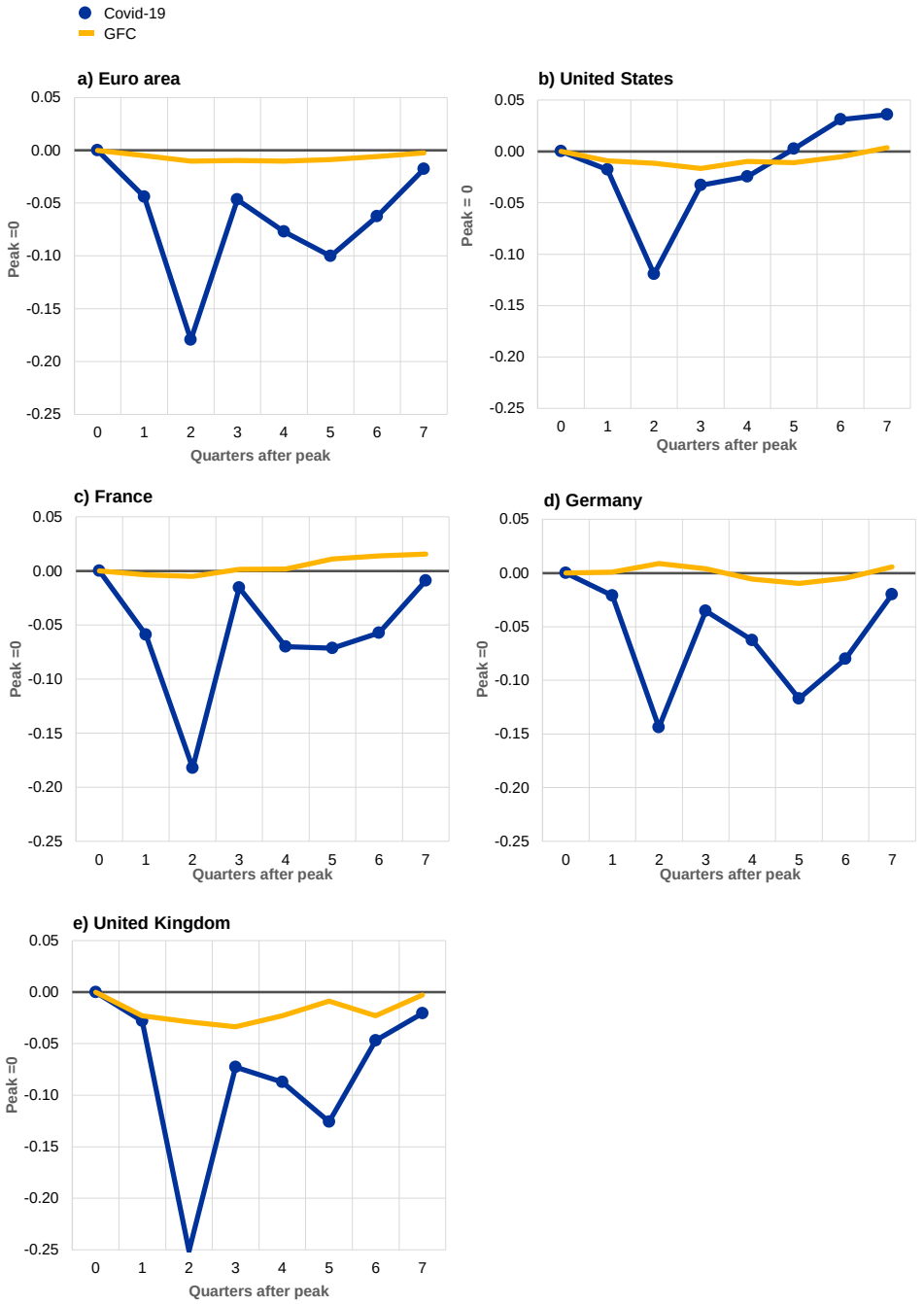
Real GDP in Selected Countries during GFC and Covid-19



Notes: This chart provides a cross-country comparison of the behaviour of real gross domestic product (GDP) for a set of countries. We compute log-deviations (percentage points) from the pre-crisis peaks in the real GDP series. We pick the same pre-crisis dates for all countries in both crises. We set 2008Q3 for the pre-crisis date in the GFC and 2019Q4 for the pre-crisis date in the Covid-19 crisis. Data comes from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). All series are seasonally adjusted.

Chart 7

Real Consumption in Selected Countries during the GFC and Covid-19

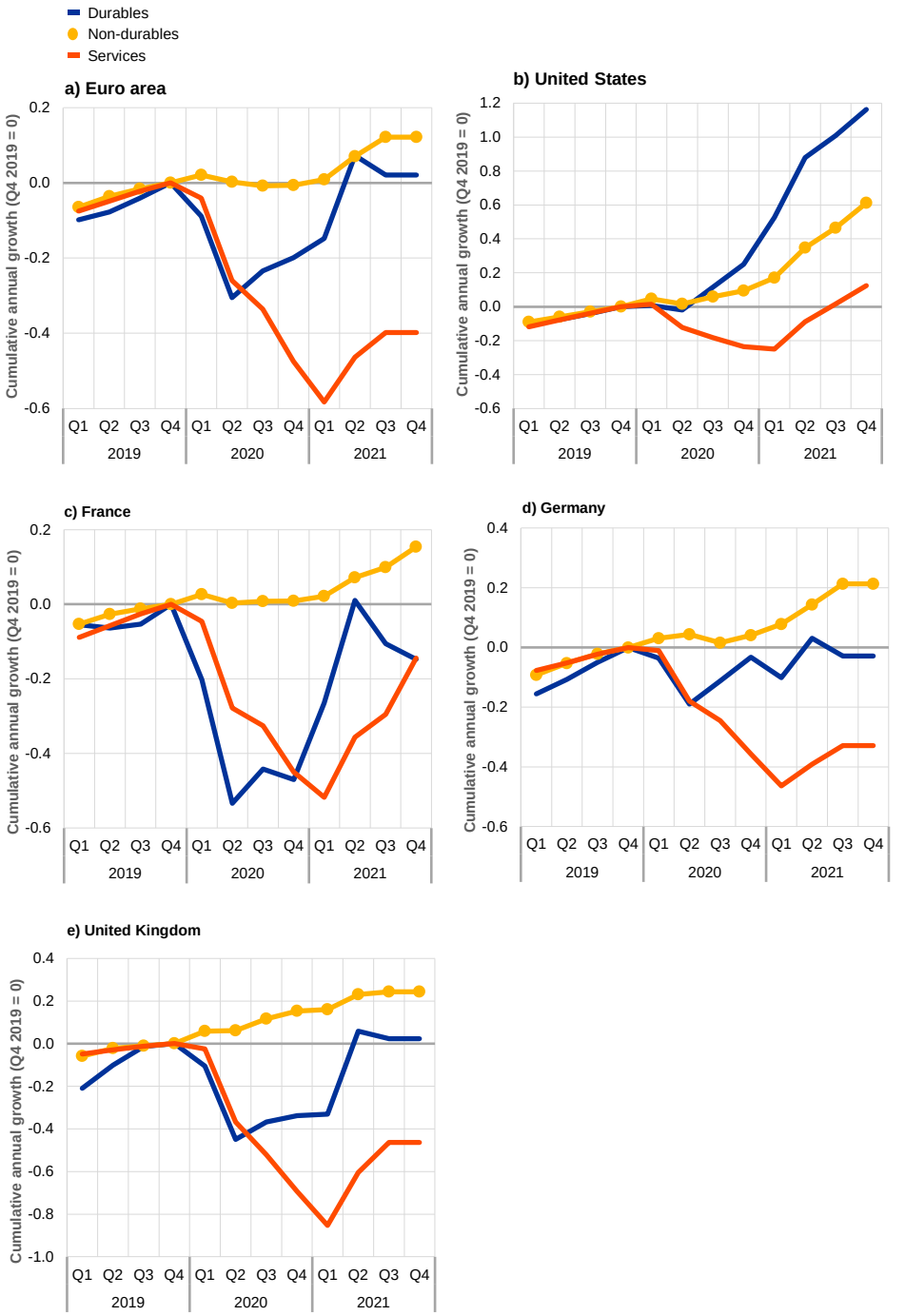


Notes: This chart provides a cross-country comparison of the behaviour of real private consumption for a set of countries. We compute log-deviations (percentage points) from the pre-crisis peaks in the real consumption series. We pick the same pre-crisis dates for all countries in both crises. We set 2008Q3 for the pre-crisis date in the GFC and 2019Q4 for the pre-crisis date in the Covid-19 crisis. Data comes from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). All series are seasonally adjusted.

As can be seen in Chart 8, which plots consumption growth, durable consumption started rising as early as 2020Q2 with the speed being much faster in the US, while services only started picking up in 2021Q2. Chart 9 shows the same growth patterns for real consumption, with similar timing differences across durables and services and very large increase in the US for durables.

Chart 8

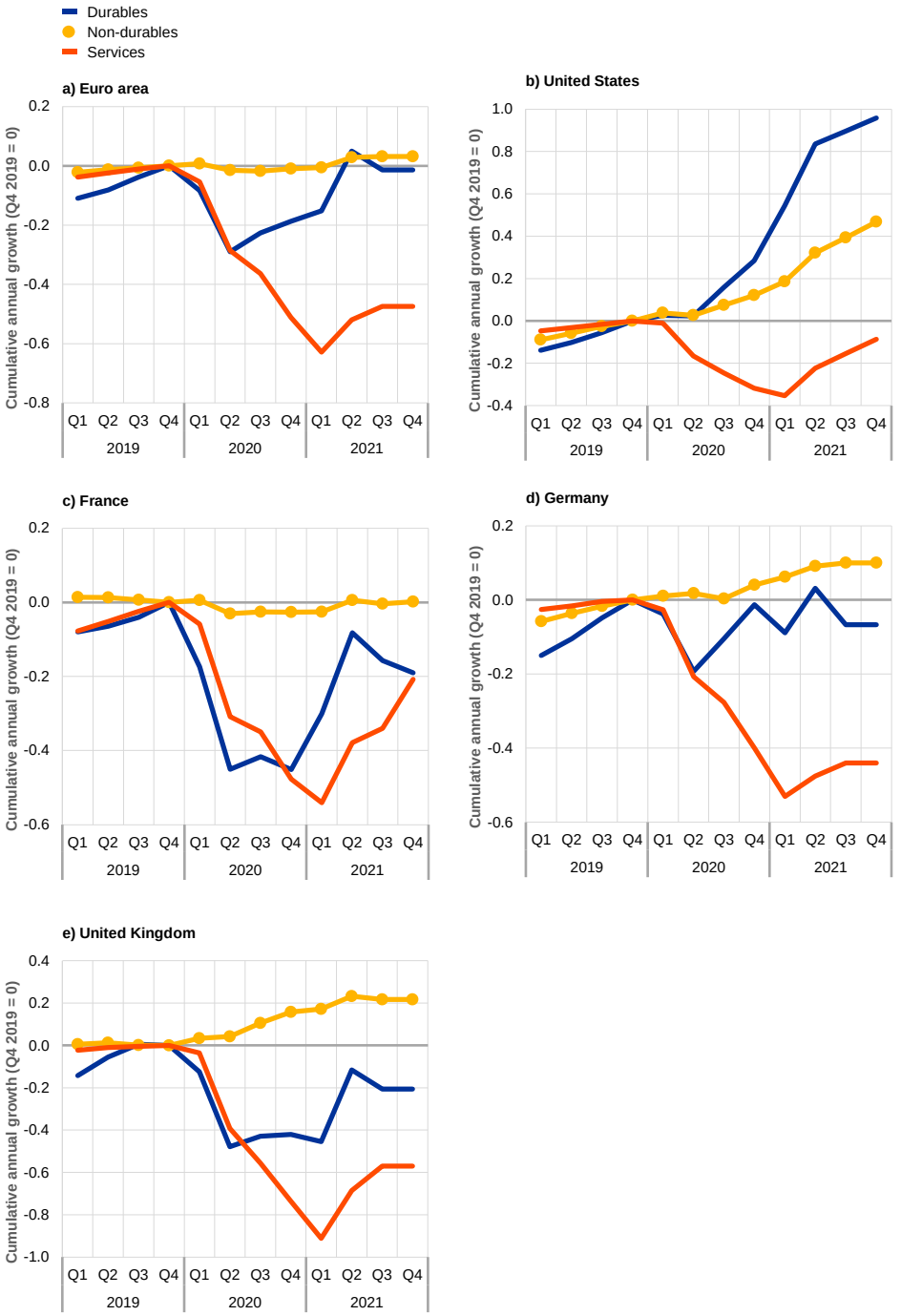
Nominal Consumption Growth in Selected Countries by Sector during Covid-19



Notes: This chart plots nominal consumption growth in each quarter vis-à-vis 2019Q4 and cumulated for three different consumption series: durables, non-durables and services. All series are nominal, de-seasonalized and comes from the OECD Quarterly National Accounts. We construct the Euro Area numbers using data for the following countries that contains information for the three series: Austria, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Luxembourg and Netherlands.

Chart 9

Real Consumption Growth in Selected Countries by Sector during Covid-19



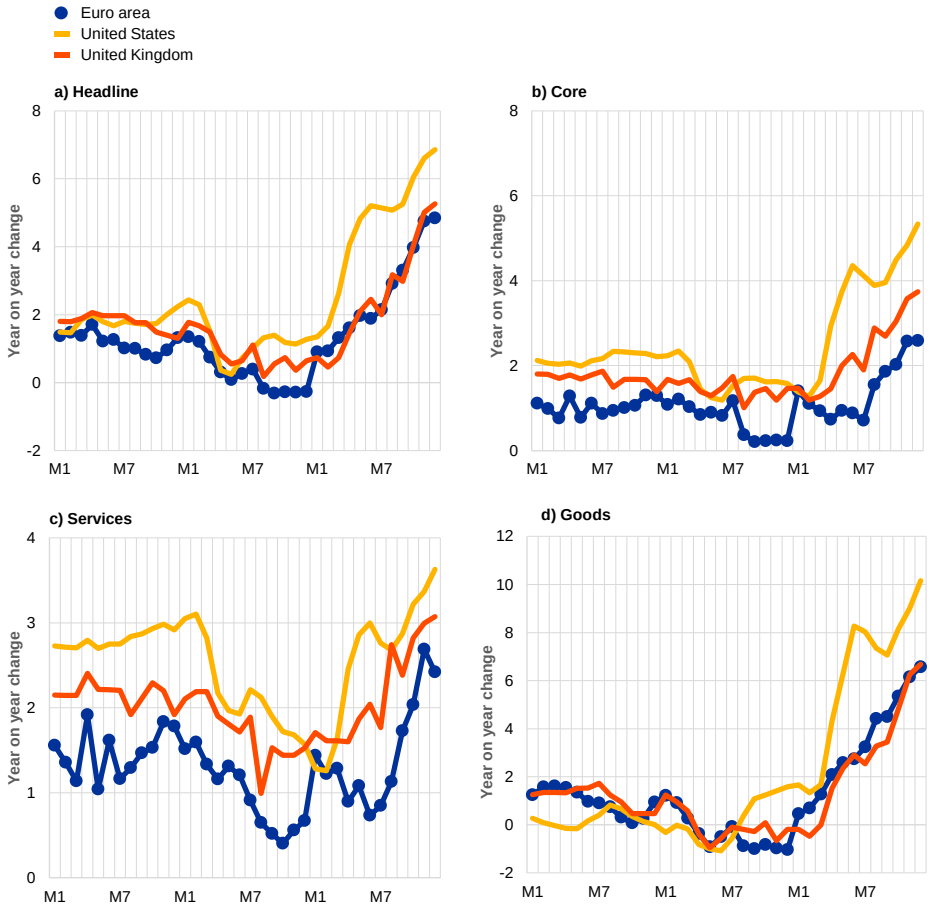
Notes: This chart plots real consumption growth in each quarter vis-à-vis 2019Q4 and cumulated for three different consumption series: durables, non-durables and services. All series are nominal, de-seasonalized and comes from the OECD Quarterly National Accounts. We construct the Euro Area numbers using data for the following countries that contains information for the three series: Austria, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Luxembourg and Netherlands.

Chart 10 plots the inflation trends that are consistent with the compositional shifts we document above. Both headline and core inflation started increasing at similar times in the US, Euro Area and the UK during early 2021, though the slope is much steeper for the US and began a few months earlier there.

What is important is the differences shown in panels (c) and (d) of this chart where services inflation was still less than 3 percent in the Euro Area and UK, and just passed this number in the US at the end of 2021, while goods inflation was almost 8 percent in the Euro Area and UK and over 10 percent in the US.

Chart 10

Inflation by Sector in the Euro Area, US and UK, Covid-19



Notes: This chart plots headline, core (headline minus food and energy), services and goods annual inflation for the Euro Area, US and the UK. Data comes from the Federal Reserve Economic Data (FRED) maintained by the Federal Reserve of St. Louis.

3 Inflation under Supply Chain Bottlenecks: Closed-Economy Model

3.1 A Simple Framework

In this section, we briefly sketch a theoretical framework borrowed from Baqaee and Farhi (2022). Their model allows us to perform a calibration exercise to obtain broad based inflation under sectoral labor shortages, relative demand shifts and aggregate demand shocks. It also allows us to assess the relative forces of demand and supply

driving inflation during the pandemic period. We outline the key components of the model that are sufficient to understand the inflation decomposition that we perform, and refer the reader to the Baqaee and Farhi paper for further details.

The model is a two-period multi-sector closed economy with perfectly competitive factors and good markets. The intertemporal block assumes households have perfect foresight and therefore there is no uncertainty about the future. We follow Baqaee and Farhi (2022) setup with the following assumptions: (i) a unitary elasticity of substitution between present and future consumption, which we denote as $\rho = 1$; (ii) a representative consumer with the ability to borrow, i.e., no hand-to-mouth consumers; (iii) factors are sector specific, hence, immobile across sectors. Assumptions (i) and (ii) imply that the consumers have log utility with consumption smoothing under no uncertainty on next period's income. Assumption (iii) implies that relative goods' demand changes in different sectors and will lead to relative factor price movements, but no factors moving between sectors. Hence, sectoral demand changes can potentially cause unemployment.

We describe the economy and present key equations below and refer the reader to Appendix A.1 for the full model derivation.

Production. We assume that each good is produced by a single sector, so sectors and goods can be used interchangeably in what follows. Let N be the number of sectors and F the number of factors. We index sectors by i and factors by f.

To save on notation, we outline the model below with only one sector-specific factor that we call sectoral labor. Hence, the number of factors and goods in this economy coincides $N = F$. Then, when going to the data, and in line with the quantitative exercise in Baqaee and Farhi (2022), we add another sector-specific factor that we call sectoral capital. This additional sector-specific factor serves two broad purposes. First, it allows us to capture better the structure of national accounts where sectoral value-added is decomposed into labor compensation and gross operating surplus (plus taxes) from the supply side. Second, this also allows the quantitative exercise to say something about other factor price changes that are not necessarily wage changes such as rental rates, or, although not strictly a factor price, profits.[12] Note, however, that the model abstracts from other potential drivers of firms' prices such as changes in mark-ups given the competitive market structure.

There is a representative firm in each sector that produces using constant returns to scale production technology, which combines factors and intermediates goods. Given that we extend this model to multi-countries below, we use generalized notation throughout the paper. Therefore, in this section we consider a single country, denoted by m. We define sectors' use of inputs as:

$$x_{ik} \equiv x_{im,kc} \text{ and } x_{0i} \equiv x_{0m,mi}.$$

[12] As highlighted in Baqaee and Farhi (2022), this follows from an argument in McKenzie (1959), where we can always express a decreasing return to scale production function, which features profits, as a constant returns to scale production function where an additional "entrepreneurial" factor receives the payments that were labelled as profits before.

In words, these equations imply that sector k provides inputs to be used in sector i. We use sector index of 0 to denote the consumption to have a unified representation of sectoral linkages. Denote the CRS production function by $\mathrm{G}(\cdot)$, then, dropping country notation in what follows, sectoral gross output y_i can be written as

$$y_i = A_i \mathrm{G}(L_i, \mathbf{X}_i),$$

where $\mathbf{X}_i = (x_{i1}, x_{i2}, \ldots, x_{iN})$ is an $N \times 1$ vector of intermediate goods. Each element of this vector records the quantity of good $j = 1, \ldots, N$ purchased by sector i to produce its output. L_i is the quantity of factor i used in sector i. A_i is a Hicks-neutral exogenous technology affecting the productivity of the sector.

Under perfect competition, the firm's cost minimization problem yields the following solution for the growth rate in prices:

$$\mathrm{d}\log p_i = \sum_{k=1}^{N} \Psi_{ik}\, \alpha_k\, \mathrm{d}\log w_k - \sum_{k=1}^{N} \Psi_{ik}\, \mathrm{d}\log A_k \tag{3.1}$$

where sectoral wages and productivities are denoted by w_k and A_k, respectively. The Ψ_{ik} terms capture sector i's use of all sectors' intermediate goods (see Appendix A.1 for details).

Equation (3.1) shows that prices in each sector are a function of changes in wages in all sectors even if a sector does not use labor from other sectors directly in production. However, given the use of intermediate goods from other sectors, changes in other sectors' wages will feed into marginal cost changes via the price of intermediate goods. This dependence highlights the importance of the production network and of supply chains more broadly in driving relative price movements across the economy.

Equation (3.1) also highlights another related but subtle point: exogenous changes in demand, both aggregate and relative, only affect good prices through changes in wages across sectors because there is no term in the equation that can be linked to the demand side of the economy. That is, demand changes, either aggregate or relative, only change prices via general equilibrium forces.

Households. We keep the household side as simple as possible and assume that there is a representative household who consumes goods from all sectors according to the following Cobb-Douglas intratemporal utility function:

$$\mathrm{U}(C) = \prod_{i=1}^{N} x_{0i}^{\kappa_i},$$

where x_{0i} denotes quantity consumed of good i and κ_i represents the expenditure share on good i with $\sum_{i=1}^{N} \kappa_i = 1$. Implicit in this functional form is the fact that the consumer substitutes across consumption goods in a given period with an elasticity

equal to unity. We denote this elasticity as $\sigma = 1$.The household also owns all factors in the economy and supply them inelastically at the given wages.

Intertemporal utility function is of the form:

$$(1-\beta)\log \mathrm{U}(C) + \beta \log \mathrm{U}(C^*).$$

We use the superscript * to denote variables in the future and no asterisk for present variables. Here, we already imposed a unitary intertemporal elasticity of substitution $\rho = 1$, which implies the log-utility across periods. The parameter β, on the other hand, governs the weight the consumer puts on future utility. For example, an increase in β signals a desire of the representative consumer to consume less in the present period and postpone its consumption to the future. This parameter will be a key in what follows since it allows us to model an aggregate demand shock in this economy in a simple way.

The household intertemporal budget constraint satisfies

$$PC + \frac{P^*C^*}{1+i} = \sum_{f=1}^{F} w_f L_f + \frac{I^*}{1+i},$$

where $PC = \sum_{j=1}^{N} p_j x_{0j}$ is consumption in the present, $P^*C^* = \sum_{j=1}^{N} p_j^* x_{0j}^*$ is consumption in the future, i is the nominal interest rate, $\sum_{f=1}^{F} W_f L_f$ are factor payments in the present and I^* is income in the future. Note that P and P^* are the price indices and reflect the cost of the consumption bundle in the present and future periods, respectively. Implicit in the intertemporal budget constraint is the assumption that the representative household can smooth consumption over periods and that it owns all factors in the economy. The household takes i, I^* and P^* as given when solving her maximization problems.

The key aspect of the household's maximization problem is how it allows us to model aggregate demand shocks. Specifically, we can express consumption as a function of an aggregate demand shifter and the price index (see Appendix A.1 for details):

$$\log C = \log \zeta - \log P \implies \log P + \log C = \log \zeta$$

$$\log \zeta = \log\big((1-\beta)/\beta\big) + \log P^*C^* - \log(1+i)$$

where $\log \zeta = \log P + \log C$ is an aggregate demand shifter that coincides with nominal expenditure in the present period. A decrease in the discount factor (β), the interest rate (i) or an increase in nominal expenditure in the future (P^*C^*), generate an

aggregate demand shifts in the current period such that, given the price index, consumption today goes up.[13]

Wee normalize the initial equilibrium (steady state) of the economy around $P = P^* = C = C^*$ by setting the discount factor (β) and the nominal interest rate (i) appropriately. As we show in Appendix A.1, this implies that $i = 0$, and therefore this economy is at the zero-lower bound on the nominal interest rate in the initial equilibrium.

Equilibrium conditions and CPI Inflation. CPI inflation is a consumption-weighted average of each price change:

$$d \log \text{CPI} = \sum_{i=1}^{N} \kappa_i \, d \log p_i \tag{3.2}$$

We can express CPI inflation as a function productivity shocks and factor price changes using the change in goods' prices that we derived for each sector i in (3.1). Before doing so, we first need to define the equilibrium conditions in each market.

The goods market clearing condition is

$$y_i = x_{0i} + \sum_{j=1}^{N} x_{ji} \tag{3.3}$$

which states that total gross output in sector i, y_i, goes to either final consumption good i, x_{0i}, or is used as an intermediate good by sector j, x_{ji}.

Given market clearing conditions along with firms' and households' first-order conditions, we can write CPI inflation as (see Appendix A.1 for the full derivation):

$$\mathrm{d} \log \text{CPI} = \boldsymbol{\Lambda}' \mathrm{d} \log \mathbf{W} - \boldsymbol{\lambda}' \mathrm{d} \log \mathbf{A} \tag{3.4}$$

where $\mathrm{d} \log \mathbf{W}$ is a $N \times 1$ vector of wage changes and $\mathrm{d} \log \mathbf{A}$ is a $N \times 1$ vector of productivity changes, $\boldsymbol{\Lambda}$ represents the factor shares in the country GDP, and $\boldsymbol{\lambda}$ is a vector of Domar weights. Equation (3.4) shows that, up to a first-order approximation, inflation mimics the behavior of factor prices, weighted by their factor shares, and productivity changes, weighted by their Domar weights; i.e., the relative importance of each sector on aggregate value added.

[13] There are many potential factors that drove aggregate demand throughout the pandemic period, as this equation makes clear. As we describe in the quantitative section below, we ultimately back out the aggregate demand shock ζ to match observed CPI inflation. Therefore, we do not need to take a strong empirical stand on what is ultimately driving aggregate demand shifts.

In what follows, we assume there are no productivity shocks and therefore set $d \log \mathbf{A} = \mathbf{0}$ to focus on the role of changes in sectoral labor and aggregate demand. Changes in CPI are then directly mapped to changes in factor prices:

$$\mathrm{d} \log \mathrm{CPI} = \mathbf{\Lambda}' \mathrm{d} \log \mathbf{W} \tag{3.5}$$

This equation links aggregate inflation with wage inflation. As it is difficult to measure sectoral wages in the data, we follow Baqaee and Farhi (2022) and translate these wage changes to changes in factor usage in each sector and changes in aggregate demand as measured by nominal expenditure changes (nominal GDP).

To do so, note that share of factor f in value added is $\Lambda_f = \frac{w_f L_f}{GDP}$ and that $\sum_{f=1}^{N} \Lambda_f = 1$. In this definition, sector-specific labor L_f is an endogenous object that can change due to supply or demand forces and should not be confused with labor supply alone. Log-differentiating these expressions and replacing into Equation (3.5) we arrive at:

$$d \log \mathrm{CPI} = d \log \mathrm{GDP} - \mathbf{\Lambda}' d \log \mathbf{L} \tag{3.6}$$

which is *Corollary 1* of Baqaee and Farhi (2022) under the assumption of no hand-to-mouth consumers and no productivity shocks. This equation tells us that inflation can be mapped to two key objects: (i) changes in nominal expenditures (= GDP in the closed economy), which capture changes in aggregate demand, and changes in equilibrium employment levels, which capture the supply side of the economy. As noted in Baqaee and Farhi (2022), it is irrelevant if these changes in equilibrium sectoral labor come from supply or demand forces: declines in these quantities are always inflationary.

In Section 3.3, we show how we map these objects to the data to compute inflation numbers for the Euro Area and the US. Before doing so, we provide the key intuition of the model using a two-sector example.

3.1.1 Two-sector stylized example

We provide a stylized example to highlight the main mechanisms in the model above. We use this example to incorporate the possibility of downward nominal wage rigidity and how it interacts with the production structure of the economy to create unemployment and, in doing so, how shocks can impact inflation.

Suppose we write Equation (3.1) for two goods (and therefore two factors) and assume there are no productivity shocks. This implies that the price equations for the two goods are

$$d \log p_1 = \tilde{\alpha}_{11} \mathrm{d} \log \mathrm{w}_1 + \tilde{\alpha}_{12} d \log \mathrm{w}_2,$$

$$d \log p_2 = \tilde{\alpha}_{21} d \log w_1 + \tilde{\alpha}_{22} d \log w_2.$$

The tilde terms are network-adjusted exposures of each sector to changes in wages in the two sectors and satisfy $\tilde{\alpha}_{if} = \Psi_{ik}\alpha_{kf}$. Note that without multi-sectors and/or a production network, there would be no transmission of wages from one sector to the other. For example, if sector 1 does not use any input from sector 2 then $\tilde{\alpha}_{12} = 0$. The network exposures highlight the importance of the production network in transmitting wage changes from one sector to the other in a world where labor is sector specific. The production network thus acts as a mechanism that allows sectors to "demand" labor from every market, even though labor is sector-specific. Intuitively, by using intermediate goods from other sectors to produce, each sector is at the end demanding labor from other sectors. This does not mean that sector-specific labor supply in equilibrium is going to move due to the presence of intermediate inputs, this is fixed in our exercise. Rather, it implies that, although labor is sector-specific, some of this sector-specific labor will end up being used in other sectors i.e. being demanded by other sectors indirectly through intermediate input linkages.

Next, suppose that there is a relative shift in demand that increases the demand for sector 1 but decreases it for sector 2. To begin, we assume that wages are fully flexible, and thus focus on a scenario where labor supply is at its potential and all adjustment is through wages. Since sector 1 needs to increase production, it demands more of its factor, which puts upward pressure on wages in that sector. Sector 2 experiences a decrease in its demand and thus demands less of its sector-specific labor, putting downward pressure on its wage.

The total effect of wage changes on aggregate inflation can be written parsimoniously starting from equation (3.5). In this two-sector example, we have

$$d\log \mathrm{CPI} = \Lambda_1\, d\log w_1 + \Lambda_2 d\log w_2.$$

Using the definition of factor shares and the fact that in the flexible price equilibrium $d\log L_1 = d\log L_2 = 0$, we can write inflation simply as

$$d\log \mathrm{CPI} = \mathrm{d}\log \mathrm{GDP}.$$

Hence, inflation maps directly to changes in nominal expenditure, which in this closed economy model coincides with a measure of total nominal value added changes, i.e. nominal GDP. Another way to look at this is to note that inflation, when measured relative to nominal GDP, is zero, $d\log CPI - d\log GDP = 0$. It is in this sense that there is no inflation in this economy when there are sectoral demand shocks and all prices are fully flexible.

With downward nominal wage rigidity in both sectors, the story is different. The increase in demand for good 1 poses no problem: it raises wages in sector 1. However, since wages in sector 2 cannot go down, employment in sector 2 must fall, and thus at the current wage, demand does not equal supply in the labor market of sector 2. In terms of equation (3.4), changes in inflation are only due to sector 1 wage changes times its income share on national income

$$d \log \mathrm{CPI} = \Lambda_1 \, d \log w_1.$$

Therefore, changes in aggregate inflation arise solely from changes in wages in sector 1 because the increase in demand hit the factor supply constraint in that sector. Sector 2, on the other hand, does not experience wage inflation, although it does experience changes in its price because of the increase in wages in sector 1 and the presence of intermediate input linkages.

We can map these nominal changes to changes in equilibrium employment quantities. To see this, recall that changes in wages in sector 1 and factor shares changes should satisfy

$$d \log \mathrm{w}_1 = \mathrm{dlog}\, \Lambda_1 + d \log GDP,$$

$$d \log \Lambda_2 = d \log L_2 - d \log GDP,$$

$$\Lambda_1 d \log \Lambda_1 + \Lambda_2 d \log \Lambda_2 = 0.$$

Where we used the fact that $d \log L_1 = 0$, due to wages being fully flexible in sector 1, and $d \log w_2 = 0$ due to the downward nominal wage rigidity in sector 2.

Replacing the above results into the expression for inflation and after some algebra, we get

$$d \log \mathrm{CPI} = \mathrm{d} \log \mathrm{GDP} - \Lambda_2 d \log L_2.$$

Hence, up to a first-order approximation, there is inflation in this economy as measured by (i) the change in nominal expenditure and (ii) the factor income share of sector 2 and the amount of unemployment in that sector i.e. how much did employment decline due to the shift in demand across sectors and the downward nominal wage rigidity. This is true even if we let $\mathrm{d} \log \mathrm{GDP} = 0$. In other words, absent an aggregate demand shock in this example. Therefore, this economy features inflation that differ from the observed change in nominal expenditure, which was not the case in the fully flexible equilibrium. This result highlights that a model with sectoral demand shifts and downward nominal wage rigidity can generate inflation, even in absence of an aggregate demand.

3.2 Data

We now discuss the data used to perform our quantitative exercise.

Nominal GDP. We use seasonally adjusted nominal GDP series from FRED for both the Euro Area (EUNNGDP) and the US (GDP). These are available at a quarterly frequency.

Total Hours Worked. We take the model literally and use changes in total hours worked as our sectoral supply shocks. We describe how we construct this data for the US and Euro Area, separately.

US data. We use Tables B1 and B2 provided by the Bureau of Labor Statistics. These tables contain information on employment and average weekly hours at a monthly frequency, respectively. Since hours in Table B2 are at a higher level of aggregation than those for employment in Table B1, we construct measures of L, by multiplying employment in a disaggregated sector by the hours of the aggregate sector. For example, the information sector contains six subsectors in Table B1 but it is only available as an aggregate information sector in Table B2. We thus multiply each subsector employment by the hours of the aggregate sector in Table B2 to get a measure of total hours worked in each of the six subsectors separately.

Euro Area data. We collect data from EuroStat, which contains information on both hours and employment at the sectoral level for the entire Euro Area at a quarterly frequency. We follow the same procedure as in the US to construct changes in total hours worked in each sector.

Input-Output Matrices, Factor and Consumption Shares: Ω, Λ, κ

Since we assume two sector-specific factors in each sector in our quantitative exercise, labor and capital, we need to compute the respective share in nominal GDP of each of these objects. For our purposes, we only need to construct intermediate input expenditure, factor and consumption shares at some initial equilibrium.

US I-O matrix. We construct all objects for the US using the BEA Use-Before-Redefinitions producer prices tables for the year 2015. As it is typical with the input-output data from the BEA, we remove the following sectors to perform our analysis: government sectors (sectors 67 to 71 in the BEA IO Table), scrap, used and secondhand goods (sector 72) and noncomparable imports and rest-of-the-world adjustment (sector 73). This immediately provide us with enough information to compute the elements of Ω. We measure sectoral labor compensation as "compensation to employees" and sectoral capital compensation as "gross operating surplus." Our measure of nominal GDP for computing factor shares is simply the sum across sectors of these two items. This notion of nominal GDP coincides with a measure of gross value added at factor costs (Horvát and Webb, 2020) that we also use below when constructing the Euro Area numbers. For consumption shares, we use sectoral consumption of the 66 sectors that are also present in the BEA Input-Output table.

Euro Area I-O matrix. We compute the input-output matrix using the Inter-Country Input-Output (*ICIO)* database from the OECD that we already used in section 3 for the baseline year 2018. Also, we use this same dataset to construct consumption shares. We collapsed all Euro Area countries into one single entity to perform our analysis.

To construct the vector of factor shares, we use the 2018 OECD Structural Analysis (STAN) Database. It contains information on labor compensation and gross operating surplus at the sectoral level matching the ICIO sectoral classification for 17 out of the

19 countries (except for Cyprus and Malta) that composed the Euro Area. We add up these items within sectors across Euro Area countries to construct sectoral measures for the Euro Area. We then proceed as in the US and take nominal GDP to be the sum of these two items across sectors. We divide each item by this nominal GDP measure to get our factor shares at the sectoral level.

We also aggregate the sectoral input-output data in the US and the Euro Area into three sectors: durables, non-durables, and services, as in Section 3 to assess whether these different levels of aggregation matter for our findings.

Price indices and Nominal Wages. We use two type of price indices to measure inflation: headline consumer price index and core (headline minus food and energy) consumer price index. For both the US and Euro Area data are sourced from FRED. We also collect nominal wage indices for the US and Euro Area. For the US, we use the Employment Cost Index: Wages and Salaries, Private Industry Workers, also available from FRED (code ECIWAG). For the Euro Area, we use the wage part from the labour cost index available from EuroStat (code D11).

Calibrated shocks. The quantitative exercise requires three sets of shocks: (i) an aggregate demand shock (which maps to $d \log \zeta$), (ii) relative demand shocks (which maps to $d \log \kappa_i$'s), and (iii) sectoral supply shocks (which maps to $d \log L_i$).

We back out the aggregate demand shock out from observed changes inflation and total hours worked using Corollary 1 of Baqaee and Farhi (2022) and Equation (3.5). Rather than using changes in nominal GDP as a measure of the aggregate demand shock, we measure the aggregate demand shift as

$$d \log \zeta = d \log \mathrm{CPI} + \mathbf{\Lambda}' d \log \mathbf{L}. \tag{3.7}$$

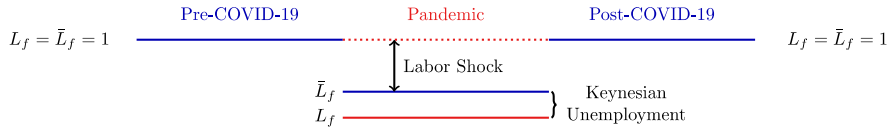
In doing so, our aggregate demand shock is the part of inflation that is not explained by observed employment changes in the data. We adopted this backed-out strategy for two reasons. First, while our stylized model provides a one-to-one mapping between nominal GDP changes and $d \log \zeta$, it does so under several assumptions, and importantly the assumption that there are no hand-to-mouth consumers, which Guerrieri, Lorenzoni, Straub, and Werning (2022) and Baqaee and Farhi (2022) show generate a negative pressure on aggregate demand following drops in sectoral employment. Our backed out aggregate demand shock thus incorporates all other forms of aggregate demand shifts that are not necessarily accounted for by changes in nominal GDP alone in a parsimonious way. Second, this approach allows us to get more sensible numbers to match inflation observed in the data as nominal GDP changes are extremely large in the data, which are in part due to base effects and will imply unplausible large inflation numbers.

Operationally, to feed this aggregate demand shock into the model, we assume that the discount factor β change is consistent with the observed changes in ζ. To generate an increase in $\log \zeta$ we require an increase in $\log 1 - \beta / \beta$, which in turn implies a lower β. The interpretation for this decrease is that the consumer suddenly wants to consume more in the present at the expense of the future. This is a relative

demand shift across time for given prices and income that generate an aggregate demand shift for all goods in the current period.

We measure changes in relative demand as changes in sectoral consumption. In the US, we use information from the BEA, which contains information for the 66 sectors. For the Euro Area, unfortunately, the level of sectoral disaggregation is quite poor for the time frequency we require. For that reason, we use information on nominal consumption expenditure for three sectors: durables, non-durables and services as in Section 3, which are available from the OECD Quarterly National Accounts. This information is available for 10 out of the 19 countries that composed the Euro Area: Austria, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Luxembourg and the Netherlands.

Figure 1
Schematic of the labor shock



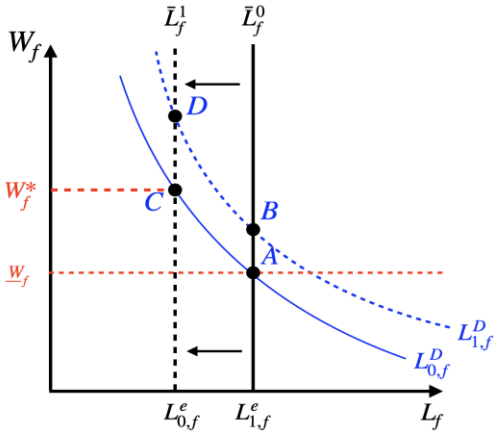
Notes: Before and after the shock, we assume there is full employment. During the pandemic, there is a decline in the potential labor, $\bar{L}_f$, and employment, L_f. For capital, we assume that the levels do not change throughout the pandemic.

Identifying supply shocks. For sectoral supply shocks, we take the Baqaee and Farhi (2022) model literally. Figure 1 shows the schematic of the labor shocks that we model. Before and after the pandemic, we assume that all factors are fully employed with employment normalized at 1. During the early phase of the pandemic, potential labor goes down to $\bar{L}_f$. But due to wage rigidities and demand changes, there is also Keynesian unemployment, potentially bringing down employment to L_f, below $\bar{L}_f$. This is the situation analyzed in Baqaee and Farhi (2022).

In contrast, the period we focus on (2019Q4-2021Q4) exhibits decreases in $\bar{L}_f$ with increases in demand for most sectors. We plot this situation in Chart 11 below. We assume that these changes occur starting from the initial pre-Covid-19 equilibrium where $L_f = \bar{L}_f = 1$. Since wages are only rigid downward, changes in equilibrium employment in those sectors where employment decreases exactly match changes in $\bar{L}_f$, movements from point A to point C in Chart 11. If this change in potential factor supply is also accompanied by an increase in labor demand, wages will move from point C to point D in Chart 11, ultimately increasing wages more.

Chart 11

Decreases in potential labor supply and increase in labor demand

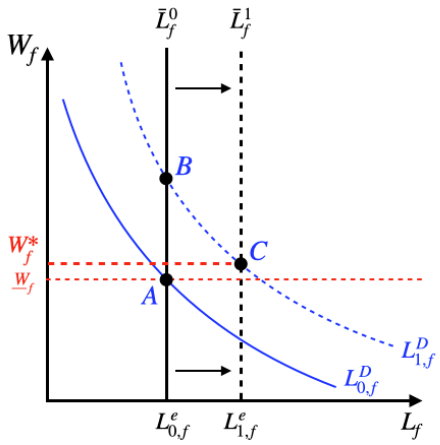


Things are more complicated in those sectors where equilibrium employment increases. The two possible outcomes can be seen in Chart 12. Panel (a) shows a situation where at the given lower bound on the wage, demand is larger than potential supply, i.e., there is excess demand at this wage. This puts upward pressure on the wage such as to eliminate this excess demand. Since the wage is not bounded above, it increases restoring the equilibrium in the market. Hence, we observe an increase in employment in the data bounded by the shift in potential labor supply.

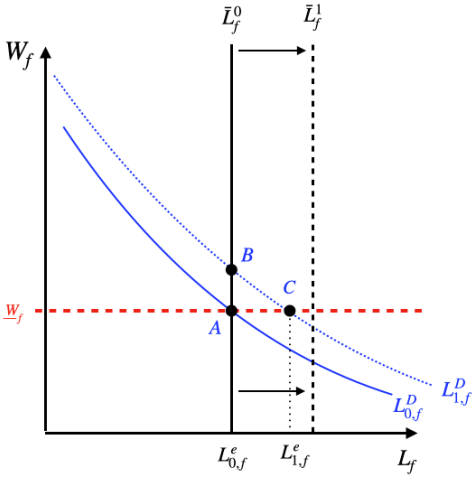
Chart 12

Increases in potential labor supply and labor demand

a) Supply constrained



b) Demand constrained



Panel (b) plots a situation where at the lower bound of the wage, potential supply is larger than labor demand, i.e., there is excess supply. Contrary to the earlier case, the wage mechanism cannot clear the market: the excess supply requires a decrease in

the wage to equate supply and demand. As this is not possible due to the downward nominal wage rigidity, this market features Keynesian unemployment due to insufficient demand. The new “equilibrium” is thus at point C.

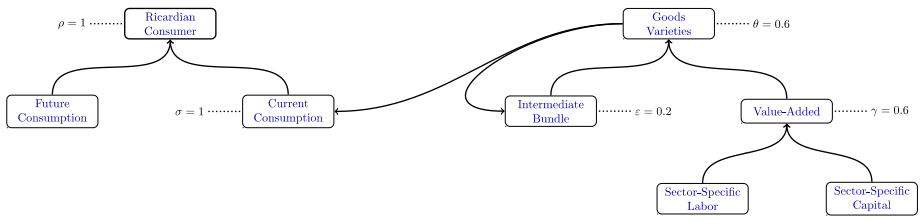
Note, however, that for employment to increase, the market needs a shift on potential labor supply as large as the increase in demand at the given lower bound of the nominal wage. Without the potential labor supply shift, the economy would move from point A to point B featuring the same employment level but higher wages. That is, we should observe no changes in equilibrium employment. Therefore, we assume that observed changes in employment in a situation like panel B comes from a shift in both supply and demand in the same amount and thus moving from point A to C features no Keynesian unemployment. Hence, we can also say that changes in potential labor supply and observed changes in employment exactly match in our analyzed period.

3.3 Quantitative Exercise

In this section, we perform our quantitative exercise. Recall that our model (based on Baqaee and Farhi (2022)) is parsimonious and stylized though it will help us to separate the demand and supply shocks underneath the observed inflation. We calibrate the model to the 2019Q4-2021Q4 period. The key result coming out of the calibration exercise is that the sectoral heterogeneous nature of the Covid-19, coupled with immobile labor and complementarities, played a key role in driving aggregate inflation. We provide a summary of the shocks and parameters we use in our calibration exercise in Table A.1. In what follows, we provide a detailed description on how we calibrate the parameters and the shocks.

3.3.1 Calibrating Parameters

Figure 2
Schematic of the Closed Economy Model



Notes: We assume that each node is an aggregation of the nodes below with the constant elasticity of substitution function with the corresponding elasticities.

As shown in Figure 2, each sector’s production function is a nested CES aggregators of labor, capital, and intermediates good. As both labor and capital are sector-specific, there are three different layers of substitution in the model. The first one is between labor and capital. We set the elasticity of substitution between these factors to $\gamma = 0.6$. The second substitution is that between value added, the one produced using labor and capital, and intermediates. We set this elasticity to $\theta = 0.6$. Finally, there is

substitution across intermediate goods. We set this elasticity to $\varepsilon = 0.2$. All these values are in line with estimates in the literature (see Atalay, 2017; Boehm, Flaaen, and Pandalai-Nayar, 2019; Oberfield and Raval, 2021; Oberfield, 2013), and are the same as the ones used in Baqaee and Farhi (2022), which points to complementarity in production across different inputs. For consumption, as we already highlighted in the previous sections, we assume a Cobb-Douglas intratemporal utility function. Thus, current consumption is an aggregate of goods with elasticity of substitution $\sigma = 1$. Finally, we set the intertemporal elasticity of substitution $\rho = 1$.

3.3.2 Calibrating Sectoral Demand and Supply Shocks

As the intertemporal elasticity of substitution equals one, households' expenditure shares do not depend on relative prices and we can therefore feed the sectoral consumption expenditures changes in the data to the model directly as measures sectoral demand shocks.

The model has labor supply shocks affecting the quantity of potential labor used by each industry. As discussed in Section 3.2, we use observed changes in employment to feed into the model potential labor supply shocks.

$$\Delta_{t-t_0} = \frac{1}{t-t_0} \sum_{\tau=t_0+1}^{t} \frac{X_\tau}{X_{t_0}} - 1,$$

where Δ_{t-t_0} is the observed average change in variable X between periods t and t_0. For total hours worked, we aggregate sectoral changes weighting by each sector labor compensation over total value added. For consumption, we aggregate using each sectoral consumption share over total consumption.

3.3.3 Calibrating Aggregate Demand Shocks

The model-specific concept for the aggregate demand shock is not changes in nominal GDP but rather a discount shock, we back this aggregate demand shock using equation (3.7) above. To calculate aggregate demand shock, we use observed inflation and labor hour changes in the specified period. We feed all these numbers into the model.

For nominal GDP, inflation, and nominal wages, we compute the change between the baseline and the period-end value as a growth rate. That is, we construct

$$g_{(t-t_0)} = \frac{X_t}{X_{t_0}} - 1,$$

where X can be nominal GDP or a CPI index, and $g_{(t-t_0)}$ is the growth rate between period t and t_0. We use two different price indices to compute inflation: headline CPI or core CPI (headline CPI minus food and energy).

3.3.4 Data

Table 1 summarizes the aggregate and sectoral data that we construct. Panel A presents sectoral statistics based on the most disaggregated data, while Panel B is based on using 3-sector aggregation.

Table 1

Observed data, 2019Q4-2021Q4 (in % changes)

	Panel A. All sectors					
	Nominal GDP	Cons.	Hours	Headline CPI	Core CPI	Nominal Wages
United States	10.64	-0.72	-2.14	8.47	7.16	7.85
Euro Area	4.42	-7.54	-1.48	4.69	2.86	5.01
	Panel B. Three sectors					
	Nominal GDP	Cons.	Hours	Headline CPI	Core CPI	Nominal Wages
United States	10.64	-1.23	-2.58	8.47	7.16	7.85
Euro Area	4.42	-7.54	-1.93	4.69	2.86	5.01

Notes: We compute nominal GDP, inflation measures and nominal wages using period-end month and quarters. Nominal GDP measures for the US and Euro Area come from the Federal Reserve Economic Data (FRED) of the Federal Reserve bank of St. Louis. US inflation measures come from FRED, while Euro Area inflation measures come from EuroStat. Nominal wages for the Euro Area come from EuroStat, while nominal wages in the US come from FRED. For consumption and total hours worked, we compute them as cumulative changes between the baseline and end period. In Panel A, for the US, we use information on all 66 sectors for both consumption and total hours worked. For the Euro Area, we use information on 45 sectors for total hours worked and for three sectors only for consumption. We aggregate sectoral consumption and total hours worked using consumption shares and labor shares, respectively. In Panel B, we aggregate to the durable, non-durable, and service sectors. For consumption and total hours worked, we compute them as cumulative changes between the baseline and end period.

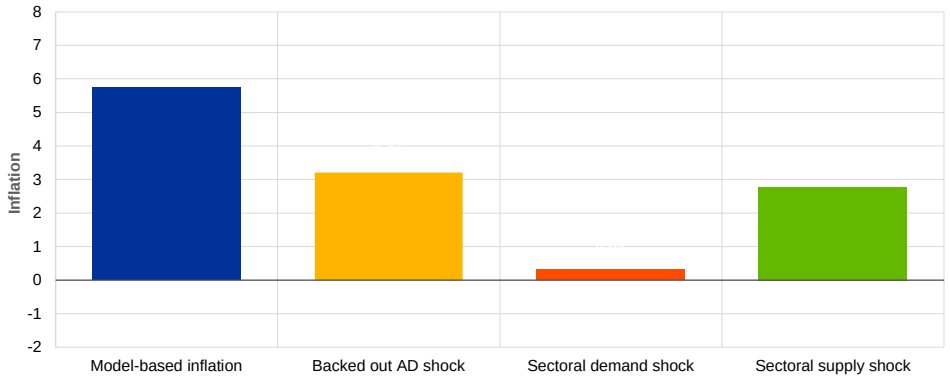
As can be seen, both in Panels A and B, when we focus on the entire period from 2019Q4 to 2021Q4, both in the US and Euro Area, nominal GDP, wages, and inflation.

3.3.5 Predicted Inflation

Euro Area Calibration. Chart 13 below shows the baseline calibration for predicted inflation for the Euro Area based on 45 sectors of data for labor hours, whereas consumption data is only for 3 sectors. Predicted inflation of 5.75 percent includes all the shocks (sectoral demand, supply, aggregate demand) and is largely due to the aggregate demand shock but the sectoral labor supply constraint still plays a large role. Put it differently, without the negative sectoral labor supply shock, inflation would have been only 3.21 percent. This is also reflected in the fact that out of the 45 sectors in our model that consider all shocks, 34 of them are supply constrained.

Chart 13

Euro Area 45 Sectors: 2019Q4-2021Q4

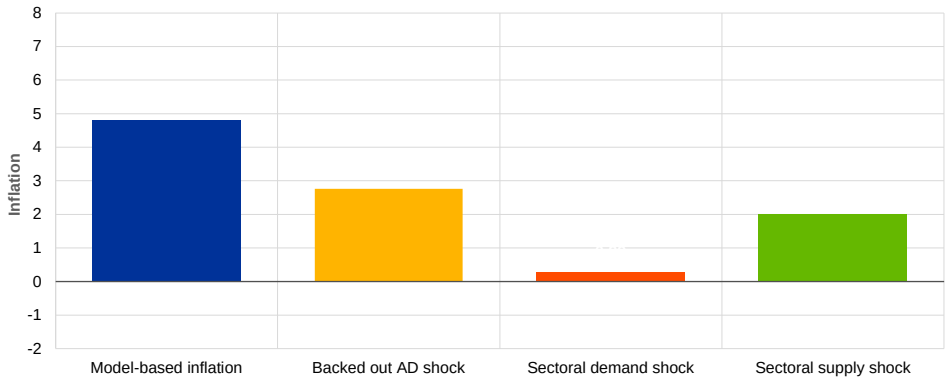


Notes: The first (blue) bar shows model-based inflation considering all shocks (demand and supply). The second (yellow) bar considers the aggregate demand shift only. The third (orange) bar uses only sectoral demand shocks. Finally, the fourth (green) bar uses sectoral supply shocks.

Chart 14 examines the robustness of aggregating all labor hours to 3 sectors from 45 and shows the same result as the 45-sector calibration: inflation would have been 2.76 instead of 4.81 if we only considered aggregate demand shocks. Therefore, regardless of the level of aggregation, sectoral supply bottlenecks played a key role in explaining Euro Area inflation over the 2019Q4-2021Q4 period. Further, notice that the fit of the model is close to the data given our backed-out aggregate demand shock strategy.

Chart 14

Euro Area 3 Sectors: 2019Q4-2021Q4



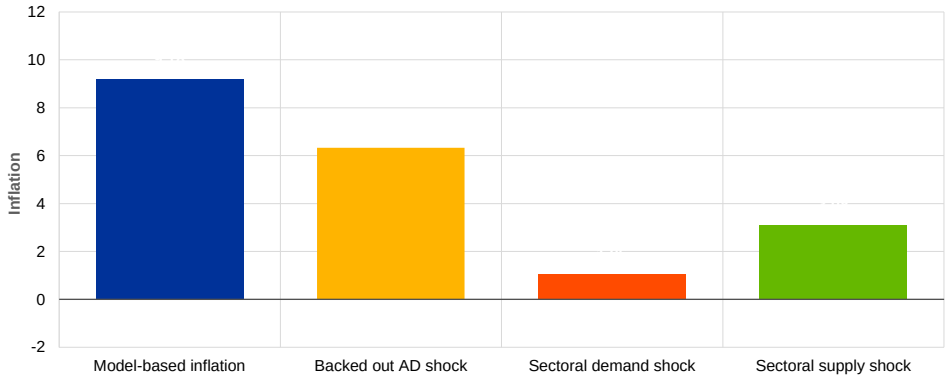
Notes: The first (blue) bar shows model-based inflation considering all shocks (demand and supply). The second (yellow) bar considers the aggregate demand shift only. The third (orange) bar uses only sectoral demand shocks. Finally, the fourth (green) bar uses sectoral supply shocks.

United States Calibration. Chart 15 replicates the same exercise for the US, using the same set of 66 sectors as in Baqaee and Farhi (2022). Supply constraints also play a role here, with a predicted inflation of 9.18 instead of 6.33 due to sectoral labor supply constraints. As shown in Chart 16, using only 3 sectors does not change the results. The observed inflation in the US during this period is 8.47. However, in contrast to the Euro Area results, aggregate demand shocks play a greater role in explaining US inflation. Consequently, most sectors in the US are supply-constrained

in our main specification (blue bar): 58 out of 66 sectors are supply-constrained. This result is consistent with Gourinchas, Kalemli-Özcan, Penciakova, and Sander (2021), where expansionary fiscal policy (an aggregate demand shock) increases the share of sectors classified as supply constrained. Further, while the relative contribution in the change of sectoral demand shifts (the orange bars) is small both for the Euro Area and US calibrations, these shifts play a relatively larger role in explaining observed US inflation (roughly double the importance for the US when going from 3 to 66 sectors).

Chart 15

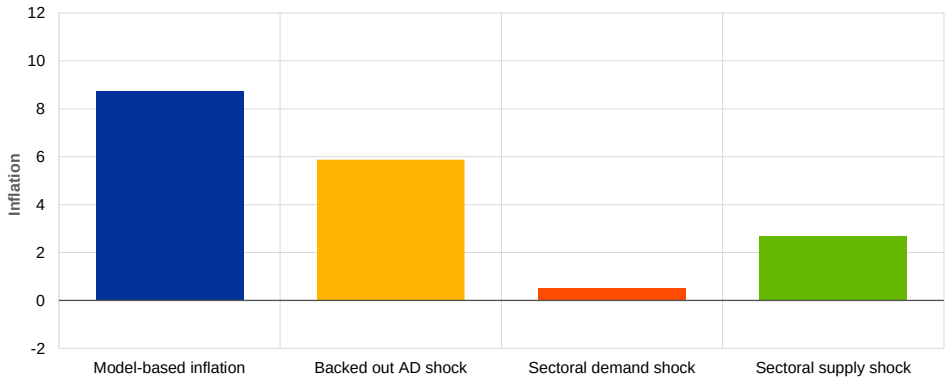
US 66 Sectors: 2019Q4-2021Q4



Notes: The first (blue) bar shows model-based inflation considering all shocks (demand and supply). The second (yellow) bar considers the aggregate demand shift only. The third (orange) bar uses only sectoral demand shocks. Finally, the fourth (green) bar uses sectoral supply shocks.

Chart 16

US 3 Sectors: 2019Q4-2021Q4



Notes: The first (blue) bar shows model-based inflation considering all shocks (demand and supply). The second (yellow) bar considers the aggregate demand shift only. The third (orange) bar uses only sectoral demand shocks. Finally, the fourth (green) bar uses sectoral supply shocks.

Sensitivity Analysis. Thus far, our results suggest that the model, although close to observed data, overpredicts inflation. We now conduct sensitivity analysis on these results using the more disaggregated data for the US and the Euro Area, i.e., 66 and 45 sectors, respectively.

We consider three scenarios where we vary the degree of substitutability across factors (labor and capital, γ), across intermediate goods (ϵ), and between factors and intermediates goods (θ) separately. As such, we can study in a transparent manner

how complementarities can affect our earlier results at different levels of the production structure. In all our exercises, we do not change the consumer side of the model, meaning that the utility function remains Cobb-Douglas both within and across periods.

Table 2 shows inflation numbers under the three different scenarios and a different set of shocks, as we did in the earlier section. We provide four shock experiments. The "All Shocks" row feeds all shocks into the model at once. We then proceed and mutes all but one shock at a time. The "aggregate demand" row only feeds in the backed-out aggregate demand shock and mute sectoral supply and demand shocks. We proceed in a similar fashion with sectoral supply and demand shocks, again including one set at a time and muting the other shocks.

The Baseline column reproduces our earlier inflation numbers. Recall that that scenario uses an elasticity of substitution of 0.6 between factors of production, 0.6 between value-added and intermediate goods, and 0.2 across intermediate goods. In the Cobb- Douglas column, we set these three different elasticities to be equal to 1. Finally, the Leontief model set these three elasticities to equal 0.2.

Quantitatively, aggregate demand shocks are more important in the US than in the Euro Area in all three cases. Indeed, they account for around two-thirds of inflation in the US, while only half of inflation in the Euro Area. Instead, sectoral supply shocks in the US account for around one-third of inflation and the other half of inflation in the Euro Area. Sectoral demand shocks alone play a minor role in driving inflation, which is more limited in the Euro Area than in the US.

Moving from a model with high complementarities in production (Leontief column) to a model with no complementarities (Cobb-Douglas column) reduces overall inflation in both the US and the Euro Area when we hit the economies with all the shocks. The behavior of sectoral supply shocks mainly drives this result and can be explained by the following intuition. In the presence of complementarities, a negative labor shock implies a great drop in the value added that enters into production.[14] In turn, by a similar argument, the complementarity between value added and intermediate inputs also brings down output. Hence, the supply of the goods decreases more with higher complementarities of production, which in turn drives prices in the opposite direction, thereby generating a higher level of inflation relative to an economy with a greater degree of substitution in the production process.

The earlier discussion suggests that inflation under our baseline scenario, which features complementarities, should mainly come from sectoral wage inflation and less from capital price inflation. Indeed, a simple decomposition of the model when all shocks are fed in shows that wage inflation is 9.14 percent and capital price inflation is 1.53 percent in the Euro Area. In comparison, it is 11.75 and 5.32 percent in the US, respectively. When compared to the actual data on nominal wage growth during this period (last column in Table 1), we can see that we are over predicting wages, as they

[14] To be precise, suppose labor decreases to Δ_L from an initial level of 1. Then the value-added decreases from the equilibrium level of 1 to:

$$\Delta_{VA} = \left((1 - \alpha_L) + \alpha_L (\Delta_L)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}.$$

were 7.85 percent in the US and 5.01 percent in the Euro Area. Yet, the model's notion of "factors" is broader than what we have in the data. As a result, factor prices in the model may capture other issues that we do not explicitly model. These include things such as mark-ups, other sector-specific factors (e.g., human capital), or open economy aspects that we do not formally include in these exercises but briefly explore in our open economy exercise below.

Interestingly, the impact of sectoral demand shocks does not have a clear monotonic relationship with the elasticities of substitution. This result is expected, however, as by construction sectoral demand shocks shift demand from some sectors to other sectors while keeping aggregate expenditure fixed. In doing so, it pressures prices downwards in some sectors and upward in others. Ultimately, it is a quantitative question of how much inflation they generate at the aggregate level. In our case, the answer is not so much.

Finally, aggregate demand shocks generically raise inflation in the same proportion in all cases as prices of goods and factors are fully allowed to adjust upwards. Therefore, elasticities of substitution have no role on the pass-through from aggregate demand shocks to inflation.

Table 2

Inflation under Different Substitution Patterns

Panel A. United States			
	Calibration Model		
	Cobb-Douglas	Baseline	Leontief
Shocks	(1)	(2)	(3)
All	8.93	9.18	9.68
Aggregate Demand	6.33	6.33	6.33
Sectoral Demand	1.01	1.06	0.77
Sectoral Supply	2.70	3.08	3.56
Panel B. Euro Area			
	Calibration Model		
	Cobb-Douglas	Baseline	Leontief
Shocks	(1)	(2)	(3)
All	5.40	5.75	6.16
Aggregate Demand	3.21	3.21	3.21
Sectoral Demand	0.28	0.31	0.22
Sectoral Supply	2.56	2.78	3.04

Notes: This table shows overall inflation under three different specifications of the production function. The baseline model, column (1), corresponds to the same model used in the previous section, which uses a elasticity of substitution of 0.6 between factors of production, 0.6 between value added and intermediate goods, and 0.2 across intermediate goods. The Cobb-Douglas model of column (2) sets all these elasticities of substitution to equal 1. The Leontief model, column (3), sets all these elasticities to equal 0.2. We use 66 sectors for the US and 45 sectors for the EA and the period 2019Q4-2021Q4 to compute these numbers in the calibrations.

Summary. Our quantitative exercise shows the important role that different shocks played in driving inflation throughout the Covid-19 period to the end of 2021. Crucially, both demand and supply shocks played quantitatively important roles in driving inflation in both the Euro Area and the US. However, the relative importance of

aggregate demand and sectoral supply (supply chain bottleneck) shocks differed across the two regions. Whereas aggregate demand shocks appear to have played a larger role in explaining US inflation, supply chain bottlenecks play a larger role in explaining European inflation. This finding is perhaps not surprising given the differing nature of government support during the crisis across the two regions as well as the consumption behavior of consumers in the two regions. Further, the impact of shocks and bottlenecks spilled over across countries, which may have also played an important role in explaining observed inflation. We tackle this issue in the following section.

4 Inflation under Supply Chain Bottlenecks: International Linkages Model

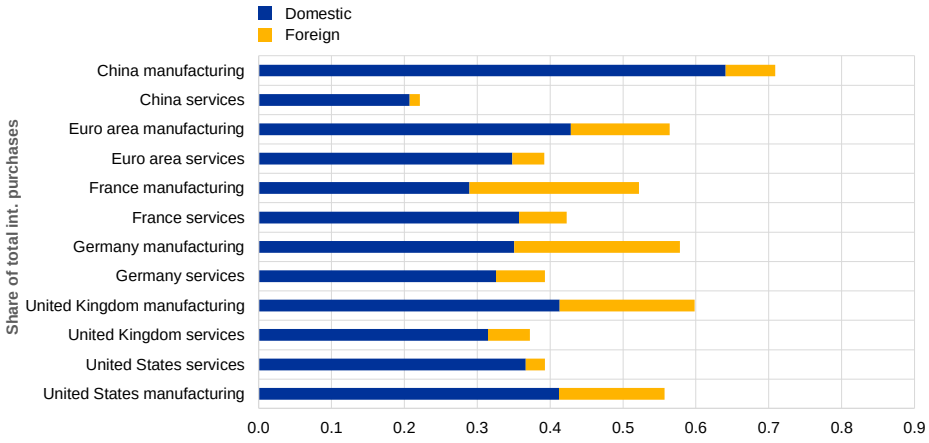
In the last section, we decomposed inflation in both the Euro Area and the United States using a closed-economy setup. Although useful, this setup may miss important features of actual economies such as their exposure to international trade in goods and services, which we evaluate next.

We follow Çakmaklı, Demiralp, Kalemli-Ozcan, Yesiltas, and Yildirim (2021) and extend the closed-economy model presented in Baqaee and Farhi (2022) to analyze the effects of the global inter-industry linkages on inflation observed in Euro Area. We use three sectors (durables, non-durables and services) and three regions (Euro Area, US and Rest of the World).

We first illustrate how different the shares of sourced inputs domestically and from abroad can be. Chart 17 shows input sourcing for the manufacturing sector in different countries. The height of each bar shows how much each sector below the bars account of total intermediate purchases by the manufacturing sector. We then split these shares into what comes from domestic and foreign sources. For example, take China: 70 percent of manufacturing intermediate purchases comes from the manufacturing sector (height of the first bar, the sum of the blue and yellow bars). Of this 70 percent, near 65 percentage points (blue bar) come from domestic manufacturing.

Chart 17

Domestic and Foreign Content of Intersectoral Trade (%, Total Intermediate Purchases): Manufacturing

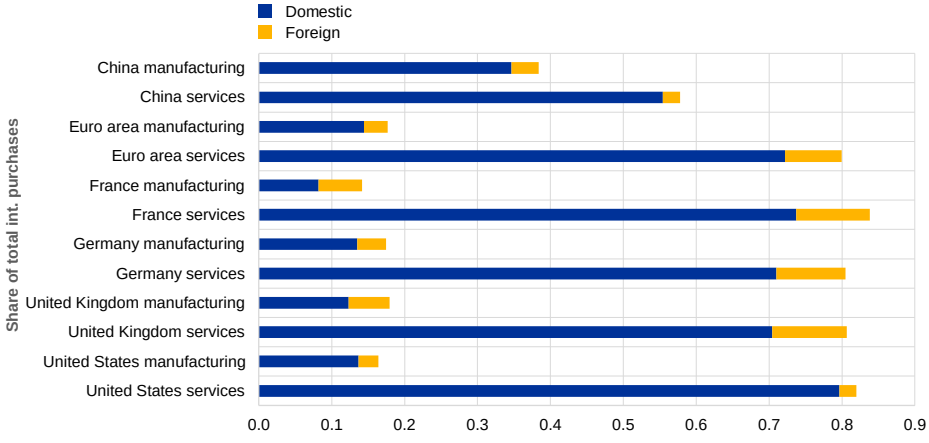


Notes: Based on ICIO Tables Year 2018. Sectors are classified as: Agriculture, Manufacturing, Services and Others.

Chart 18 shows the same figure for services. Taking China again as an example: 40 percent of services intermediate purchases comes from the manufacturing sector (height of the first bar). Of this 40 percent, near 37 percentage points (yellow bar) come from domestic manufacturing.

Chart 18

Domestic and Foreign Content of Intersectoral Trade (%, Total Intermediate Purchases): Services



Notes: Based on ICIO Tables Year 2018. Sectors are classified as: Agriculture, Manufacturing, Services and Others.

The details of the full model is in Appendix A.2, which we refer the interested reader to[15]. For the sake of saving space, we note that the model structure is like the closed-economy model of Section 3, though now with households and firms being able to source goods from abroad.

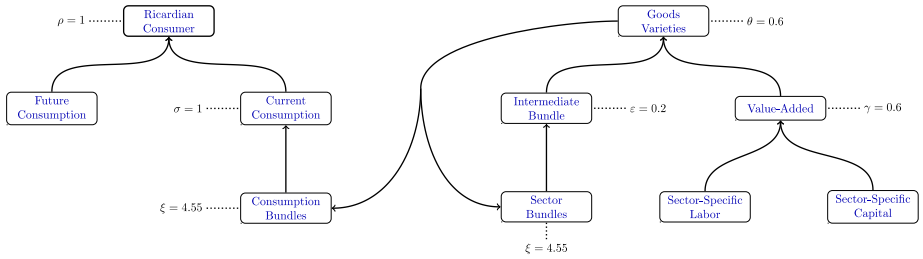
[15] The log-linearized solution for this model (except the future consumption) is present in Çakmaklı, Demiralp, Kalemli-Ozcan, Yesiltas, and Yildirim (2021). Here we use a numerical solver to find the solution.

Figure 3 shows the structure of our model with international linkages. In contrast to the closed economy-model outline in Figure 2, we have additional layers of sector bundles in both the consumption and production sides. Specifically, each sectoral bundle is made of goods from sourced from different countries, and the sectoral bundles are then aggregated to a final consumption or production goods. These elasticities for this sectoral aggregation are set to the aggregate elasticity of 4.55 reported by Caliendo and Parro (2015). The rest of the parameters are the same as the closed-economy case.

Our multi-country framework assumes that countries all have balanced trade. In Appendix A.2.1, we show how we operationalize this assumption to match the observed input output linkages by adjusting observed value-added levels (similar to inventory wedge approach in trade literature). Finally, our model incorporates exchange rate dynamics by assuming that central banks are inflation targeters[16]. With this assumption, we are able to model a country-specific downward nominal wage rigidity.

Figure 3

Schematic of the model



Notes: This model is adopted from Çakmaklı, Demiralp, Kalemli-Ozcan, Yesiltas, and Yildirim (2021) and Baqaee and Farhi (2022). We assume that each node is an aggregation of the nodes below with the constant elasticity of substitution function with the corresponding elasticities.

In our multi-country framework, we use the same labor shocks, demand shocks and aggregate demand shocks for the Euro Area and the US as in Section 3. We aggregate all the data for "Rest of the World" into a fictive country that we denote by RoW. We create the sectoral demand shock for RoW by aggregating the demand changes that we use in Section 5 below for countries outside the Euro Area and US. For the aggregate demand shock for the Euro Area and US, we use the same backed out values reported in Charts 14 and 16. For the RoW, we calibrate its GDP change over the period to 2 percent so that the predicted inflation in the Euro Area falls between the values reported in Charts 13 and 15. For the labor shock, we do not have data on the sectoral labor hour changes for RoW. Hence, we use the population weighted Oxford stringency index (Hale et. al, 2021) and compare it to the labor declines obtained for the US and Euro Area. Given this strategy, we calculate a 2.5 percent fall in labor for RoW over 2019Q4-2021Q4. Finally, we build the labor shares of value-added for each sector from Baqaee and Farhi (2019), who obtain these values from the World Input Output Database.

[16] Appendix A.2.1 notes that our results are robust to other monetary policy/exchange rate assumptions.

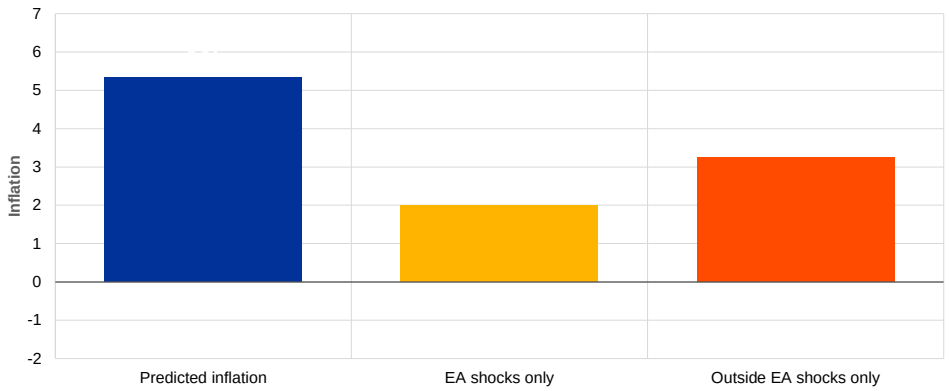
Using these values, we run three alternative scenarios. In **scenario 1**, we run the model with the full shocks present in Euro Area, the US and the RoW. In **scenario 2**, we only apply shocks to the Euro Area, and in **scenario 3** we do the opposite and only apply shocks to outside of the Euro Area. For all scenarios, we compare the inflation implications.

Chart 19 shows the results for Euro Area inflation for the calibration of the three scenarios. Scenario 1 (blue bar) gives a similar inflation level to the closed-economy counterparts presented in Section 3. In scenario 2 (yellow bar), where we assume shocks are present only in the Euro Area, the predicted inflation goes down by more than 3.3 percent. This fall in predicted inflation arises because domestic goods demanded by Euro Area households can be substituted with the goods produced abroad, and these regions (the US and RoW) have not been hit by expansionary demand shocks or contractionary labor supply shocks, thus keeping prices of their goods (which are reflected in Euro Area import prices) lower than domestic prices in the Euro Area. In scenario 3, even though there are no shocks present in the Euro Area, shocks abroad increase prices faced by Euro Area households significantly, resulting an inflation level of 3.26 percent in the Euro Area.

Therefore, given that the Euro Area is quite open to trade with the rest of the world and was also subject to a relatively smaller domestic aggregate demand shock, the impact of foreign demand and supply shocks played a larger role relative to domestic shocks in explaining observed inflation over the 2019Q4-2021Q4 period.

Chart 19

Euro Area Inflation over 2019Q4-2021Q4 in a 3 Sectors-3 Countries Model with I-O Linkages: Scenario Analysis



Notes: The first (blue) bar shows predicted inflation considering all shocks in the US, Euro Area and Rest of the World (demand and supply). The second (yellow) bar considers the case when all shocks occur only in the Euro Area shutting down shock in the US and Rest of the World. The third (orange) bar uses feed in shocks for the Rest of World and the US shutting down any shocks occurring starting in the Euro Area.

5 The Composition of Demand and International Trade

5.1 Analytical Framework

The previous section highlighted several stylized facts on the cross-country and cross-sector differences in the economic collapse and recovery during the Covid-19 pandemic. Further, consumption, output and international trade also behaved differently during the Covid-19 period relative to the GFC. In particular, given the rebound in world trade (see Chart 3) in the recent period compared to the GFC, some economists had inferred that the problems with the global supply chains should also smooth out quickly. We argue that the recovery in trade may not be a good metric on its own to understand supply chain issues and bottlenecks and support this point below by using a simple decomposition accounting framework.

We compare the two periods to point out why the patterns we observe in the data are not surprising given the nature of the Covid-19 health shocks vs. what we observed during the GFC. Our analysis follows the work of Bems, Johnson, and Yi (2010), who provide a partial equilibrium global input-output framework that links changes in domestic sector-level consumer demand to foreign countries' output across sectors. Given their model setup and assumptions, a change in a country's demand for a given sector's goods will spillover across countries due to (i) imports of final goods in that sector, and (ii) intermediate trade arising from the production of the sector's goods along the global value chain.

We do not derive the whole quantitative framework. Instead, we lay out the key equations which we use to conduct our accounting exercise and refer the interested reader to Bems, Johnson, and Yi (2010) for the full derivation of the framework and their fascinating analysis of the role of the global production network in generating international spillovers during the GFC, explaining the Great Trade Collapse of 2008-09.

The framework allows for C countries, N sectors, each with constant returns to scale production that combines local factor inputs along with domestic and foreign intermediate goods. Denote the quantity of final goods produced in a given country m, sector j by y_{jm}; the quantity of sector-country good jm used as intermediates for production in sector-country kc by $x_{kc,jm}$, and final demand for sector-country good jm by country c by $x_{0c,jm}$,[17] then market-clearing for the good jm implies that:

$$y_{jm} = \sum_{c}\sum_{k} x_{kc,jm} + \sum_{c} x_{0c,jm}, \tag{5.1}$$

where the double summation on the right-hand side of equation (1) measures total intermediate demand for good jm across sector-country pairs kc, and the second term captures final demand for the good across all countries c.

[17] To interchangeably use the sector indices in consumption, we define sector 0 to be the "consumption" sector.

Taking Equation (5.1) and applying a set of model assumptions, Bems, Johnson, and Yi (2010) show that the percentage change of a sector-country output over two points in time can be related to output changes across all sectors in all countries in the world and final demand for the goods across countries by the following equation:

$$\hat{y}_{jm} = \sum_{c}\sum_{k}\left(\frac{p_{jm}x_{kc,jm}}{p_{jm}y_{jm}}\right)\hat{y}_{kc} + \sum_{c}\left(\frac{p_{jm}x_{0c,jm}}{p_{jm}y_{jm}}\right)\hat{x}_{0c,j}, \tag{5.2}$$

where the hat notation refers to percentage changes. Let's define $M_{kc,jm} \equiv p_{jm}x_{kc,jm}$ as the value of sector-country kc's use of sector-country jm good as an intermediate, and $D_{c,jm} \equiv p_{jm}x_{0c,jm}$ as the value of sector-country jm good demanded by country c, $Y_{jm} \equiv p_{jm}y_{jm}$ as the value of output in sector-country jm. We assume $\hat{x}_{0c,j} \equiv \hat{x}_{0c,jm}$; i.e., the demand change of final good j by country c is identical across potential source countries m. With these definitions, we can rewrite (5.2) as:

$$\hat{y}_{jm} = \sum_{c}\sum_{k}\left(\frac{M_{kc,jm}}{Y_{jm}}\right)\hat{y}_{kc} + \sum_{c}\left(\frac{D_{c,jm}}{Y_{jm}}\right)\hat{x}_{0c,j} \tag{5.3}$$

Equation (5.3) shows that a sector j's output change in country m is equal to a weighted sum of output changes of other countries and demand changes of final goods. The first term on the right-hand side is a weighted sum of a sector-country outputs, where the weights measure the share of good jm used by sector-country kc as an intermediate relative to total output of good jm. This term captures the importance of the global production network, whereby output changes spillover across country-sectors due to intermediate usage. The share is deflated by jm's total output to reflect how important the use of the good by kc relative to jm's total output. The second term on the right-hand side of (5.3) captures the importance of demand changes for jm's goods across countries, again scaled by jm's total output.

What is key to note in Equation (5.3) is that the first term that captures intermediate goods demand can be brought over to the left-hand side of the equation and after stacking this equation across all pairs, we can invert the system (a matrix) in order to express the vector of sector-country output changes, $\hat{y}_{jm}$, as a linear function of sector-country final demand changes, $\hat{x}_{0c,j}$. In particular, the output and demand changes are related by a matrix $\boldsymbol{\Omega}$ that captures global input-output linkages (intermediate goods linkages) and the importance of a sector-country good in countries' final demand. This formulation, therefore, allows to use observed intermediate and final goods shares from global input-output tables to construct $\boldsymbol{\Omega}$, and then feed in observed final demand changes across pairs to calculate the corresponding sector-country output changes implied by this global input-output framework.

Thus far, this framework feeds in observed consumption data and produces output at the sector-country level. We can next use these series and aggregate up to calculate country level measures of total output, GDP, exports, and imports using the following equations:

$$\hat{Q}_m = \sum_i \frac{Y_{jm}}{Y_m} \hat{y}_{jm} \tag{5.4}$$

$$\widehat{GDP}_m = \sum_i \frac{VA_{jm}}{VA_m} \hat{y}_{jm} \tag{5.5}$$

$$\widehat{EX}_m = \sum_{m \neq c} \sum_j \left[\sum_k \left(\frac{M_{kc,jm}}{EX_m} \right) \hat{y}_{kc} + \left(\frac{D_{c,jm}}{EX_m} \right) \hat{x}_{0c,j} \right] \tag{5.6}$$

$$\widehat{IM}_m = \sum_{m \neq c} \sum_j \left[\sum_k \left(\frac{M_{jm,kc}}{IM_m} \right) \hat{y}_{jm} + \left(\frac{D_{m,jk}}{IM_m} \right) \hat{x}_{0m,j} \right] \tag{5.7}$$

Equation (5.4) calculates the country m's output change using the countries sectoral shares of total output. Equation (5.5) calculates country m's GDP change by weighting sectoral output growth by value added shares.[18]

Note that the assumption in this aggregation is that sector-country value added grows at the same rate as total output. Equations (5.6) and (5.7) calculate country-level export and import growth by essentially aggregating up over (5.2) to the country-level, while removing domestic demand. Specifically, the first term on the right-hand side of (5.6) measures how much of country m's exports are driven by intermediate demand for its goods from abroad, while the second term captures the contribution from final goods exports. Meanwhile, the first term in (5.7) measures the importance of imported intermediate inputs to country m's total import growth, while the second term measures the contribution of imported final consumption goods to aggregate import growth.

5.2 Data

The accounting framework requires several pieces of data. First, we require data on both intermediate and final goods trade as well as demands shares of final goods at the country-sector level to construct the matrix $\mathbf{\Omega}$, which allows us to map observed consumer demand changes to final output changes using the matrix version of (5.2). These data are available at the annual level in global input-output tables. We source these data from the OECD ICIO tables for 2007 and 2018 for the GFC and Covid-19 period exercises, respectively. We use data at the onset of the shock on purpose to keep the global linkages at their pre-shock level, assuming during the shock in the short run these supplier relations cannot change. These data are available for 67 countries and 45 sectors.

Second, we need to feed in data series for changes in real domestic demand at the country-sector level, $\hat{x}_{0m,j}$. We source direct measures of real household

[18] We create these shares by aggregating domestic sectors valued added in each country, as observed in the input-output table, to calculate GDP.

consumption growth at the quarterly level for OECD countries for three aggregate sectors: durable goods, non-durable goods, and services. These three sectors are the same that Bems, Johnson, and Yi (2010) examined in their analysis of the Great Trade Collapse, but they did not have direct data available for these series. Instead, they estimated sectoral consumption demand from measures of total domestic demand using various data sources and assumptions.[19] While we follow this methodology to fill in missing non-OECD countries and sectors not covered by the OECD for some countries in the sample, our baseline measure is the observed real household consumption growth from the OECD, which is particularly relevant to consider given our analysis focuses on Euro Area, the US, and other industrial countries.

Finally, note that since we only have time series data for the consumption series for three sectors, we are forced to aggregate the more detailed OECD input-output data to match these three sectors. We aggregate up the OECD input-output tables from 45 sectors to the three sectors by using the same concordance as Bems, Johnson, and Yi (2010). We do this when calculating input-output coefficients as well as domestic and foreign demand shares. Appendix C presents further details on the input-output aggregation and the data series we use for $\hat{x}_{0m,j}$.

5.3 Results

Table 3 begins by presenting summary statistics for the durables, non-durables, and services sectors based on the 2018 Input-Output table sourced from the OECD ICIO database. We present each sector's share as a share of gross output, value added, domestic final demand, imports, and exports for the United States (US), Euro Area (EA), United Kingdom (UK), and the World, where shares for country groups are weighted averages based on the country sample.

Two key facts emerge from looking across the countries and sectors. First, the services sectoral share dominates a country's gross output, value added (i.e., GDP), and domestic final demand. Further, while not as important as for production and final demand, services also represent the largest share of both imports and exports.[20] Second, when zooming in on the goods' sectors (durables vs. non-durables), we see that non-durables tend to be a larger share for an economy's production as well as imports and exports, but domestic total demand is approximately the same across durables and non-durables.

[19] See Appendix C of their paper.

[20] Note that the services sector share of trade is larger than what is reported by countries' customs and that would be calculated using product-level data. This reflects the fact that we include the Wholesale & Retail sector as part of the services sector and domestic wholesalers often act as middlemen in international trade Bernard, Jensen, Redding, and Schott (2010).

Table 3

Sectoral shares based on 2018 input-output tables

	Output	VA	Final Demand	Imports	Exports
United States					
Durables	0.06	0.05	0.08	0.31	0.22
Non-Durables	0.13	0.08	0.08	0.29	0.25
Services	0.81	0.87	0.83	0.40	0.52
Euro Area					
Durables	0.11	0.07	0.12	0.20	0.22
Non-Durables	0.16	0.10	0.10	0.32	0.35
Services	0.73	0.83	0.78	0.48	0.43
United Kingdom					
Durables	0.06	0.04	0.07	0.20	0.16
Non-Durables	0.10	0.07	0.09	0.24	0.20
Services	0.84	0.89	0.85	0.56	0.64
World					
Durables	0.09	0.06	0.10	0.21	0.21
Non-Durables	0.20	0.14	0.12	0.35	0.44
Services	0.71	0.79	0.78	0.45	0.35

Notes: This table presents the sectoral shares of output, value added, final demand, imports and exports for the three sectors in the economy: (i) Durables, (ii) Non-Durables, and (iii) Services. All calculations are based on the 2018 OECD ICIO table, which has information for 71 countries and 43 sectors, which we aggregate to countries or country-groups and three aggregate sectors. The disaggregate sectoral data are assigned to (i), (ii), or (iii) following Bems, Johnson, and Yi (2010).

Table 4 presents country-level elasticities of real imports and real exports viz. real GDP for the US, Euro Area, UK and the World. Panel I, columns (1)-(4), construct the elasticities based on observed data, while Panel II, columns (5)-(8), construct the elasticities based on the quantitative exercise and equations (3.4)-(3.6). Panel A results are based on data from the Great Financial Crisis and uses year-on-year growth rates between 2008Q2-2009Q2 for the Collapse and 2009Q2-2010Q2 for the Recovery. Panel B results are based on data from the Covid-19 Pandemic and use year-on-year growth rates between 2019Q2-2020Q2 for the Collapse and 2020Q2-2021Q2 for the Recovery.

Looking at the elasticities calculated with the data in Panels IA and IB, several interesting facts stand out in looking at the ‘Collapse’ and ‘Recovery’ periods across the two crises. First, and foremost, Covid-19 elasticities are much lower than the GFC elasticities, indicating a lower response of trade to changes in GDP. This is true both for the collapse and recovery periods. This fact holds true for all country samples, except for the World sample during the pandemic collapse, though the difference with the GFC’s world elasticity is minor. Trade responded more to the changes in GDP during GFC relative to Covid-19. The difference in elasticities between the two periods is notable and perhaps not surprising given that the shocks hitting economies in the two periods are very different, i.e., the financial shock of the GFC vs. the Covid-19 health shock.

The second fact is that the import and export elasticities are always larger for the US relative to the Euro Area, the UK and the world as a whole. This is true both for imports and exports as well as during periods of collapse and recovery.

To better understand how the composition of demand played a role in the difference in elasticities, we begin by calculating the country-level trade elasticities using the quantitative framework outlined above in Panels IIA and IIB. The structure of these model-based results is identical to what we just described for the elasticities calculated for using realized trade and GDP data, except now we have fed in observed country-sector consumption growth rates and compute the implied growth rates of imports, exports, and GDP given the model setup.

In comparing the model-implied elasticities of columns (5)-(8) to their data counterparts in columns (1)-(4), it is notable that the model-implied elasticities are smaller. This is not surprising given that model framework is partial equilibrium and has several assumptions built into that only approximate reality. However, the quantitative results still match up reasonably well to what we calculate using realized trade and GDP data: the model-implied elasticity is roughly one-half of the actual across all observations in Panel A for the GFC period, and three-quarters of the actual across all observations in Panel B for the Covid-19 period.

Importantly, the results that the trade elasticities are larger during the GFC than the Covid-19 pandemic period hold up for most of the observations when looking at the model results. While we utilize different vintages of input-output tables (2007 and 2018) when implementing the quantitative framework to the two crisis periods, these data do not differ dramatically in the cross-section, providing further support that supply chain relations do not change easily (i.e., a 2007 version of Table 3 looks very similar to the 2018 version presented). Rather, differences in how consumption changed across sectors in the two periods is key for understanding the smaller elasticities during the Covid-19 period relative to the GFC.

Table 4

Trade elasticities with respect to GDP

	Panel I. Data				Panel II. Model			
	Panel A. Great Financial Crisis							
	Collapse		**Recovery**		**Collapse**		**Recovery**	
	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
United States	4.35	3.31	5.90	4.99	2.65	1.74	1.67	2.09
Euro Area	2.74	3.11	5.39	5.65	1.34	2.05	0.86	2.39
United Kingdom	1.99	2.02	3.72	3.04	1.28	0.39	0.87	0.49
World	1.29	1.29	4.15	4.15	1.63	1.63	1.34	1.34
	Panel B. Covid-19 Pandemic							
	Collapse		**Recovery**		**Collapse**		**Recovery**	
	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
United States	2.43	2.63	2.50	1.52	0.60	1.09	1.31	1.20
Euro Area	1.42	1.45	1.49	1.82	0.87	0.74	1.04	1.16
United Kingdom	1.31	0.64	0.92	0.25	0.89	0.29	1.01	0.63
World	1.48	1.48	2.03	2.03	0.89	0.89	1.06	1.06

Notes: This table presents country-level elasticities of real imports and real exports viz. real GDP. Panel I, columns (1)-(4), construct the elasticities based on observed data, while Panel II, columns (5)-(8), construct the elasticities based on the quantitative exercise and equations (3.5)-(3.7). Panel A results are based on data from the Great Financial Crisis and uses year-on-year growth rates between 2008Q2-2009Q2 for the Collapse and 2009Q2-2010Q2 for the Recovery. Panel B results are based on data from the Covid-19 Pandemic and use year-on-year growth rates between 2019Q2-2020Q2 for the Collapse and 2020Q2-2021Q2 for the Recovery.

Table 5 next decomposes the model-based elasticities into responses driven by the intermediate and final goods' components of trade, where the intermediates' contributions are calculated in the first terms of equations (5.6) and (5.7) and the final goods' trade values are in the second terms of the equations. The table's structure follows that of Table 4, but we now report the imports and exports elasticities split into the 'Inter.' and 'Final' terms. For example, the total imports elasticity for the US reported in column (1) of Table 4, Panel A, is a weighted average of the terms in columns (1) and (2) of Panel A in Table 5, where the weights are the intermediate and final goods' share of total imports, respectively.

Table 5

Trade elasticities decomposition

	Panel A. Great Financial Crisis							
	Collapse				Recovery			
	Imports		Exports		Imports		Exports	
	Inter.	Final	Inter.	Final	Inter.	Final	Inter.	Final
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
United States	1.88	3.53	1.53	2.00	1.43	1.95	1.87	2.36
Euro Area	1.31	1.45	1.64	2.58	1.19	0.52	2.27	2.53
United Kingdom	1.04	1.51	0.36	0.43	0.91	0.83	0.52	0.45
World	1.36	1.98	1.36	1.98	1.27	1.39	1.27	1.39
	Panel B. Covid-19 Pandemic							
	Collapse				**Recovery**			
	Imports		Exports		Imports		Exports	
	Inter.	Final	Inter.	Final	Inter.	Final	Inter.	Final
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
United States	0.80	0.39	1.06	1.14	1.16	1.48	1.19	1.29
Euro Area	0.86	0.89	0.77	0.72	1.05	1.03	1.14	1.18
United Kingdom	0.90	0.88	0.54	0.50	0.95	1.04	0.65	0.64
World	0.92	0.84	0.92	0.84	1.03	1.09	1.03	1.09

Notes: This table presents the decomposition of the model-based country-level elasticities of real imports and real exports viz. real GDP, reported in Table 4, into the contribution of intermediates goods' trade ('Inter.') and final goods trade ('Final'). Panel A results are based on data from the Great Financial Crisis and uses year-on-year growth rates between 2008Q2-2009Q2 for the Collapse and 2009Q2-2010Q2 for the Recovery. Panel B results are based on data from the Covid-19 Pandemic and use year-on-year growth rates between 2019Q2-2020Q2 for the Collapse and 2020Q2-2021Q2 for the Recovery.

Panel A's results show that most the trade's collapse during the GFC was driven by final goods' trade, particular for US imports and Euro Area's exports, confirming results reported in Bems, Johnson, and Yi (2010). A similar pattern holds for the first year of the recovery period. Looking at the world, we see that final goods trade played a somewhat larger role in explaining the total elasticity of both imports and exports in both the collapse and recovery periods.

Turning to the Covid-19 pandemic results in Panel B, it's interesting to note that results reverse, and the relative contribution of intermediates play a greater role in explaining the trade elasticities relative to the GFC period, consistent with supply chain bottlenecks. This switch is particularly notable for US imports and Euro Area exports, where the share of intermediates goods trade dominated. This changing pattern highlights the role in the collapse of the service sector during initial lockdown, which then spilled over across countries given the demand of intermediate goods by the service sector. Indeed, the elasticities of intermediates trade was larger than that of final goods when looking at the last row of the table for the world during the trade collapse, highlighting how lockdowns spilled over through the global value chain. Meanwhile, the recovery period more balanced viz. the contribution of intermediate and final goods trade to the rebound, but the relative contribution of intermediates trade can still explain roughly half of world trade and more important during Covid-19 episode than the GFC.

To summarize, this section highlights the key role that the composition of demand plays in driving the observed trade patterns during the Covid-19 pandemic. We show that the change in trade relative to GDP was more muted during Covid-19 than the GFC, and that this result follows naturally given the health shock, which resulted in a shutdown of the service sector in the latest crisis, a shortage of labor and the related supply chain issues. We also show that the effects of such lockdowns spilled over across countries given the service sector's reliance on intermediate trade goods.

While it has been argued that trade recovered quickly during Covid-19 relative to the GFC, it should be emphasized that this change in trade was muted compared to the change in domestic output (Table 4). This difference reflects the contrast in shocks in the two periods (financial vs. health), which impacted production as well as the composition of demand. It would therefore be misleading to say that the rebound in trade observed in the Covid-19 recovery period reflected well-functioning supply chains. Indeed, trade flows are an equilibrium outcome, which capture demand and supply pressures. Therefore, focusing only on quantities may be misleading and one needs to also consider price dynamics to fully understand the macroeconomic impact of supply-chain bottlenecks via the global production network, as our quantitative exercises in Sections 3 and 4 show.

6 Conclusion

Our results point to several factors underlying the persistent inflation that the Covid-19 pandemic has generated. Interestingly, the relative importance of these factors varies across countries, with marked differences in the Euro Area and United States. While global supply bottlenecks have played a key role in generating inflation across all countries, our analysis shows that the relative importance of these negative supply shocks (domestic and foreign) is larger for the Euro Area than the US, where aggregate demand shocks played a comparatively greater role in explaining the observed inflation between 2019Q4-2021Q4. These findings present a mixed view on the potential potency of monetary policy in taming current inflation. While our model-based calibrations imply that a contraction in aggregate demand will help dampen inflation, there will remain upward pressure on price growth as long as global supply bottlenecks persist.

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Appendix

A A model details

In this appendix, we outline the details of both the closed and open economy models.

A.1 Closed-economy model details

A.1.1 Firm's cost minimization problem

Under perfect competition, firms take good and factor prices as given and solve the following cost minimization problem:

$$\min_{L_i, \mathbf{X_i}} \sum_{j=1}^{N} p_j x_{ij} + w_i L_i$$

$$s.t. \tag{A.1}$$

$$A_i \mathrm{G}(L_i, \mathbf{X}_i) \geq \bar{y}_i,$$

where $\bar{y}_i$ is a given level of output produced in sector i. In equilibrium, sectoral good prices equal sectoral marginal costs:

$$p_i = MC_i(A_i, w_i, \mathbf{p}) \tag{A.2}$$

Given constant returns to scale production, a firm's marginal costs are a function of productivity in that sector, A_i, the wage of the factor it employs, w_i, and a vector of intermediate good prices, denoted by $\mathbf{p}$.

Log differentiating (A.2) implies that the log change in sector i's price is related to technology and factor and intermediate goods price changes by

$$d \log p_i = \alpha_i \, d \log w_i + \sum_{j=1}^{N} \Omega_{ij} \, d \log P_j - d \log Z_i \tag{A.3}$$

Where

$$\Omega_{ij} = \frac{p_j x_{ij}}{p_i y_i}, \text{and } \alpha_i = \frac{w_i L_i}{p_i y_i}.$$

Ω_{ij} represents sector i's expenditures on goods from sector j as a share of sector i output, which is referred to as an input-output coefficient. A_i is the expenditure on the specific factor by sector i again as a fraction of its total output and captures the value-added share.

Using (A.3) to solve for prices as a function of factor prices and productivity changes yields

$$\mathrm{d}\log p_i = \sum_{k=1}^{N} \Psi_{ik}\, \alpha_k\, \mathrm{d}\log w_k - \sum_{k=1}^{N} \Psi_{ik}\, \mathrm{d}\log A_k \tag{A.4}$$

A.1.2 Household's problem

The household maximizes utility both intertermporally and intratemporally as follows.

Intertemporal Problem. Utility maximization implies the following Euler equation

$$C = \frac{(1-\beta)}{\beta} \frac{P^* C^*}{P} \frac{1}{1+i} \tag{A.5}$$

Taking logs and rearranging the terms, we can express consumption as a function of an aggregate demand shifter and the price index:

$$\log C = \log \zeta - \log P \implies \log P + \log C = \log \zeta,$$

$$\log \zeta = \log\big((1-\beta)/\beta\big) + \log P^* C^* - \log(1+i),$$

where $log\, \zeta = \log P + \log C$ is an aggregate demand shifter and coincides with nominal expenditure in the present period. A decrease in the discount factor (β), the interest rate (i) or an increase in nominal expenditure in the future ($P^* C^*$), generate an aggregate demand shifts in the current period such that, given the price index, consumption today goes up.

When going to the data we assume an initial equilibrium to which we can compare small deviations from. Imposing our desired steady state in Equation (A.5), $\mathrm{C} = \mathrm{C}^* = \mathrm{P} = \mathrm{P}^* = 1$, yields the following equality

$$(1+i) = \frac{1-\beta}{\beta}.$$

We resolve this equation as in Baqaee and Farhi (2022) setting $i = 0$, a zero lower-bound on the nominal interest rate, and thus $\beta = 1/2$ for our calibration exercise.

Intra-temporal Problem. Taking goods prices p_i, and total expenditure in the present PC as given, the consumer maximizes the intratemporal Cobb-Douglas utility function choosing consumption quantities C_i subject to the intratemporal budget constraint

$$\sum_{i=1}^{N} p_i x_{0i} = PC.$$

Solving the maximization problem simply gives

$$p_i x_{0i} = \kappa_i \, PC \tag{A.6}$$

And thus, the representative consumer spends a fraction κ_i of its total expenditure on good i.

Equilibrium conditions and CPI Inflation. The full derivation of CPI inflation follows from combining first-order conditions and market clearing conditions. To begin, it is convenient to rewrite the market clearing condition in terms of observables. Multiplying (3.3) by the price of good i and dividing by nominal gross domestic product, GDP, we arrive at

$$\frac{p_i y_i}{GDP} = \frac{p_i x_{0i}}{GDP} + \sum_{j=1}^{N} \frac{p_i x_{ji}}{p_j y_j} \frac{p_j y_j}{GDP} \tag{A.7}$$

Next, we define a sector's Domar weight:

$$\lambda_i = \frac{p_i y_i}{GDP},$$

which measures the importance (size) of each sector for total value added of the economy. Further, note that we have written the summation in (A.7) as a function of a sectors' input-output coefficients, $\Omega_{ji} = \frac{p_i x_{ji}}{p_j y_j}$. We use these expressions to rewrite (A.7) as:

$$\lambda_i = \kappa_i + \sum_{j=1}^{N} \Omega_{ji} \, \lambda_j \tag{A.8}$$

We next stack the N market clearing conditions into a vector-form and invert the system to arrive at

$$\boldsymbol{\lambda}' = \boldsymbol{\kappa}' \boldsymbol{\Psi}, \tag{A.9}$$

Where

$$\boldsymbol{\Psi} = (\mathbf{I} - \boldsymbol{\Omega})^{-1},$$

$$\boldsymbol{\lambda} = (\lambda_1, \lambda_2, \ldots, \lambda_N)',$$

$$\boldsymbol{\kappa} = (\kappa_1, \kappa_2, \ldots, \kappa_N)'$$

$\boldsymbol{\Psi}$ is the Leontieff inverse matrix, which is a $N \times N$ matrix that records the direct and indirect exposure of each sector to other sectors in the economy via intermediate input usage.

Factor shares in this framework can be written as

$$\Lambda_f = \frac{w_f L_f}{GDP} = \alpha_{i=f} \lambda_{i=f},$$

which we can stack into the $N \times 1$ vector

$$\boldsymbol{\Lambda} = diag(\boldsymbol{\alpha})\boldsymbol{\lambda},$$

and the diagonal matrix

$$diag(\boldsymbol{\alpha}) = \begin{pmatrix} \alpha_1 & 0 & 0 & \cdots & 0 \\ 0 & \alpha_2 & \cdots & \cdots & 0 \\ \vdots & \ddots & \ddots & \ddots & \vdots \\ 0 & \cdots & \cdots & \ddots & \alpha_N \end{pmatrix}.$$

records the factor usage of each sector.

Weighting price changes with $\boldsymbol{\kappa}'$, the sectoral consumption shares, and using (3.1) and (A.9), we can write CPI inflation as

$$\mathrm{d}\log \mathrm{CPI} = \boldsymbol{\Lambda}' \mathrm{d}\log \mathbf{W} - \boldsymbol{\lambda}' \mathrm{d}\log \mathbf{A}, \tag{A.10}$$

where $\mathrm{d}\log \mathbf{W}$ is a $N \times 1$ vector of wage changes and $\mathrm{d}\log \mathbf{A}$ is a $N \times 1$ vector of productivity changes.

A.1.3 Closed Economy Model's Calibration

Our model requires several pieces of information before fully solving it and decompose the drivers of inflation. In Table A.1, we summarize the necessary pieces and, when possible, its values.

Table A.1
Closed-Economy Calibration

	Value	Description
Elasticities		
ε	0.2	elasticity of substitution across intermediate inputs
θ	0.6	elasticity of substitution between factors and intermediates
γ	0.6	elasticity of substition between factors
σ	1	elasticity of substitution between consumption goods within period
ρ	1	intertemporal elasticity of substitution
At initial steady state		
β	0.5	Weight on future utility
i	0	Interest rate
P = P* = C = C*	1	Steady state values of real GDP and price index both present and future (*)
Λ		Factor shares from Input-Output Tables
κ		Consumption shares from input output tables
λ		Domar weights from input-output
Shocks		
d log ζ = d log (1-β)/β		Match backed out aggregate demand shock
d log L		Match sectoral total hours worked change
d log κ		Match changes in sectoral consumption expenditure

A.2 Open-Economy Model

Following Çakmaklı, Demiralp, Kalemli-Ozcan, Yesiltas, and Yildirim (2021), we extend Baqaee and Farhi (2022)'s framework to a multi-country multi-industry setting. In essence, instead of assuming a single country with a closed economy, we consider the world as a closed economy. One major difference is that now we need to also aggregate the varieties coming from different countries in both production and consumption. Let's take German auto industry as an example. It might use steel imports from Turkey, China, Russia, etc. It also uses plastics from different countries. Steel from different countries are most likely to be substitutes for each other but steel and plastic are complements. We incorporate these differences in our model using sector (industry) bundles that are aggregates of country varieties.

The analytic framework is similar to the closed economy case with the caveat that we need to keep track of between-country heterogeneity. Suppose there are C countries and N industries. Next, we will define the changes in the consumption and production.

Consumption. Consumption is a Cobb-Douglas aggregator over industry consumption bundles present in the country. Industry consumption bundles are aggregates of country-industry varieties with a CES aggregator with elasticity of substitution of $\xi = 4.55$ (Caliendo and Parro, 2015).

Production. Each country produces a variety in industry j using the intermediate bundle and value-added with a constant elasticity of substitution of $\theta = 0.6$. Value-added is a bundle of country-industry specific labor and capital with a constant elasticity of substitution of $\gamma = 0.6$. Intermediate bundle is composed of industry specific input sector bundles a constant elasticity of substitution of $\epsilon = 0.2$. Industry specific sector bundles are bundles of goods coming from all over the world with elasticity of substitution of $\xi = 4.55$.

Input-Output Matrix. Here, we will create $\widetilde{\Omega}$ matrix that incorporates the rich structure explained above. Denote the observed Ω with:

$$\Omega_{kc,jm} = \frac{p_{jm}\mathrm{x}_{kc,jm}}{p_{kc}\mathrm{y}_{kc}}.$$

Where p_{kc} is the price of good k produced by country c. Note that k could also be the consumption good. For simplifying the notation, we will index all country-industry or country-factor pairs with a single index whenever we can. Let kI denote the intermediate bundle and kVA denote the value-added for industry k. We define:

$$\widetilde{\Omega}_{kI} = \sum_{jm} \Omega_{k,jm} = 1 - \alpha_{k,VA} \quad \text{and} \quad \widetilde{\Omega}_{kVA} = \alpha_{k,VA}$$

We will index the sector bundle for industry j that enters to the production of industry k with kj. Hence:

$$\widetilde{\Omega}_{kIj} = \frac{\sum_j \Omega_{k,jm}}{1 - \alpha_{k,VA}}.$$

Each industry bundle is formed by different varieties from countries with:

$$\widetilde{\Omega}_{kjm} = \frac{\Omega_{k,jm}}{\sum_j \Omega_{k,jm}}.$$

In total, there are C consumption aggregates, $C \times N$ consumption bundles, $C \times N$ goods, $C \times N$ value-added bundles, $C \times N$ intermediate bundles and $C \times N^2$ sector bundles.

Value-added is composed of capital and labor. Each share will be denoted by:

$$\widetilde{\Omega}_{kL} = \alpha_{kL} \quad \text{and} \quad \widetilde{\Omega}_{kK} = \alpha_{kK} \quad \text{with} \quad \alpha_{kL} + \alpha_{kK} = 1.$$

Note that capital and labor are industry specific. Hence, there are $2C \times N$ factors.

Intertemporal Choice. To model the temporal choice, we will have a country specific Ricardian consumer who bridges the current consumption and future consumption decision. Country specific future consumption is denoted by an aggregate factor $*c$. Therefore, there are C Ricardian consumers and C future consumption aggregates. $\widetilde{\Omega}_{Rc,0c}$ and $\widetilde{\Omega}_{Rc,*c}$ denotes the Cobb-Douglas weights that this Ricardian consumer gives to the current and future consumption, respectively.

Input-Output Matrix Structure. With these additions of consumption, sector bundles, goods, intermediates, value-added and factor, the total size of the $\widetilde{\Omega}$ matrix becomes $(3C + 6CN + CN^2) \times (3C + 6CN + CN^2)$. The rows and the columns of this matrix are depicted in Table A.2.

Table A.2
Rows and Columns of $\widetilde{\Omega}$

Description	Row / Column Indices
Consumption	$1 \rightarrow C$
Consumption Bundles	$C + 1 \rightarrow C + CN$
Goods	$C + CN + 1 \rightarrow C + 2CN$
Intermediates	$C + 2CN + 1 \rightarrow C + 3CN$
Sector bundles	$C + 3CN + 1 \rightarrow C + 3CN + CN^2$
Value-Added	$C + 3CN + CN^2 + 1 \rightarrow C + 4CN + CN^2$
Labor	$C + 4CN + CN^2 + 1 \rightarrow C + 5CN + CN^2$
Capital	$C + 5CN + CN^2 + 1 \rightarrow C + 6CN + CN^2$
Ricardian consumer	$C + 6CN + CN^2 + 1 \rightarrow 2C + 6CN + CN^2$
Future consumption	$2C + 3CN + CN^2 + 1 \rightarrow 3C + 6CN + CN^2$

Solving the model. With these definitions, we can solve prices and Domar weights with the following equations and constraints implemented in AMPL/Knitro. Below, with an abuse of notation, instead of showing country-industry varieties separately, we will use a single index to address to address rows or columns of $\widetilde{\Omega}$ matrix.

Prices for goods (including sector bundles and value-added bundles).

$$p_k = \left[\sum_{j \notin F} \Omega_{kj} p_j^{1-\theta_k} \right]^{\frac{1}{1-\theta_k}}$$

Price indices for consumption goods.

$$\log p_{0c} = \sum_{j \in N} B_{Oc,j} \Omega_{Oc,j} \log p_j^{0c}$$

Where p_{0c} is the consumption price index and p_j^{0c} is the price of consumption bundle of industry j in country c.

Price Index for Ricardian consumers.

$$\log p_{Rc} = B_{Rc,0c}\Omega_{Rc,0c}\log p_{0c} + B_{Rc,*c}\Omega_{Rc,*c}\log p_{*c},$$

where p_{*c} is the price of future consumption in country c.

$$\lambda_k = \sum_{j \notin F} \lambda_j \Omega_{jk} B_{jk}^{\theta_j} p_k^{1-\theta_j} p_j^{\theta_j - 1}$$

In particular:

$$\lambda_{0c} = \lambda_{Rc}\Omega_{Rc,0c}B_{Rc,0c}$$

And

$$\lambda_{*c} = \lambda_{Rc}\Omega_{Rc,*c}B_{Rc,*c}$$

Hence:

$$\lambda_{0c} = \frac{\Omega_{Rc,0c}B_{Rc,0c}}{\Omega_{Rc,*c}B_{Rc,*c}}\lambda_{*c} = \frac{B_{Rc,0c}}{B_{Rc,*c}}\lambda_{*c} = \frac{\beta}{1-\beta}\lambda_{*c}$$

This pins down the aggregate shock in terms of the expenditure share in the normal times. We assume that the future consumption levels are the same as pre-shock levels and the prices are also normalized. Hence:

$$\lambda_{*c} = \sum_{j \in F_c} \lambda_j^i \text{ and } p_{*c} = 1$$

Domar weights for Ricardian consumers.

$$\lambda_{Rc} = \sum_{j \in F_c \cup \{*c\}} \lambda_j.$$

Factor clearing conditions for capital. Since the factor levels do not change, we have the following identity:

$$\lambda_{fc} = p_{fc}\lambda_{fc}^i.$$

Factor clearing conditions for Labor.

$$\left[p_{fc} - 1\right]\left[\frac{\lambda_{fc}}{p_{fc}} - A_{fc}\lambda_{fc}^{i}\right] = 0,$$

Maximum labor could be $\bar{L}_{fc}$.

$$\frac{\lambda_{fc}}{p_{fc}} \leq A_{fc}\lambda_{fc}^{i} = \bar{L}_{fc}.$$

All factor prices are downward rigid.

$$p_{fc} \geq 1.$$

Here, this downward rigidity is assumed to be imposed at the US dollar level. Following Baqaee and Farhi (2021) this price rigidity should be implemented using the exchange rates. Let $\hat{p}_{fc}$ denote the wage paid to factor fc in local currency. We can impose the downward wage rigidity with:

$$d\log\hat{p}_{fc} = d\log\lambda_{fc} - d\log L_f + d\log e_c + d\log \mathrm{GDP} \geq 0. \tag{A.11}$$

where e_c is the exchange rate of the country c and GDP is the nominal gross domestic product in base country's units. The exchange rate is pinned down depending on a country's monetary policy.

Exchange Rates and Monetary Policy. We need to take a stand on exchange rate determination, which is pinned down by monetary policy. We follow Baqaee and Farhi (2019) where central banks can either (i) target inflation, (ii) peg the currency, or (iii) operate somewhere in between (i) and (ii). Our baseline results are based on (i) where central banks target inflation. However, the decomposition results are robust to assuming (ii) or (iii).

The inflation-targe rule implies:

$$d\log p_{0c}e_cGDP = 0$$

where p_{0c} is the price of consumption good in country c. Plugging this expression into (A.11) for downward wage rigidity implies:

$$d\log p_{fc} = d\log\lambda_{fc} - d\log L_f \geq d\log \mathrm{p_{0c}}$$

Model Output. After solving for prices and Domar weights, we can calculate the CPI and GDP growth for each country.

A.2.1 Creating a balanced input-output network

The international version of our model requires that the expenditures and income of a country to be equal to each other. However, in the current ICIO matrix, the sum of the final consumption of countries do not necessarily add up to the total value-added of the country once we include the heterogeneity in sectoral spending. To circumvent this issue, OECD uses taxes to make the expenditure and the production sides equal to each other at the sectoral level. Nevertheless, incorporating taxes into our model would result in intractability. Therefore, we will use the following equations to recover the self-consistent input-output tables.

Let's assume that we know $\mathrm{x}_{kc,jm}$ and $\Omega_{0c,jm}$. We would like to find value-added levels va_{kc} such that the final expenditures and value-added levels of a country match. The expenditure of each country is equal to its total value-added:

$$E_c = \sum_k \mathrm{va}_{kc}.$$

Total output of each industry should equal to each other both from the consumption and production side:

$$\mathrm{va}_{kc} + \sum_{jm} \mathrm{x}_{kc,jm} = \sum_m E_m \Omega_{0m,kc} + \sum_{jm} \mathrm{x}_{jm,kc}$$

Hence:

$$\mathrm{va}_{kc} = \sum_m \sum_j \mathrm{va}_{jm} \Omega_{0m,kc} + \sum_{jm} \mathrm{x}_{jm,kc} - \sum_{jm} \mathrm{x}_{kc,jm}. \tag{A.12}$$

These equations give us $\mathrm{C} \times \mathrm{N}$ equations and $\mathrm{C} \times \mathrm{N}$ unknowns. Note that, if we sum up both sides of this equation with respect to kc, we arrive at:

$$\sum_{kc} \mathrm{va}_{kc} = \sum_m \sum_j \mathrm{va}_{jm} \sum_{kc} \Omega_{0m,kc} + \sum_{kc} \sum_{jm} \mathrm{x}_{jm,kc} - \sum_{kc} \sum_{jm} \mathrm{x}_{kc,jm},$$

which is a tautology which would make the system un-invertible. We replace one of the equations with matching the world GDP:

$$\sum_{kc} \mathrm{va}_{kc} = \mathrm{GDP}, \tag{A.13}$$

which we assume to be given. Combining equations (A.12) and (A.13), and using a matrix notation with matrices A and B given by replacing the relevant terms of these equations, we can write:

$$va' = va'A + B.$$

Solving this equation gives us va values which are balanced under given expenditure patterns and input-output linkages.

A.2.2 Open-Economy Model's Calibration

Table A.3 shows the pieces of data we use to solve the open-economy model. While most of these values are the same as those in the closed-economy case (see Table A.2) there are a few differences such as the elasticity of substitution between foreign and domestic inputs/consumption goods (ξ) and other moments we need for the Rest of the World composite, as we described in Section 4.

Table A.3
Open Economy Calibration

	Value	Description
Elasticities		
ε	0.2	elasticity of substitution across intermediate inputs
θ	0.6	elasticity of substitution between factors and intermediates
γ	0.6	elasticity of substitution between factors
ξ	4.55	elasticity of substitution between foreign and intermediate
		goods in production and consumption
σ	1	elasticity of substitution between consumption goods within period
ρ	1	intertemporal elasticity of substitution
At initial steady state		
β	0.5	weight on future utility
i	0	interest rate
P = P*	1	steady state values of price index in each country c both present and future (*)
C = C*	GDPc/GDP	Real GDP share of each country c in world GDP both present and future (*).
		See Section A.2.1. for details
Λ		Factor shares from Input-Output Tables
κ		Consumption shares from input output tables
λ		Domar weights from input-output
Rest of the World Shocks		
d log ζ = d log (1-β)/β		Match the level so that the predicted inflation in the Euro Area falls
		between values reported in Chart 13
d log L		Match using population weighted Oxford Stringency Index (Hale et al. 2021).
d log κ		Match changes in sectoral consumption expenditure for countries outside
		the Euro Area and United States

B Effects of sectoral shocks on trade elasticities

To better understand the role of the sectoral composition of demand, Table B.1 utilizes the model framework to perform several "counterfactual" exercises for the GFC and Covid-19 periods. We feed in observed consumption changes for all countries but only for a subset of sectors. Column (1) labeled 'Dur.' feeds in observed changes only for consumption growth in the Durables sector while setting other sectors consumption growths to be zero, column (2) labeled 'Dur. + NDur.' feeds in observed changes for consumption growth in the Durables and Non-Durables sectors while setting the Services sector consumption growth to be zero, while column (3) labeled 'Serv.' feeds in observed changes only for consumption growth in the Services sector while setting other sectors consumption growths to be zero.

Table B.1

Composition effect: great financial crisis and Covid-19 pandemic

	Panel A. Great Financial Crisis Collapse						Panel B. Covid-19 Pandemic Collapse					
	Imports			Exports			Imports			Exports		
	Dur.	Dur.+NDur.	Serv.	Dur.	Dur.+NDur.	Serv.	Dur.	Dur.+NDur.	Serv.	Dur.	Dur.+NDur.	Serv.
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
United States	4.36	3.99	0.55	2.63	2.31	0.85	1.45	1.61	0.55	#####	8.90	0.73
Euro Area	3.17	2.69	0.59	7.10	4.47	0.71	2.49	2.40	0.65	2.24	2.14	0.55
United Kingdom	4.82	4.17	0.69	2.46	1.84	0.09	4.57	4.12	0.71	2.10	2.49	0.42
World	3.01	2.90	0.61	3.01	2.90	0.61	2.90	2.37	0.64	2.90	2.37	0.64
	Panel C. Great Financial Crisis Recovery						**Panel D. Covid-19 Pandemic Recovery**					
	Imports			Exports			Imports			Exports		
	Dur.	Dur.+NDur.	Serv.	Dur.	Dur.+NDur.	Serv.	Dur.	Dur.+NDur.	Serv.	Dur.	Dur.+NDur.	Serv.
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
United States	3.71	3.44	0.55	4.46	4.18	0.77	4.73	4.08	0.55	3.32	2.95	0.75
Euro Area	0.89	1.31	0.59	6.51	4.72	1.02	2.17	2.13	0.67	2.52	2.45	0.73
United Kingdom	2.85	2.60	0.69	4.06	3.69	0.16	3.95	3.57	0.71	2.59	2.68	0.42
World	2.29	2.01	0.60	2.29	2.01	0.60	2.93	2.51	0.59	2.93	2.51	0.59

Notes: This table presents model-based elasticities for real imports and real exports viz. real GDP, where we plug in observed consumption growth rate for all countries across a subset of sectors during the Great Financial Crisis and the Covid-19 Pandemic: (i) 'Dur.': the Durables sector only; (ii) 'Dur.+NDur.': the Durables and Non-Durables sectors only; 'Serv.': the Services sector only. All other sectors assume zero consumption growth. Panels A presents results for the GFC Collapse period (2008Q2-2009Q2), Panel B presents results for the Covid-19 Collapse period (2019Q2-2020Q2), Panels C presents results for the GFC Recovery period (2009Q2-2010Q2), and Panels D presents results for the Covid-19 Recovery period (2020Q2-2021Q2). Columns (1)-(3) present results for import elasticities and column (4)-(6) for export elasticities.

Panels A and B of Table B.1 compare the trade collapse of the two episodes, while Panels C and D compare the recovery year. First, looking at within a Panel, whether it be for a fall or rebound in trade, it is evident that trade elasticities are always larger when applying the growth rates only to the goods' sectors, and particular to Durables goods. This is true both for the GFC and the Covid-19 health shock and reflects several key points highlighted by Bems, Johnson, and Yi (2010). First, goods are more tradable and thus changes in final demand in these sectors will have a larger direct impact on trade than a change in final demand for services. Second, given global

production linkages, this change in goods demand will amplify across borders given intermediates trade thus increasing trade further as the volume of trade is measured in gross output terms rather than value added. This in turn will lead to a larger elasticity viz. GDP, which is measured in value added. Finally, given that Services contribution to GDP (country's value added in Table 3) is much larger than its contribution to exports or imports, an equally sized change in consumption of services will have a larger impact on GDP than trade, while the opposite holds true for the goods' sectors.

Except for decompositions where we only allow consumption to change in the Services sector (columns (3) and (6)), results vary across countries when turning to comparing the decompositions across the two crises. Looking at the import elasticities during the Collapse periods in Panels A and B, we see these elasticities tend to be smaller in columns (1) and (2) during the Covid-19 crisis than the GFC trade collapse. This difference is particularly noticeable for the US relative to Euro Area or other countries and reflects the fact that household consumption of goods (durables goods in particular) did not fall as much during Covid, which in turn implied a smaller transmission across countries being picked up in international trade via production linkages. A similar story holds when looking at exports in columns (4) and (5). One exception is that the implied export elasticity for the US was larger during Covid, which reflects a fall in the demand for US goods by the Euro Area – this result follows from shocking only Euro Area consumption of goods in an unreported exercise.

The results for the Recovery periods in Panels C and D present a different picture than the Collapse decompositions. Looking at import elasticities across countries, we see that they are larger during the Covid-19 recovery than the GFC. This fact reflects the extremely fast recovery of goods' consumption starting in mid-2020. This final demand change in goods is amplified to total imports via imports given domestic and foreign production linkages, while its impact on GDP is relatively muted. Note further that the elasticity is more than twice as large for the US than for the Euro Area, as US consumption of goods surged. Meanwhile, export elasticities are in fact larger during the GFC than the Covid-19 period for the US and Euro Area, which reflects the depressed demand for these countries' growth from the rest of the world in the Recovery period as other countries' demand lagged due to delayed vaccination and less of boom for consumption goods. For example, European demand for US consumption goods remained muted, while demand for Euro Area countries' durables (e.g., Germany) also remained muted. Meanwhile, Americans' demand for goods from around the world help prop up exports for the world.

Global Supply Chain Pressures, International Trade, and Inflation

By Gabriel Felbermayr[1]

Abstract

Di Giovanni et al. (2022) provide much needed analysis to disentangle two types of shocks that potentially explain the surge of inflation during the Covid-19 crisis: demand shocks and supply shocks. Using a quantitative model that carefully integrates supply chains, they find that supply shocks, in particular those occurring abroad, played a dominant role in explaining inflation dynamics in the Eurozone, while aggregate demand shocks turn out much more important quantitatively in the US. This finding has obvious implications for monetary policy. It should not be used, however, as a motivation to decouple from global value chains (GVC). This comment discusses the evidence on rising protectionism and its implications. It also reviews results obtained from a model similar to Di Giovanni et al. to argue that decoupling GVCs would indeed provide some insulation against foreign shocks but at a prohibitive price.

1 Introduction

In the Covid-19 crisis, the European and world economies were hit by two types of exogenous adverse events: supply shocks and demand shocks. Their nature was, however, quite different. Supply shocks occurred because quarantine measures forced substantial shares of the labor force into inactivity. This occurred in a desynchronized yet correlated fashion in various countries, so that the productive capacity was affected through direct domestic adverse labor supply shocks and through shortfalls of imported intermediate inputs caused by labor supply shocks abroad. Problems were exacerbated by severe disruptions in the logistics of international supply chains, causing international shipment costs to soar and delivery delays to cumulate.

Demand shocks involved not so much a decline in aggregate demand as initially feared but rather a sudden change in the composition of expenditure: demand for durable consumption goods relative to non-durable goods and services increased almost everywhere, while fiscal stabilization programs compensated households for income losses due to reduced labor market incomes and profits from entrepreneurial activity, effectively stabilizing the level of aggregate demand.

The consequences of these interrelated shocks affect the world economy still today. In particular, the combination of a negative supply shock and a sudden change in relative

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demand created price pressures that still persist, posing substantial challenges to policymakers and central banks around the world. In order to develop appropriate counter-strategies, it is important to understand the relative importance of supply versus demand shocks for price dynamics during the Covid-19 crisis. The paper by Di Giovanni et al. (2022) (DKSY) successfully tackles this task using state-of the art modeling.

After presenting a wealth of empirical facts that illustrate the arguments sketched in the paragraphs above, the authors employ a quantitative general equilibrium model with many sectors. Each sector produces a good that can be consumed or used as intermediate input in any sector. Importantly, production combines sector-specific labor (so that wage rates are not equalized across sectors) and intermediate inputs (sourced domestically and from abroad) according to an input-output table. With this structure and assuming perfect competition, holding technological conditions constant, the price of any good is a function of wage rates in potentially all sectors of the economy, reflecting the network structure of production. Consumer price index (CPI) inflation is a weighted sum of sectoral price changes which can be alternatively expressed as the weighed sum of sectoral wage changes. Wage changes, in turn, can be translated into the change in nominal aggregate expenditure and in the weighted sum of changes in sectoral labor input. Consequently, CPI inflation can be decomposed into changes in sectoral employment and aggregate demand. Observing inflation, the input-output tables and sectoral employment, the aggregate demand shock can be constructed. Wages are downward rigid, so that the model exhibits Keynesian unemployment.

DKSY conclude that supply shocks explain about half of the inflation dynamics in the Eurozone from the last quarter of 2019 to the last quarter of 2021. In the US, demand shocks explain only one third of the price level increase. Moreover, in the Eurozone, foreign shocks played a major role, explaining about 60 percent of the entire inflation dynamics. This finding has immediate implications for monetary policy: in Europe: Due to the larger role of supply side disturbances, monetary policy has less bite for taming inflation than in the US.

In the following a comment on the empirical picture drawn by DKSY. First a come back to comparing the Great Financial Crisis of 2008/09 with the Covid-19 crisis. Then I discuss a factor missing in DKSY's analysis: the role of protectionist policies. And finally I take a more normative perspective by arguing with the help of a quantitative model akin to DKSY's framework that decoupling global value chains can help insulate economies from foreign supply shocks but that the welfare cost of doing so would be prohibitive high compared to the benefits.

2 How resilient were global supply chains? A tale of two crises

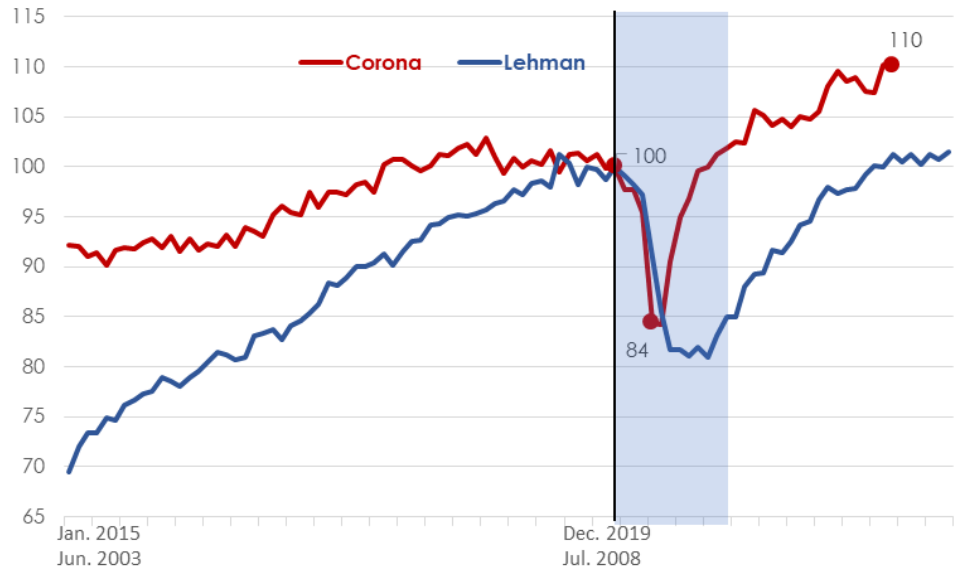
The analysis of Di Giovanni explains how the Covid-19 crisis led to an increase in the inflation rate in many countries. While the logic of their argument is compelling ex post, one may wonder why very few market analysts or economists foresaw the

development. One reason may be lie in the lack of recent experience with global pandemics and with wrong analogies drawn from the Great Financial Crisis (GFC) of 2008/09. Indeed, according to various indicators, the Covid-19 crisis unfolded quite similarly as the GFC in the beginning. This can be seen, for instance, by comparing the dynamics of real world trade. In the middle of 2008, global trade started to decline fast. The global quantity index of goods trade, normalized to 100 in June 2008 and depicted in Chart 1 declined by almost 20 percent in the course of a few months. But then, it took about 24 months for global trade to return to the pre-crisis level. Global industrial production evolved very similarly. Economic analysis of the GFC suggests that the trade collapse was caused by a shortfall in demand and, to a smaller extent, by increased frictions in trade finance (see, e.g., Bussière et al., 2013). Due to strong international input-output linkages – the essence of global value chains – demand shocks led to strong trade responses. Protectionist trade policies played a much smaller role than initially feared.

The corona crisis started off similarly. Chart 1 shows that trade fell very quickly by about 15 percent from December 2019 onwards, mimicking the GFC. The expectation was that economic activity would return only sluggishly. Many mainstream economists advocated expansionist policies to avoid a protracted crisis like in the aftermath of the GFC. However, unexpected by most, trade – and in tandem industrial production – returned very fast, returning to the pre-crisis level in September 2020, therefore performing an almost perfect V-turn. By June 2022, the quantity index of world trade was 10 percent above the pre-crisis level. While this rapid turn-around was unexpected, ex post it can be rationalized by the effects of exactly those expansionist policies that were recommended at in mid-2020. However, as argued in DKSY, one should not conclude that supply side frictions did not play an important role.

Chart 1

Monthly global quantity indicators of goods trade (Dec. 2019 = Jul 2008 = 100)



Source: CPB, own calculations and illustration. Last data point: March 2022. Vertical line denotes onset of crises. Shaded area denotes first twelve months after onset of crises.

This picture could suggest that, in the Covid-19 crisis, global supply chains were in fact very resilient. Di Giovanni et al. warn against this interpretation, and quite rightly so. They point towards a strong shift in the demand for durable goods while the demand for services fell. Many durable goods are tradeable while services are not. When lockdowns in China were relaxed, this compositional change in aggregate demand was satisfied in large parts by increased industrial production in China, fueling an unexpected increase in westbound Chinese trade (and, to a smaller extent, in eastbound trade).

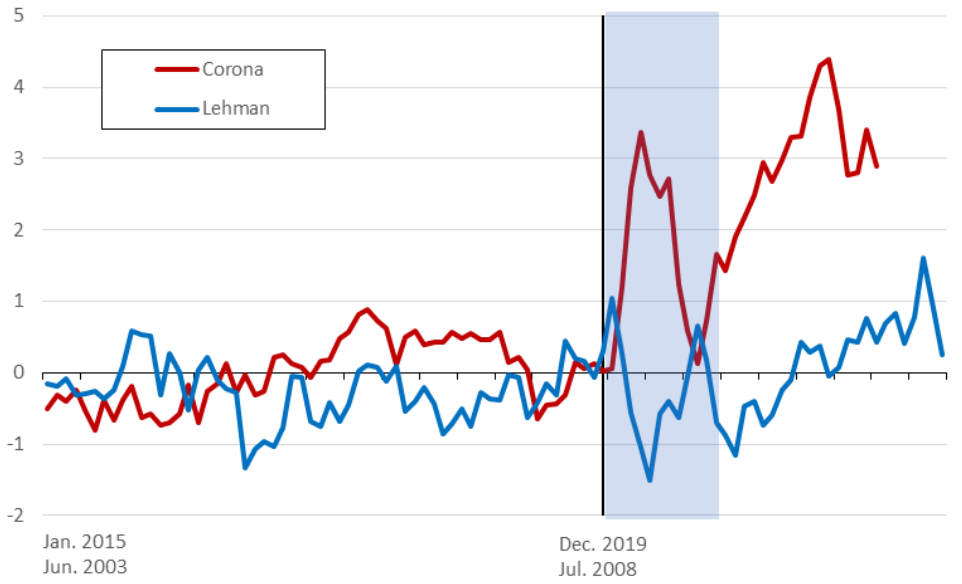
However, as that trade boom was largely unexpected, it hit the world logistic systems unprepared. In fact, at the onset of the crisis, when trade started to collapse, shipping companies cancelled orders and reduced capacity. When the unexpected surge in demand hit reduced supply, freight rates soared. Moreover, as corona restrictions were imposed in various parts of the globe, port activities were halted, adding to the problems. Finally, many countries adopted inward-looking policies, such as export controls, that generated further frictions.

Detailed information on the positions of container ships positions collected and analyzed by the Kiel Institute for the World Economy (Stamer, 2021) show that container ships waiting to be loaded or unloaded reduced the active global shipment capacity by up to 14 percent in spring 2021; normally, idle container ships amount to 6 to 8 percent of overall capacity. In early 2020, about 8 percent of global shipping capacity was sitting idle in the port areas of Shanghai-Zheijang and Hong Kong – Guangdong alone. When this traffic jam in the Chinese sea was resolved, it took only a few months to build up off the coast of South California. Such echo effects, with maritime traffic jams shifting over time and space, have continued to weigh on the global logistic system. Even now, about 11 percent of shipping capacity is idle.

The Federal Reserve Bank of New York combines supply side shortages and price data from international logistics (and more information) into a global supply chain pressure index (GSCPI) that has proven extremely helpful for policy analysis. Chart 2 plots that index in terms of standard deviations from the long-run average. Once more, it contrasts the experience in the GFC (Lehman) and the Covid-19 crisis (Corona). The differences are quite striking: in the Lehman crisis, the pressure index actually plunged as global demand for tradeable goods fell; in the Covid-19 crisis, the opposite occurred. And even after the first impact of the crisis, the index increased dramatically, reaching a local maximum in fall 2021.

Chart 2

Global Supply Chain Pressure Index (Dec. 2019 = Jul 2008 = 100), standard deviations from average



Source: Federal Reserve Bank of New York, own illustration. Vertical line denotes onset of crises, shaded area denotes first twelve months after onset of crises.

The effect of these logistic disruptions was that global trade was held back. So, after bouncing back from the immediate impact of the Covid-19 crisis, without the supply-side shortages and logistic troubles, trade would have increased by more than what Chart 1 shows. In other words: absent supply chain troubles, the world would have been in for a downright trade boom.

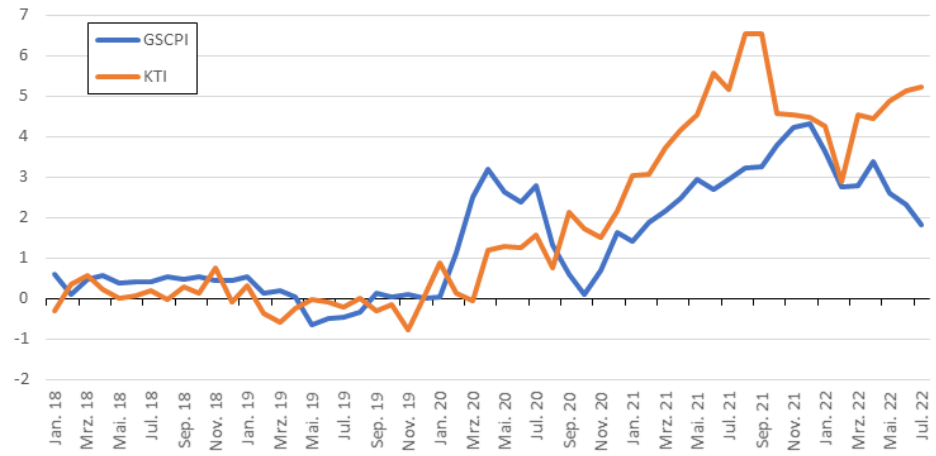
This interpretation, however, highlights a possible problem. If the GSCPI moves up because of labor shortages in many countries, further growth in international trade would be constrained by a lack of resources. In that sense, it is rather industrial production that is held back than trade itself. Reducing the bottleneck would then require policies to stimulate labor supply. If, however, the GSCPI moves upwards because of frictions in the functioning of maritime supply chains, the situation would be different. Then, the critical shortage would be imported inputs and the crucial bottleneck would be transportation, not manufacturing production. While both phenomena are obviously interrelated, DKSY do not distinguish between these two issues.

In fact, recent data highlight that this distinction could be important. Chart 3 contrasts the evolution of the GSCPI with that of an alternative index produced by the Kiel Institute (Stamer, 2021). The Kiel Trade Index (KTI) measures the percentage share of the global container ship capacity that lies idle in the proximity of ports, presumably because of problems in the smooth functioning of port facilities, so that ships cannot be loaded or unloaded. In normal times, about 7 percent of the capacity is affected. That share has increased substantially during the pandemic crisis. In line with the GSCPI excess frictions have built up from spring 2020 onwards. However, the KTI has not fallen back to normal over 2020. From winter 2021 it has rapidly increased, again

in line with the GSCPI. It has started to fall earlier than the GSCPI starting in September 2021, but it has risen again during spring and summer 2022. It is possible that the frictions shown by the KTI appear in the GSCPI with some lag; it is also possible that their contribution to the aggregate measure is outweighed by other phenomena, for example, a relaxation of labor shortages as reported by industry or by falling freight rates as new shipping capacity becomes available (but need not become fully operative due to maritime traffic jams). In any case, the picture suggests that the recent improvement in the reading of the GSCPI may be limited and fragile so that it would be premature to conclude that the maritime logistic system has returned to smooth operation.

Chart 3

Global Supply Chain Index (GSCPI) versus Kiel Trade Index (KTI): recent developments



Source: Federal Reserve Bank of New York and Kiel Institute, own illustration. Both measures denote deviations from long-run averages.

The KTI observes container ships waiting to enter ports. It does not inform about the reasons for the difficulties. These could be technical problems in port logistics, they could also relate to policy interventions that prolong customs inspections or other red tape. In fact, there is some evidence that protectionism, in particular in the form of non-tariff barriers to trade, has increased during the pandemic.

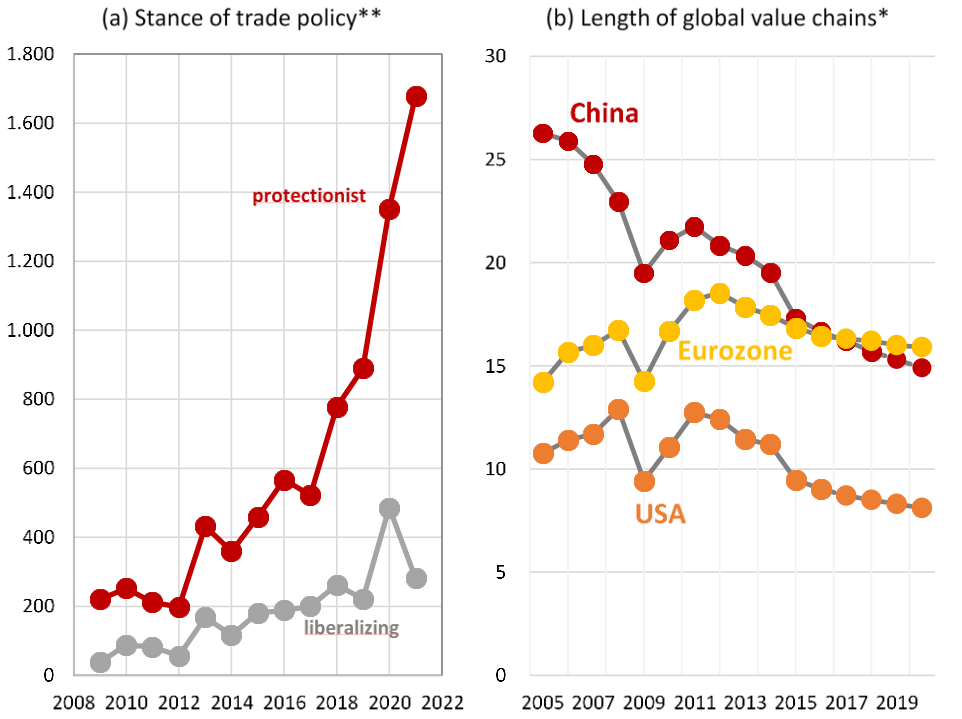
3 The rise of protectionism

The supply chain problems displayed in Chart 2 are a relatively recent phenomenon. However, they are not the only factors that slow down international trade and lead to the disintegration of supply chains. In the early phase of the Covid-19 crisis, several countries started to enact export restrictions in the areas of medical products or protective equipment. These measures add to a list of trade distorting measures that has kept growing over the last decade. The Global Trade Alert (GTA) website, maintained at the University of Saint Gallen in Switzerland, has recorded a trend of increasing protectionism since 2009 (Evenett and Fritz, 2020); see panel (a) in Chart 4. During the pandemic, many policymakers enacted export controls in order to keep

medical equipment deemed existential inside their countries and to avoid rising prices. Already before this, the US-China trade war and its global repercussion has brought tariffs back to the policy stage; various programs to foster local value added have led to new non-tariff barriers to trade.

Chart 4

Trade policy stance and length of value chains



Source: OECD Trade in Value Added Statistics, own illustration and forecast; Global Trade Alert. *The figure reports simple counts of discriminatory (protectionist) measures and of liberalizing ones across the world. **Share of imported foreign value added in gross exports of countries.

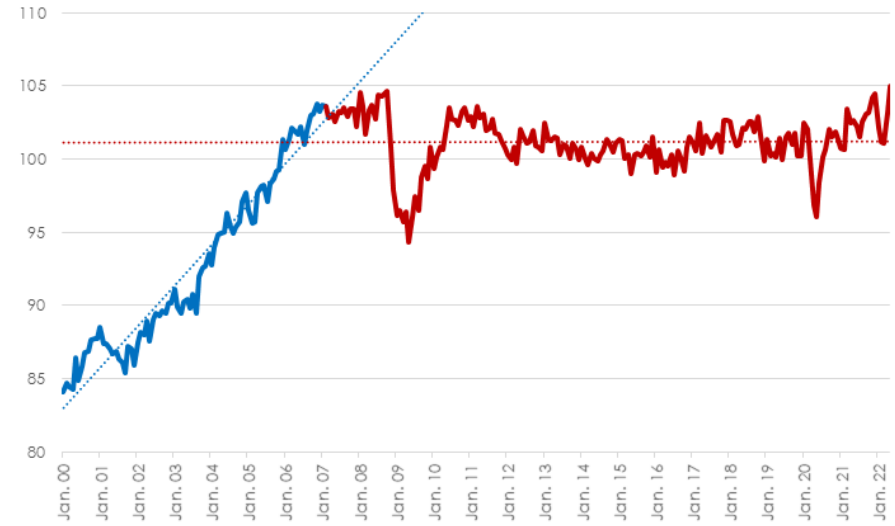
Kinzius et al. (2019) show that the rise in protectionism documented in the GTA does indeed lead to a slow-down in international trade flows. Moreover, as shown in the Global Sanctions Database (Felbermayr et al., 2021), increasing political tensions have led to a boom in economic sanctions with widely varying objectives and coverage. Finally trade policy uncertainty has increased, as shown by Caldara et al. (2020), with stifling effects of investment. The consequence of these developments can be seen in dynamics of global supply chains. The trade in value added (TiVA) data from the OECD (Martins Guilhoto, 2022) show that the foreign value-added content of gross exports – a measure of the "length" of global value chains – has fallen in many countries. It has gone down substantially in China (from about 22 percent in 2008 about 17 percent in 2018), but also in the USA (from 13 to 10 percent) or in many European countries such as Germany, with a market acceleration after 2011; see panel (b) of Chart 4. So, the pandemic hit the world economy in a situation in which protectionism was already comparably high and global value chains retracting.

The precarious state of globalization is illustrated in Chart 5 which shows an index of global goods market globalization derived as the ratio of two quantity indices: the one

of global goods trade and the one of industrial production. It appears that, interrupted by the GFC and the Covid-19 crisis, after about 2007, global goods trade has grown at about the same speed as industrial production; before that date, and starting from the late 1980s (not shown), trade outpaced production quite substantially. The rise of protectionism explains a significant fraction of this slow-down (Kinzius et al., 2019); other determinants related to exhaustion of special drivers such as lower physical trade costs or the gradual integration of formerly communist countries into the world economy play an important role as well.

Chart 5

Monthly Index of Goods Market Globalization



Source: CPB, own calculations and illustration. Last data point: March 2022. Index relates global index of goods trade to a global index of industrial production.

However, the general point is that a rise in protectionism and the decline in the speed of global market integration drive up production costs of firms and lower the degree of competition, creating environments in which inflationary pressure can increase. The paper by DKSY focuses on labor supply shortages but does not capture the increased costs in international logistics or a rise in global protectionism. Both hinder the smooth functioning of global value chains and, by reducing the supply of foreign intermediate inputs and by hindering international competition, drive up the costs of production. DKSY also do not study the normative question, whether or not countries should limit the scope of global value chains to insulate themselves against importing inflation from abroad.

4 Insurance through decoupling of global value chains

Eppinger et al. (2021) work with a quantitative trade model that shares many properties with DKSY. In particular, it uses the same Ricardian description of technology and it incorporates a global input-output table that captures intra- and international linkages between sectors. The number of countries and sectors in the model is large. The analysis adopts a medium-term perspective in that factors of

production are allowed to move across sectors, but movement is subject to stochastic frictions so that foreign supply shocks can only gradually be neutered by expansion of domestic production. The model studies labor supply shocks abroad (as DKSY) and quantifies the effects on trade partners with and without the presence of trade in intermediate goods. In that fashion, the authors can assess by how much undoing global value chains mitigates the adverse price (and welfare) effects of foreign shocks, and whether the benefits of such mitigation (if any) outweigh the costs of decoupling (modeled as a prohibitive increase in non-tariff trade costs on intermediate goods). The foreign labor supply shock is calibrated to the observed reduction in effective Chinese labor supply (modeled as a decrease in labor productivity) during the first wave of the Corona crisis. In the model, welfare can be understood as the inverse of the aggregate price index. Hence, a reduction in welfare is equivalent to an increase to inflation.

First, the paper shows that decoupling global value chains (while keeping trade in final goods going) would have a clear inflationist effect. Welfare would go down substantially in all of the forty countries contained in the simulation exercise. The column at the right-hand-side edge of Chart 6 shows the welfare costs of decoupling. These cost range between 2.2 percent of baseline GDP in the US and 59.1 in Luxembourg. The cells in the matrix in Chart 6 report the difference in the welfare effect in countries listed on the y-axis from a labor supply shock (amounting to a reduction of effective labor of 29%) in the country listed on the x-axis in a hypothetical situation of decoupling and in the baseline situation of no decoupling. Positive numbers (yellow to red colored cells) indicate a positive difference, i.e., the damage of a foreign shock is smaller in a decoupled situation; blue or green colored cells indicate the opposite.

The figure shows that most cells in the matrix feature positive numbers. Hence, the adverse effects of supply shocks (modeled as a productivity shock) are often smaller when there is no trade in intermediate goods. However, the gains are rarely larger than 0,2 percent of baseline welfare. The direct costs of decoupling are much higher, typically by two orders of magnitude. Hence, a generalized strategy of cutting global value chains would not make any sense. Rather than curbing inflation it would exacerbate it.

Eppinger et al. (2021) report numerous robustness checks that corroborate this result. In particular, the general message holds true when members of the Eurozone (or the European Union) do not decouple value chains amongst themselves.

5 Conclusions

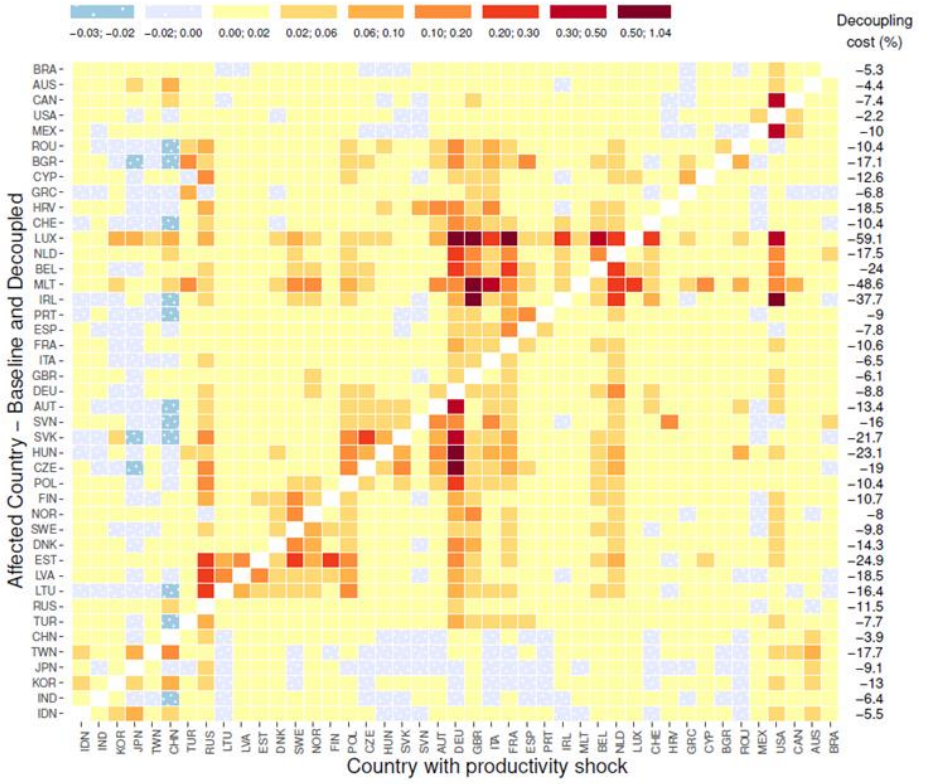
Di Giovanni et al. (2022) provide much needed analysis to disentangle two types of shocks that explain the surge of inflation during the Covid-19 crisis: demand shocks and supply shocks. Importantly, they integrate the complex input-output relationships that characterize modern economies. They find that supply shocks, in particular those occurring abroad, play a dominant role in explaining inflation dynamics in the

Eurozone, while aggregate demand shocks turn out much more important quantitatively in the US.

This comment sheds some further light on the differences of the Covid-19 crisis with the Global Financial Crisis of 2008/09. It also presents some simulation results based on a model comparable to Di Giovanni et al. to argue that a decoupling of global value chains could insulate domestic economies from foreign supply chains but at a prohibitively high welfare cost.

Chart 6

Foreign labor supply shocks and the gains and pains of decoupling on welfare



Source: Eppinger et al., 2021, Figure 5. For each origin of a productivity shock (x-axis), the cells show the differential welfare effect in the baseline versus a decoupled scenario.

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Experiencing Inflation

By Ulrike Malmendier[1]

Abstract

In this brief presentation, I would like to draw your attention to---and make you pause to think about---what the current experience of living through an inflationary period will do to our beliefs and, ultimately, our decision making. I will consider the effects of these experiences not only on households, but also on firms, and even include monetary policymakers themselves. Finally, I will touch on the question of what these insights mean for inflation expectations as a variable of interest for monetary policy.

1 Inflation Expectations Reflect the Lived Reality of Households

The starting point of this discussion is the research on "experience effects," or experience-based learning, which Isabel Schnabel alluded to in her introduction. By now, researchers have accumulated lots of evidence on the effects of personal inflation experiences on inflation expectations and on related financial decision-making. As it turns out, the personal exposure to past inflationary periods, or to high-stability periods, has a lasting and very strong impact.

1.1 An Illustration Using US Data

Chart 1, for example, is an updated graph from our work on "Learning from Inflation Experiences" (Quarterly Journal of Economics 2016, joint with S. Nagel), which uses US data from the Michigan Survey. The dots represent one-year ahead inflation expectations separately for people below age 40, ages 40 to 60 (in red), and above age 60 (in blue) after taking out the population mean. In other words, the figure shows the disagreement across these three age groups. Focusing on the dots first, as opposed to the lines, we can see that sometimes older generations are more pessimistic, and sometimes younger generations are more pessimistic. We also see that sometimes the different generations have consistent views on inflation and sometimes there is large dispersion. Note that, in the period of the 1970s up to 1980s, there was increasing dispersion up to three percentage points at the time. Next, if you're trying to predict these cross-sectional differences, individual-level lifetime exposure to inflation is enormously powerful – and that holds after accounting for common control variables for demographics and even monetary policy with fixed effects. This can be seen visually. The solid and the dashed lines are fitted

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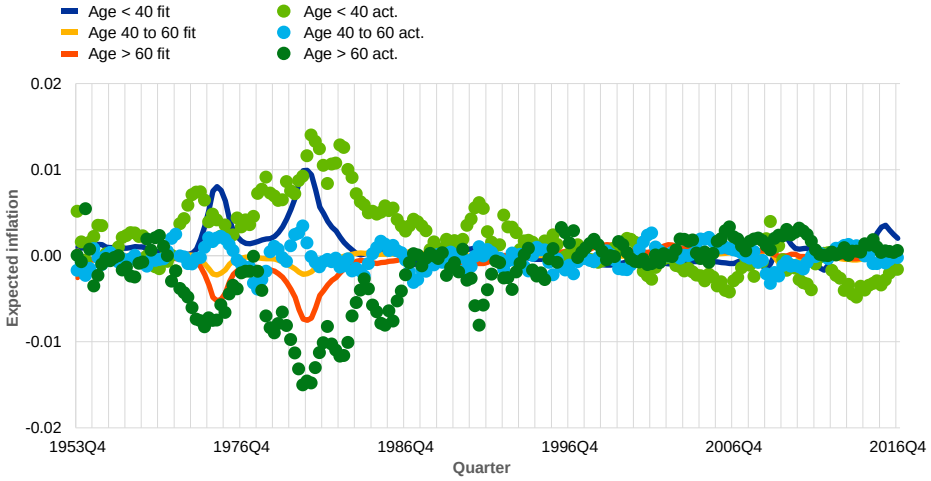
experience-based expectations. In other words, if you give me your birth year and data on the inflation you have experienced over your lifetime so far, I can average it with somewhat declining weights, as there is some recency bias, and will then have a lot of predictive power regarding your inflation expectations.

Chart 1

Disagreement about Future Inflation

(Horizontal axis shows time (year, quarter) and vertical axis shows experience-based inflation expectations in pp deviation from the mean)



Sources: Data from Michigan Survey of Consumers. Figure from Malmendier (2021), updated from Malmendier & Nagel (2016).
Notes: Fitted experience-based expectations. Fitted and actual relative to full-sample c.s. mean (4-quarter MA).

1.2 Inflation Experiences Predict Inflation Beliefs

As the example illustrates, our personal experiences seem to stay with us: we tend to put more weight on realizations experienced during our lifetimes than on other historical data. In some ways, experience-based learning is a “close relative” of adaptive-learning models, but the crucial difference is that it accounts for individual lifetimes. Experience-based learning postulates that it is not enough to recognize that people overweight recent realizations– e.g., that everybody puts too much weight on the last year, the last five years, or other time period. Rather, it depends on the individual. If you are twenty years old, you will overweight the last couple of years. You have not seen much before that. If you are sixty years old, you remember the 1980s and circumstances that came along with it.

Stepping back, there is tremendous amounts of data now on past realizations having an over-proportional influence on our expectations. We find this effect not only from inflation experiences, but also from experiences with the stock market (Malmendier and Nagel 2011). Even unemployment experiences stay with us: we remain cautious spenders for years to come, even if life-cycle consumption-savings models would say otherwise (Malmendier and Shen 2019). The resulting expectations affect, not only what we answer in survey questions about inflation expectations or other expectations, they affect actual decisions. Ricardo Reis alluded to this in his remarks.

We can see that experiences influence investment in long-term bonds, the decision to buy a house, the choice between fixed- and variable-rate mortgages etc.

1.2.1 Inflation Experiences of Firms

Now, while I'm focusing here on households, I do want to say it's not only households who exhibit this behaviour. In a paper on managers in New Zealand, Kumar, Afrouzi, Coibion, and Gorodnichenko (2015), asked managers of New Zealand firms how they typically form their inflation expectations. Two of the top four answers included shopping experience and prices of competitors and suppliers. In other words, the prices managers have seen in the recent past have a disproportionate impact on their forecast of future inflation. Another major influence on beliefs is meetings and discussions, i.e., information they get from other people, but those other people are not financial advisors or monetary policy experts. Rather, it's information from people "like them," such as co-workers and family. It seems to be the case that information coming from people who we identify with-- information that resonates-- has an impact. This is something to think about later in the discussion when considering what the central banks could do.

1.2.2 Inflation Experiences of Experts

Finally, after covering households and firms, I would like to talk about monetary policymakers. These experts on inflation are, themselves, strongly affected by their prior experiences. My favourite example is a man born as Heinrich Wallich in Berlin in Germany in 1914 to a family of bankers. He lived through Germany's hyperinflation in 1923, and then emigrated to the US in the 1930s, where he had a very successful career in the Fed system. He began his career at the New York Fed, earned a PhD at Harvard, and then served as a Fed governor from the mid-1970s to the 1980s. To my knowledge, he still holds the record in Federal Reserve history of dissenting the proposal of the chairperson and kept warning people that they don't understand the dangers of inflation.

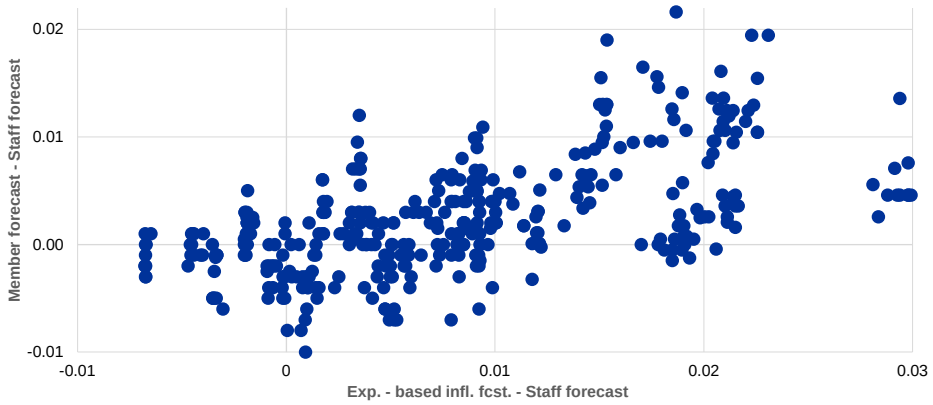
The reason why I love this anecdote, and why I think Henry Wallich would appreciate being cited during the current period, is that he was clearly a highly educated person, who had all the inflation data and models at his fingertips. He undoubtedly knew that, in the 1970s and 1980s in the US, he was living in a different country and in a different time than that of the Weimar hyperinflation, but he still could not shake his experience.

But of course, the argument does not rest on the case of Heinrich Wallich alone. We can see the effects of personal experiences by looking at the one-year-ahead forecasts of FOMC members in their semi-annual Monetary Policy Reports. As illustrated in Chart 2, if you correlate each member's one-year-ahead inflation forecast with their personal experience-based inflation forecasts, both normalized by the staff forecasts, you obtain significant predictive power. This relationship can explain why FOMC members deviate from their staff forecasts so strongly.

Chart 2

FOMC Members' Inflation Experiences and Forecasts

(Horizontal axis shows FOMC members' experience-based inflation forecasts, vertical axis shows FOMC members' inflation forecasts in the semi-annual Monetary Policy Report, both normalized by subtracting the corresponding staff forecast)



Sources: Member forecasts from semi-annual Monetary Policy Report to Congress, 1992 – 2007; Greenbook forecasts; Figure from Malmendier (2021). Originally published in Malmendier, Nagel, & Yan (2021).
Notes: FOMC members' inflation forecasts and experience-based forecast. Member forecasts from semi-annual Monetary Policy Report to Congress, 1992 - 2007. Staff forecasts are Greenbook forecast from the same period. Experience-based forecast are AR(1) model forecasts estimated based on weighted life-time inflation data for each FOMC member.

2 Neuro, not (only) Knowledge

Why is it that our personal experiences stay with us so strongly, even if we are highly informed, theoretically equipped, etc.? Why does personal exposure to inflation or to price stability, on the margin, push us rather strongly in one direction or the other?

2.1 Synaptic Tagging

My message today is that we economists might want to pay more attention to neurobiology rather than information, or knowledge, about inflation-relevant data. We should acknowledge that as humans we are living and breathing organisms, whose brains change as we walk through life. Every new experience leads the human brain to form new connections between neurons, aka synapses, and these synapses tell our body how to react to the world around us.

Importantly, for the inflation context that we are discussing here, it matters how and how often we have an experience. For example, Federal Reserve Bank of Cleveland president Loretta Mester mentioned in her panel remarks the increases in gas and food prices, which tend to get an over-proportional weight in consumers' considerations. Such overweighting is exactly what the neuroscience underpinnings imply: if one experiences repeated stimulation of a certain type, particularly over a prolonged time, that causes longer-lasting effect, a process dubbed long-term potentiation. Every time we go to the gas pump and see the higher price, we can't stop our brain from forming an increasingly strong association between gas and high inflation fears. In fact, the word fear is important here because neuroscientists talk not

only about synaptic tagging, but emotional tagging. Emotional events attain privileged status in memory and fear is particularly powerful.

When experiences result in panic, anxiety, or fear, they become deeply ingrained in the shared memory of an entire population, which of course is what politicians and policymakers would want to avoid. Learned knowledge has very limited power to undo these effects. Despite our best efforts to explain the seasonal AR(1) model of inflation better, we are limited in our ability to fix overweighting or other biases in expectation formation purely using education. A good reference for understanding how these events change us is the literature on trauma and how synaptic changes are caused by traumatic stress. It is a good reference also because trauma is not only the “big-T trauma” we typically think of -- the war experiences, adverse childhood experiences, or, in the economic environment, the German hyperinflation, Great Depression, and the pandemic. There is also small-t trauma, which includes the daily exposure to increasing prices, even if it doesn't completely destroy your livelihood. Small-t trauma can also include daily worries about food, food insecurity, and even unemployment insecurity. All of these experiences reshape and reform our brains and lead us to think differently about the world.

2.2 Example: Gendered Differences

One of my favourite examples in this context are gender differences in inflation expectations, which President Mester also mentioned in her presentation. There is now over 50 years of evidence, starting from the Swedish data analysed in Jonung (1981), that women typically tend to have higher inflation expectations.

When my co-authors and I did a survey during the low-inflation years of 2015-16, we replicated these gender differences. In fact, we were able to show that even within households, the male and female heads of households differ in their inflation expectations, controlling for everything else.

Where does the gender expectations gap come from? We can show that it is not due to differences in literacy. Nor is it education. It turns out that the culprit is the difference in prices men and women see in their daily lives. The difference in their everyday exposure to prices and price changes has a lasting and strong impact. To show this, we looked at under whose responsibility grocery shopping falls within households (D’Acunto et. al. 2021). Traditional gender roles make that very much the woman’s role, still. However, in households where the men indicate that they do some or all of the shopping, the gender differences in inflation expectations completely disappear. That, of course, reflects the highly volatile food prices where people tend to latch on to the increases rather than decreases.

3 Implications for Monetary Policy

To conclude, in terms of implications for monetary policy, the experience effect perspective highlights three, or four, things. First, the frequency of being exposed to

certain price signals is important. This explains the disproportional roles of food and gas prices or personal shopping. From a monetary policy perspective, it is important to understand that this reflects the lived reality of consumers. This influence won't disappear even if one argues that individuals "should" not pay as much attention to those prices as they are high-volatility items whose prices merely obfuscate actual inflation trends and that, instead, individuals should focus on core inflation. If we really want to understand where expectations come from, we need to acknowledge frequency more. Second, duration matters. Inflationary experiences are extra powerful, and their effect will last for a long time, if inflation remains high for a long time.

Policy makers need to account for the lasting effects of inflationary periods. That is, once an economy is back to the "before" situation, e. g., back to 2014-15 levels after the inflation experiences starting in the early 2020s, people will still be different decision-makers. They will make different spending decisions and form different expectations than they would have without the higher inflation experiences.

Lastly, this is particularly true if the inflation events are emotionally anchored. Panic leads to strong anchoring in memory. It is key from a monetary policy perspective to try and combat such a development. Policymakers should not try to teach people that, say, "Food and gas is only 15% of a typical urban consumer's consumption bundle." Instead, policymakers should acknowledge consumers' lived reality and reassure them. They could use more resonant channels of information conveyed by people who know their world.

Finally, I also wanted to talk about anchoring. To some extent, the perspective of experience effects breaks the link to the usual way we think about credibility. Normally, we think that if inflation is well anchored around, say, the two percent target this means the central bank is credible and can pursue effective monetary policy. My perspective says instead that individual expectations reflect what individuals have experienced in their lives so far. If their lived reality averages out to two percent, individuals will indicate two-percent expectations when asked. And if their lived reality corresponds to five percent, they will say five percent. While this does not necessarily undermine credibility, in the sense that the central bank is clear on their triggers for decisions, is following through, etc., it underlines the importance of the impact of lived experiences on expectations. Expectations, in turn, show us whether the central bank is successfully fighting the inflation reality. As a result, some of the monetary policy topics such as forward guidance might not be as powerful as we have thought.

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The Role of Inflation Expectations in Monetary Policymaking: A Practitioner's Perspective

By Loretta J. Mester[1]

Abstract

In these panel remarks, I discuss the role of inflation expectations from a practitioner's perspective. There is a gap between inflation expectations in theory and in practice. Given this gap, I suggest some practical considerations for monetary policymakers, including looking at a number of different measures of inflation expectations; focusing not only on means and medians of survey measures of inflation expectations but also on the dispersion across survey responses; and taking a risk-management approach to ensure that longer-term inflation expectations remain well-anchored at the inflation target when they are beginning to rise.

1 Introduction

I thank the ECB Forum on Central Banking for inviting me to participate on this panel. In my brief prepared remarks, I will discuss the role of inflation expectations from the practitioner's perspective.

1.1 Inflation Expectations in Theory

Inflation expectations have been a central factor in models of inflationary dynamics since the 1960s and 1970s, with the seminal work of Phelps, Friedman, and Lucas, and they play a key role in New Keynesian dynamic stochastic general equilibrium (DSGE) models used to inform and evaluate monetary policy.[2] In many inflation models used by central banks, inflation is driven by three key factors: some measure of a resource utilization gap (for example, the output gap or unemployment rate gap), or marginal cost of production; lagged inflation, which captures the inertia in the inflation process; and expectations of inflation. Different models put different weights on these fundamental factors, but household and business expectations matter, since they affect wage demands and offers, and therefore firms' price-setting behavior. Empirical work on the determinants of inflation finds that the output gap matters when it is large and that, in recent years, forward-looking measures of inflation expectations

[1] Federal Reserve Bank of Cleveland. The views here are my own and not necessarily those of the Federal Reserve System or of my colleagues on the Federal Open Market Committee (FOMC).

[2] See Phelps (1967), Friedman (1968), and Lucas (1972).

play a larger role in explaining inflation dynamics than do backward-looking measures.[3] Work done at the Cleveland Fed and by other researchers finds that including measures of inflation expectations in inflation forecasting models reduces the size of forecast errors.[4] Anecdotal information from business contacts indicates that firms do base pricing decisions on their expectations about inflation, and recent empirical research documents that higher inflation expectations cause firms to raise their prices.[5] In addition to their role in inflation dynamics and helping to forecast inflation, inflation expectations also provide an indication of how credible the public finds the central bank's commitment to achieving its policy goals.

The Federal Reserve's monetary policy framework emphasizes the role of well-anchored inflation expectations in helping to achieve and maintain price stability. In 2012, the FOMC first established its explicit 2 percent longer-run inflation goal. The FOMC's statement on longer-run goals and monetary policy strategy, revised in 2020 and reaffirmed since then, says that the Committee judges that longer-term inflation expectations that are well anchored at 2 percent contribute to achieving its monetary policy goals.[6] There are various ways to define "well anchored." Here, I mean longer-term inflation expectations that are insensitive to data and are at levels consistent with 2 percent inflation. Achieving "well anchored" in this sense would depend on how well the public understands the central bank's inflation goal and how strongly it believes the central bank is committed to returning inflation to goal when it has deviated. This implies that central bank communications can play an important role in keeping inflation expectations anchored and, via this channel, communications can help to mitigate the persistence of shocks to inflation. It is important to note that if inflation expectations are stable but are well anchored at levels inconsistent with price stability, then they would be an impediment to achieving the inflation goal.

Theory indicates that well-anchored inflation expectations can help to mitigate the pull of resource gaps on inflation, and therefore, the cyclical movements in interest rates that policymakers induce to maintain price stability need not be as large as when inflation expectations are not well anchored. This is particularly useful when the zero lower bound constrains interest rates. Arguably, the U.S. might have suffered much lower inflation during the Great Recession had inflation expectations not been relatively stable, offsetting some of the influence the negative output gap had on inflation. Similarly, in the face of today's very high inflation readings, if inflation expectations were to become unanchored, their influence would offset the impact of any beneficial change in the output gap and monetary policy would have to act more forcefully to return inflation to goal.

While the theory is compelling, the real world does not always cooperate. For example, in Japan, inflation expectations have run well above actual inflation for a number of years.[7]

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3 For further discussion, see Fuhrer and Olivei (2009) and Clark and Davig (2009).

4 See Faust and Wright (2013), Zaman (2013), Chan, Clark, and Koop (2018), and Tallman and Zaman (2020).

5 See Coibion, Gorodnichenko, and Ropele (2020).

6 Federal Open Market Committee (2022).

7 See Trehan and Lynch (2013) and Hattori and Yetman (2017).

1.1.1 Inflation Expectations in Practice

One of the first things policymakers need to confront in practice is that while the theory speaks of "inflation expectations," these expectations are not directly observable. Instead, there are a number of measures, which differ by type of agent and time horizon. These include measures based on surveys of consumers, businesses, and professional forecasters, and measures derived from financial markets.[8] So, in practice, to get an indication of where inflation expectations are and where they are going, policymakers need to look at a variety of different indicators or a composite such as the index of common inflation expectations.[9] But a clear signal is not always forthcoming, because the inflation expectations of different groups of agents can behave differently from one another and the literature has not firmly established whose expectations are most important for inflation dynamics.[10] For example, survey measures of the inflation expectations of professional forecasters and financial industry participants were fairly stable over the course of the Great Recession and recovery, while those of households and businesses drifted down.[11]

Even within a particular group of agents there is considerable heterogeneity. The inflation expectations of consumers appear to vary with demographic and socioeconomic factors.[12] And changes in the prices of particular salient items, including gasoline and food, can have an outsized effect on households' inflation expectations.[13]

Empirical results also raise questions about the direction of causality. Reduced-form forecasting equations are not able to answer the question of whether high inflation leads to increases in inflation expectations, or whether expectations of high inflation affect household and business decisions, leading to higher inflation, or both.[14] And while businesses are the ones that set prices, we have only limited information on the inflation expectations of these relevant actors.

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8 Model-consistent expectations, or rational expectations, get around the unobservability issue by assuming that agents' expectations will be consistent with the underlying fundamentals of the model. But empirically, these model-consistent expectations alone are not good predictors of inflation. This should not be too surprising. A model is a representation of the economy and may not capture factors relevant to expectations formation or changes to the underlying structure of the economy that are not fully understood by either the public or policymakers.

9 The index of common inflation expectations is a research data series maintained by the Board of Governors' staff. See Ahn and Fulton (2021).

10 See Candia, Coibion, and Gorodnichenko (2021).

11 For further discussion, see De Pooter, et al. (2016).

12 This measure indicates that women's inflation expectations are higher than men's and that older respondents and more educated respondents also report higher inflation expectations. The Cleveland Fed's indirect consumer inflation expectations measure, which started in 2021, is based on a nationwide survey with more than 10,000 responses and is updated on a weekly basis. Instead of asking consumers directly about overall inflation, the survey asks consumers how they expect the prices of the things they buy to change over the next 12 months and how much their incomes would have to change for them to be able to afford the same consumption basket and be equally well-off. See Hajdini, et al. (2022).

13 For the effect of experiences from high-inflation eras on inflation expectations, see Malmendier and Nagel (2016). For the effect of salient prices on inflation expectations, see Coibion and Gorodnichenko (2015), Cavallo, Cruces, and Perez-Truglia (2017), D'Acunto, et al. (2021), and Campos, McMain, and Pedemonte (2022).

14 See, for example, the recent critique by Rudd (2021).

Another practical consideration for policymakers is how to assess whether inflation expectations are becoming unanchored from the target and, relatedly, the level of the central bank's credibility in the eyes of the public. Levels of longer-term inflation expectations relative to shorter-term expectations can provide some indication. For example, longer-term expectations remaining stable in the face of a positive shock to inflation would indicate that the public believes that inflation will come down, although it need not indicate that the public believes monetary policy will be the main driver of the reduction. In addition to the stability of the median or mean level of inflation expectations across respondents to a survey, dispersion across the respondents might also indicate how well inflation expectations are anchored, with lower dispersion indicating better anchoring.[15] Policymakers also need to contend with the possibility that financial markets may have more confidence than the general public in the central bank's ability and commitment to bring inflation back to goal, which suggests again that policy communications are important for keeping inflation expectations well anchored.

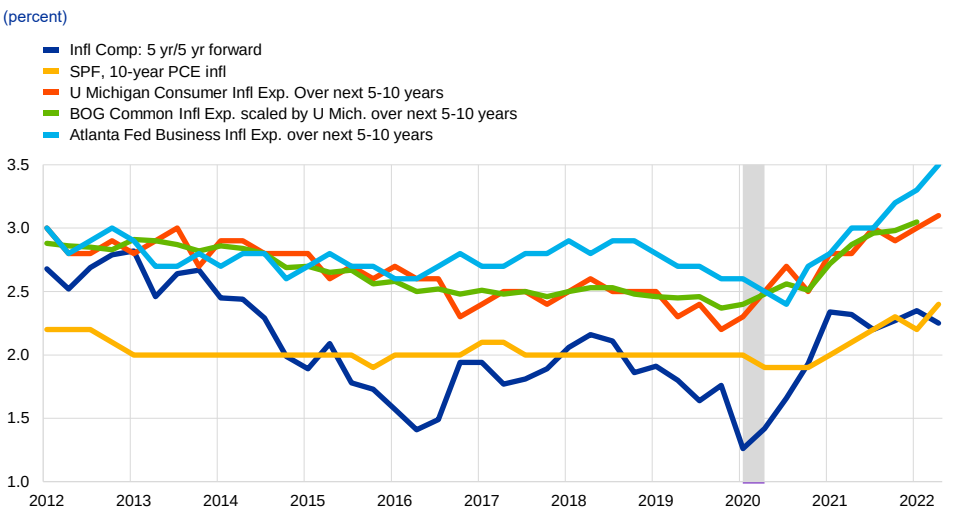
Policymaking Given the Gap Between Theory and Practice

Taken all together, the research suggests that there is still much to learn about how inflation expectations are formed, yet policymakers need to make decisions based on the available limited information. Recent data in the U.S. indicate that longer-term inflation expectations are below current inflation readings, suggesting that the public expects inflation to move back down from its unacceptably high level. But the level of inflation expectations at longer horizons is rising, and dispersion across respondents in household surveys has begun to increase (see Charts 1 and 2). The fact that the salient prices of gasoline and food remain elevated suggests that there is some risk that longer-term inflation expectations of households and businesses will continue to rise.

[15] Naggert, Rich, and Tracy (2021) find that the lower end of the distribution of 5-year/5-year-forward PCE inflation expectations from the U.S. Survey of Professional Forecasters shifted up toward 2 percent and the dispersion of inflation expectations across respondents narrowed after the FOMC announced its revised monetary policy framework in August 2020.

Chart 1

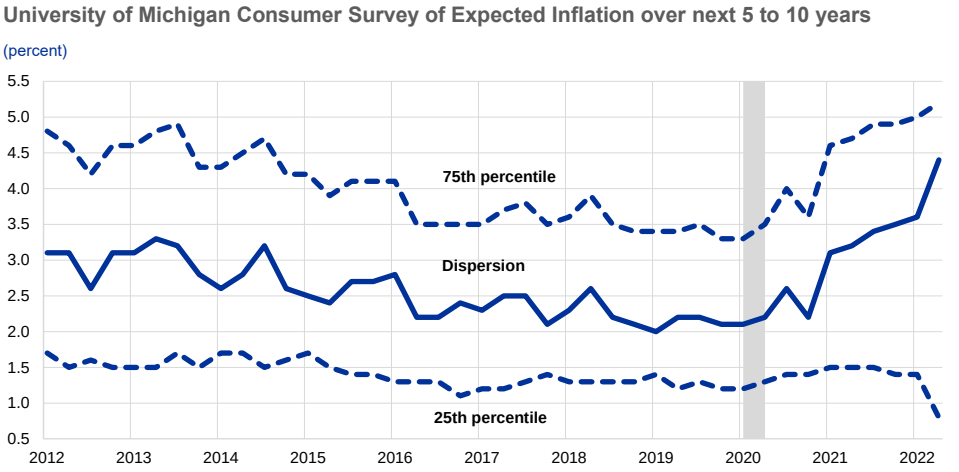
Measures of longer-term inflation expectations in the U.S. are rising



Sources: Federal Reserve Board, Federal Reserve Bank of Atlanta, Federal Reserve Bank of Philadelphia, University of Michigan, via Haver Analytics
Notes: Quarterly data (last month of qtr for U Mich and Infl Comp): Last obs. 2022Q1 for CIEI, June 2022 for U Mich and Infl Comp, 2022Q2 others.

Chart 2

Dispersion in longer-term inflation expectations of households is rising



Sources: University of Michigan
Notes: Last month of each quarter: Last obs. June 2022.

In the current situation, from a risk-management perspective, it is important for policymakers to ask which situation would be more costly: erroneously assuming longer-term inflation expectations are well anchored at the level consistent with price stability when, in fact, they are not? Or erroneously assuming that they are moving with economic conditions when they are actually anchored? Simulations of the Board's FRB/US model suggest that the more costly error is assuming inflation expectations are anchored when they are not.[16] If inflation expectations are drifting up

[16] See De Pooter, et al. (2016).

and policymakers treat them as stable, policy will be set too loose. Inflation would then move up and this would be reinforced by increasing inflation expectations. If, on the other hand, inflation expectations are actually stable and policymakers view the drift up with concern, policy will initially be set tighter than it should. Inflation would move down, perhaps even below target, but not for long, since inflation expectations are anchored at the goal.

These simulation results, coupled with research suggesting that persistent elevated inflation poses an increasing risk that inflation expectations could become unanchored, strongly argue against policymakers being complacent about a rise in longer-term expectations. Indeed, inflation expectations are determined not only by movements in inflation but also by policymakers' actions to follow through on their strongly stated commitment to return inflation to its longer-run goal, thereby justifying the public's belief in the central bank's commitment.

The current inflation situation is a very challenging one. Central banks will need to be resolute and intentional in taking actions to bring inflation down. The low inflation readings during the pre-pandemic expansion led to considerable research on how low equilibrium interest rates and the zero lower bound can create a downward bias to inflation and inflation expectations. The policy implication some drew from this research was that if policy had to err, it should err on the side of being too accommodative, since it would be easier to address high inflation than low inflation. The current challenging situation in which a sequence of supply shocks have contributed to inflation being at a 40-year high belies that view. It also calls into question the conventional view that monetary policy should always look through supply shocks. In some circumstances, such shocks could threaten the stability of inflation expectations and would require policy action. My hope is that just as the period of low inflation generated important research, the current period will generate new research to help the FOMC deliver on its commitment to price stability and maximum employment.

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Limitations to the role of inflation expectations in monetary policymaking: A markets' perspective

By Erik F. Nielsen

Long-term inflation expectations, as reflected in surveys and markets, are very important for the general credibility of a central bank committed to price stability. Short-term inflation expectations do not provide a similar signal, as they predominantly reflect the perception of existing inflation.

However, both survey-based measures and markets' pricing of "inflation compensation" over the next five years, or longer, are volatile, opaque and/or prone to revisions. Therefore, any indication from such readings of a possible change in the perception of a central bank's credibility should be taken with a pinch of salt until deviations become relatively widespread among the readings, as well as persistent over an extended period of time of, say, six months or more.

Importantly, therefore, any adjustment to the path of monetary policy, as determined by the research-based outlook for inflation and the economy more broadly, due to changes in individual monthly readings of long-term inflation expectations – or readings over e.g. 2-3 months – would be ill advised.

In particular, during periods when market participants are on high alert with respect to changes in monetary policies because of fear that excessive inflation might trigger a wage-price spiral, as is now the case (or fear of deflation, as was the case ten years ago), central bank communication becomes particularly important. Monetary policymaking is more an art than a science (but like all great arts, based on deep technical skills), which means that the speed of policy adjustments, let alone the direction of policies, should not be guided by individual data points. References in central bank communication to specific data points, particularly volatile ones and those read from the pricing in markets (which come with a fast and potentially disruptive feedback loop) should therefore be done only with the utmost care and clarity of the limitations of their signalling effects.

1 The limitations of market-based and survey-based inflation expectations

Specifically, market-based inflation expectations suffer from two impediments when it comes to their usefulness as input in policymaking:

First, they are too volatile, given the policy relevant horizon. For example, the 5y/5y – i.e. the market's pricing of inflation during the five-year period, beginning in five years – had fallen to 1.75% early this year, then it jumped to 2.5% in March, before it dropped

back below 2% in July. Surely, any adjustments to the policy path during those six months, on the back of any of the readings of the 5y/5y, would have been misplaced, given the policy relevant horizon of about 6-24 months.

Second, they are far from straightforward to interpret because of the liquidity and risk premia. For example, as illustrated by Isabel Schnabel in her speech on "The globalisation and inflation" on 11 May, the estimate of the inflation risk premia on a 1y/3y Inflation Linked Swap moved from deducting 80 basis points in early 2020 to adding 40 basis points in May of this year. That's a 120 basis points' shift in the estimated risk factor alone inside what would have been the policy relevant period for any consideration of policy changes in early 2020.

These impediments suggest that once adjusted for the risk premium, market-based inflation expectations become little more than a weighted average of the forecasts by private-sector professional forecasters, which is less surprising to us commercial economists than it may appear to observers from outside markets. After all, our profession is – precisely – to forecast market prices and on that basis to recommend changes to investors' asset allocation, including to protect the real value of assets. If the pricing of the key asset classes, including inflation protection assets, on average over time, did not reflect the collective outlook among commercial professional forecasters, wrong as they may turn out to be, chances are that our employment – collectively – would find an early end.

The survey-based inflation expectations are not only volatile, like market-based readings, but prone to changes or revisions, which – in the present environment of elevated, indeed excessive, focus on such readings – causes unnecessary volatility in markets.

For example, on Friday 24 June the University of Michigan (UMich) revised its estimate of consumer 5-10-year inflation expectations for May down to 3.1% (and hence just a sliver above the April number and presumably therefore not a dramatic change) from the preliminary reading of 3.3%. Fed Chair Jay Powell had called the preliminary reading of 3.3% "eye-catching" in his press conference following the Fed's 75bp rate hike, a characterisation which had led most market participants to conclude that this one number had been a significant reason for the Fed to hike by 75bp instead of the 50bp indicated, and priced in by markets, just a few days before the decision. As a result, the revision of the survey data point caused considerable volatility in markets as confusion about what this revision might mean for future rate decisions spread among market participants.

Whether driven by Fed communication as to the importance for monetary policymaking of this survey-based inflation expectations reading, or not, markets' intense focus on these readings then caused further confusion in mid-July when the June reading was published. Indeed, the UMich 5-10-year inflation expectations fell to 2.8%, the lowest level since July 2021, which is below its 2001-07 average of 2.9% and only slightly above its 2012-19 average of 2.6% (a period when PCE inflation was below target in every single year but one). Worse, for the interpretation, however, the headline number hides unprecedented dispersion in responses: The 75th percentile sits at 5.1%, 1.1pp above its 2012-19 average, while the 25th percentile dropped to

0.3%, 1.1pp below its 2012-19 average. Surely, an index with such volatility and sudden dispersion in responses can serve no more than a marginal input in policymaking.

1.1 Beyond the general signal of credibility, do inflation expectations matter?

The key reason why inflation expectations may matter for policymakers is the risk that they become self fulfilling. In the present environment of tight labour markets, they may lead to higher wages, triggering a self-fulfilling spiral. In times when inflation expectations approach zero, the risk of deflation becomes real. Yet, while research shows that there is a good correlation between long-term inflation expectations and wage growth, we only have very few episodes during the past decades of significant deviations from the inflation target. In the present high-inflation environment it appears that high wage growth, or the prospect of it, hinges more on past inflation and wage earners' demand for partial compensation for the inflation shock (as the cost of the terms of trade shock gets distributed in society), than on inflation expectations. Consistent with this, much of the higher wage growth appears to have taken the form of one-off bonus payments.

In the US, where massive fiscal support was provided during the pandemic, notably in the form of direct payments to households, and where markets are more flexible (and the worries about the war in Ukraine more distant), there are clear signs of demand-pull effects in the inflation numbers – and labour markets have become very tight, although largely due to a (still partly unexplained) drop in participation. As a result, average hourly earnings growth on a 3-months annualised basis accelerated to more than 6% by the end of last year, but has more recently dropped to about two-thirds of that, and hence to a level only a little above that consistent with the inflation target plus (pre-pandemic) trend labour productivity growth of about 1.5%. (Granted, what underlying productivity growth will be in a post-pandemic world remains uncertain).

In Europe, there are concerns about upcoming wage negotiations, in particular in Germany, as well as the effect of the indexation of minimum wages in France and other countries. These are important issues to consider for a central bank, and yet, it appears that the unions' wage demands (and certainly the wage growth on the back of indexation) have very little to do with inflation expectations, and everything to do with past inflation and an attempt to recover some of the loss that wage earners have suffered. In several countries, the involvement of the fiscal authorities, including for tax relief for one-off payments, has either taken place or is being considered.

As a result, the ECB can remain confident that the risk of a wage-price spiral is limited, if still the key topic to watch, analyse – and be vigilant about. Importantly, however, there is little or no evidence that European wage developments are about to be driven by elevated inflation expectations.

2 Conclusion

Monetary policymaking is complex and much more than a quantifiable science – and more so now than ever. Obviously, it has to be data dependent, but just like policies should not be set on the back of only a few data points, monthly measures of inflation expectations – whether markets-based or survey-based – should not be an important input in setting the direction or details of policy changes. Only if a collection of longer-term inflation expectations data starts to deviate measurably – e.g. by 50bp or more – over an extended period of time – say, six months – should they be used to inform the direction and speed of policy.

Whether formed by the collective wisdom of financial markets (by the price formation reflecting shifting views of traders and investors or by professional forecasters), individual market participants have no greater insight into the future of inflation than, e.g. central banks' research teams. Scottish philosopher, Thomas Carlyle, once opined, "I do not believe in the collective wisdom of individual ignorance". I tend to agree.

Expected inflation in the euro area: measurement and policy responses

By Ricardo Reis[1]

Abstract

Measures of expected inflation from both surveys and market prices provided valuable signals during the 2021-22 rise in euro area inflation. Combining these measures, as opposed to picking just one, and looking at distributions, as opposed to only measures of central tendency, showed a sustained drift upwards in inflation expectations since the middle of 2021. In June of 2022, these measures point to an expected gradual decline in inflation over the next two years, and a small risk to the credibility of the ECB's inflation target. A baseline model suggests that a central bank should respond to these measures by raising interest rates. How much and how fast depends on how it assesses the source of the shock and how expectations are linked to actions.

1 Introduction

Both academics and policymakers closely follow measures of expected inflation. Yet, it is sometimes argued that these measures are too noisy to be useful, that surveys reflect the cluelessness of the population about inflation, and that market prices are driven by liquidity factors and distortions. This paper provides some answers to three related questions:

- Did measures of expected inflation foreshadow, or did they at least sensibly follow, the large increase in euro area inflation in 2021-22?
- What is expected inflation in the euro area in June of 2022, and what challenges does it pose for the ECB?
- Given the noise in measures of expected inflation, should monetary policy ignore these measures when choosing nominal interest rates?

Section 2 looks at data to answer the first two questions, while section 3 writes a simple canonical model to answer the third. Section 4 concludes with general answers to questions on the role of inflation expectations in monetary policy.

[1] A.W. Phillips professor at the London School of Economics. I thank Marina Feliciano, Salomé Fofana, and Borui Zhu for research assistance.

2 Measuring expected inflation

There are three well-established alternative ways to measure inflation expectations.[2]

The first is to ask ordinary people in surveys. For the euro area, the best source of publicly available data today is the Bundesbank online survey of consumers, conducted since January of 2019, which has expectations for inflation 1, 3, 5, and 10 years ahead. In survey data, you always worry about biases coming from personal experiences, overreaction to news, and inattention, especially after twenty years of stable inflation. The signal-to-noise ratio is small. Moreover, while people seem to make the distinction between 1-year ahead and longer horizons, the forecasts for 3, 5, or 10-years ahead are often the same, as people do not really distinguish between them.

Second, you can ask people whose job is, at least in part, to forecast inflation. The best euro area data probably comes from the ECB's survey of professional forecasters, available since the first quarter of 1999. This has more signal to noise and usually provides better forecasts than household's answers. However, it suffers from the strategic behaviour of the respondents, who do not want to be so far off from others that they are branded as out of touch, while still wanting to be slightly different to signal they have private information. It also suffers from conformism, as many of these professionals spend much time in conferences with policymakers listening to common arguments. More worryingly, if we look at the record of the large turning points in US inflation---the great inflation of the 1970s, and its sharp reduction during Volcker---both times, professionals were way off, adding little to the central bank's poor forecasts at the time.[3]

Third and finally, you can turn to asset prices. In the euro area, there are data on both inflation swap contracts and options. One difficulty here is how to extract compensation for risk, especially since we know from other asset prices that the price of risk fluctuates widely. Another problem is that the signal from prices is polluted by trading frictions and liquidity factors, while measuring payoffs and horizons takes some care.

2.1 One-year ahead euro area inflation expectations

Chart 1 plots euro area inflation expectations data one-year ahead, since the start of 2021 and until June of 2022. The household expectations, which have their level adjusted for biases and overreaction using a formula from Reis (2020), were the first to start drifting upwards. They were rising already in the middle of 2021 and have gone up ever since. Markets were close behind, and since the start of 2022 have risen more aggressively, perhaps because the Russian invasion of the Ukraine has increased the chances of a recession at the same time as inflation is high, raising risk compensation.

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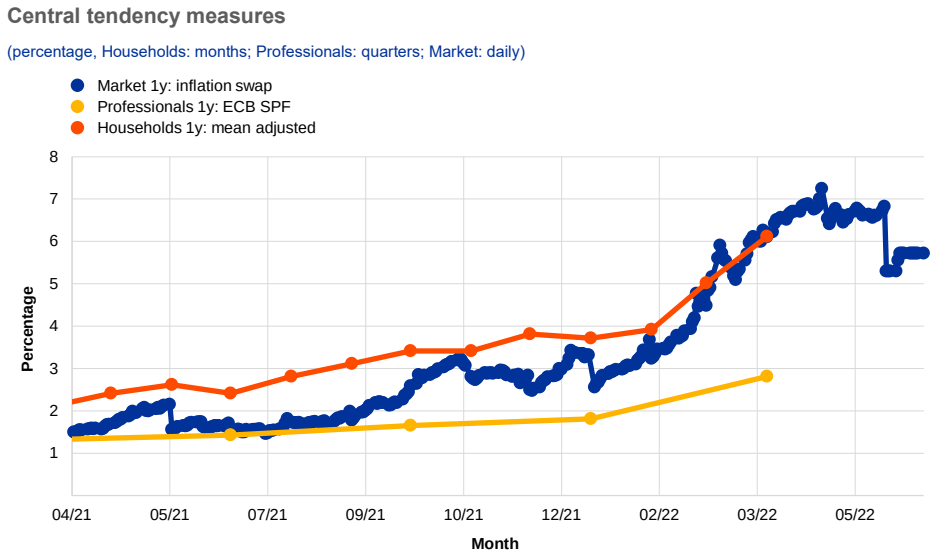
[2] Aside from surveys of households and professionals, research over the last few years has made great advances in surveying firm managers as well (Candia et al, 2021). These surveys are not publicly available yet, and still have short time samples, but soon they should become a reliable fourth source of data.

[3] See Reis (2021) for a discussion of expectations around these turning points.

The professionals have been, for the most part, useless in keeping up with the increase in inflation that happened in the last twelve months.

Chart 1

One-year ahead euro area inflation expectations



Sources: Bundesbank household panel survey, ECB Survey of Professionals, Bloomberg for 1-year inflation swap rate
Notes: The household adjusted mean is given by the formula: Average – StandardDeviation (0.5 Skewness)^0.5, where the moments are calculated using the whole sample, so this shifts the series downwards relative to the original data.

We already know how much inflation has risen in these past eighteen months, and what it will likely be over the next six months. Therefore, we can already conclude that household surveys and market prices were quite useful in spotting the extraordinary rise in inflation during this period. Policymakers, academics, or commentators that ignored or undermined the value of these data, were wrong to do so, especially as they were more on track than were the forecasts from many central bank models or from surveys of professionals.

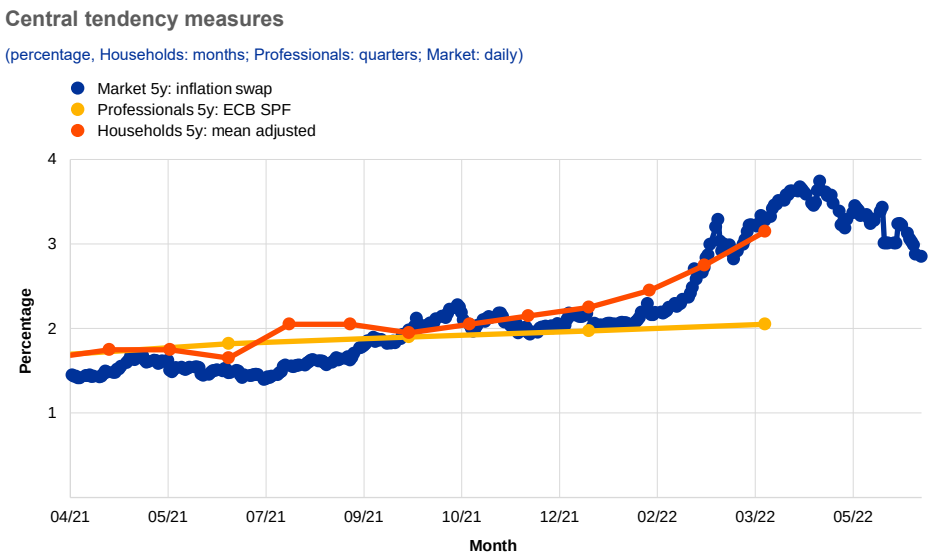
What do the data suggest for the next twelve months? In May and June, as European monetary policy started talking of tightening, market expectations have stabilized, or slightly reverted. The data on household expectations has still not been released. Only in a few months, looking at these two series, will we be able to see if this is a true inflection, but at least the data tentatively suggests that the upward drift has halted.

2.2 Five-year ahead euro area inflation expectations

Chart 2 shows data for the harder, but perhaps more useful, question of what inflation will be over the next five years. These data can tell us whether inflation expectations are anchored, because averaging over five years may take out conflicting interpretations of current events and transitory shocks.

Chart 2

Five-year ahead euro area inflation expectations



Sources: Bundesbank online panel of households, ECB Survey of Professionals, Bloomberg for 1-year inflation swap rate
Notes: The household adjusted mean is given by the formula: Average – StandardDeviation (0.5 Skewness)^0.5, where the moments are calculated using the whole sample.

The pattern in the household survey data is quite similar to the one-year ahead data. It started rising in the second half of 2021 and, once it did, it rose steadily and persistently for many months in a row. Markets again followed closely behind, especially since January of 2022, and have stabilized or reverted since May of 2022. Again, professionals' forecasts barely changed. Altogether, there seems to have been a de-anchoring upwards starting towards the end of 2021, with the more recent data faintly suggesting that the worst may have been reached.

2.3 Combining measures

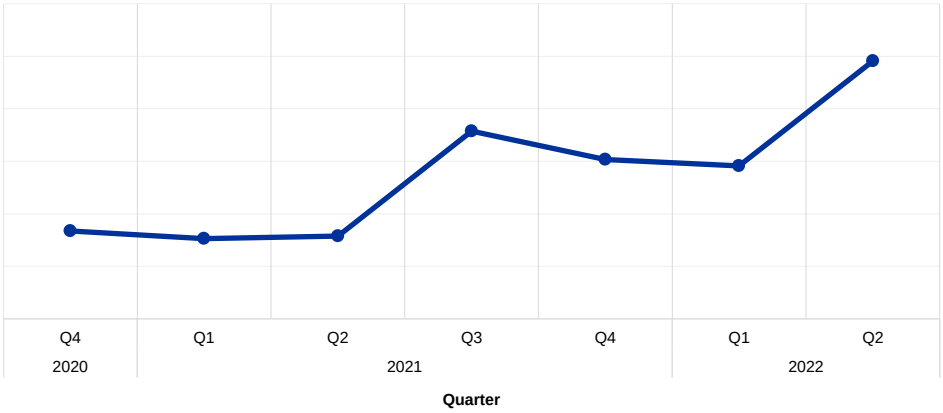
Which of these three measures is the best? In my view, this is the wrong question to ask. Instead, one should rather ask how to combine them to obtain more accurate signals than those from each individual series. Chart 3 does so by using the statistical model developed in Reis (2020). This model treats the data from the surveys as being biased, over-reacting to events, and sluggish on average; it treats the professional medians as being potentially far from the marginal informed agent; and it treats the market data as being sensitive to news but filled with noise. The model adjusts the data on averages for these features, complementing it with data on second and third moments to capture disagreement. Aside from parameters measuring the extent of each of these properties of the data, it produces a measure of underlying fundamental expected inflation. Chart 3 plots 5-year ahead expected inflation for the euro area.

Chart 3

Fundamental expected euro area inflation five years ahead

Combining survey and market data using the Reis (2020) model

(percentage, quarters)



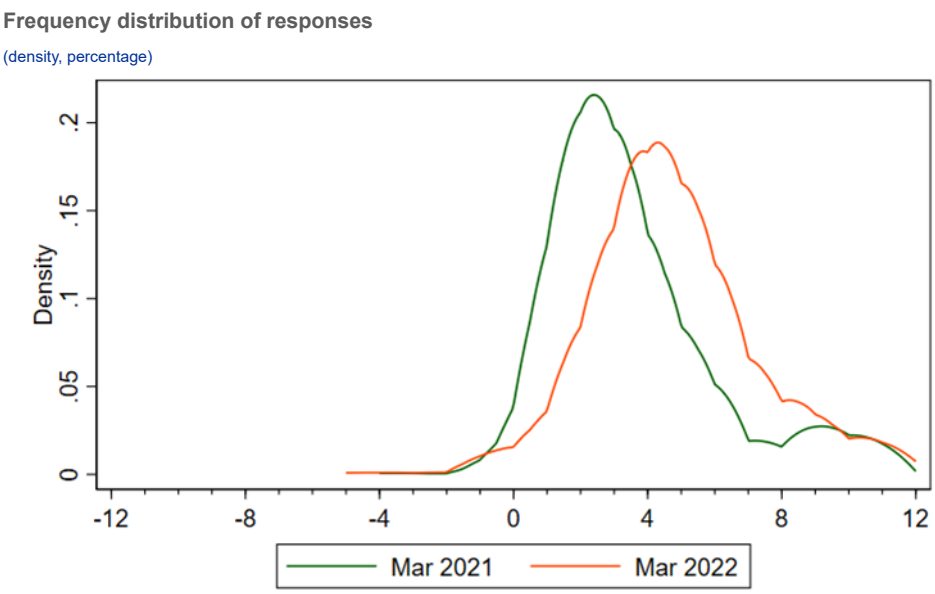
Sources: Own calculations.
Notes: Each horizontal gridline corresponds to 1% inflation.

Purposefully, the chart does not include a label in the vertical axis, even if each tick and gridline indicate 1% units. The reason is that the measurement model delivers estimates of how expected inflation has changed from the starting point, but not of what that starting point is. So, if you think that, at the end of 2020, inflation expectations in the euro area were firmly anchored at the 2% inflation target of the ECB, then the chart says that in 2022Q2 they are now about 5%. If instead you think they were anchored at 1% in 2020, following the undershooting of inflation of the previous years, then, in mid 2022, they are about 4%. Even discounting for a possible increase in compensation for inflation risk of 1%, which seems to me like an upper bound, then the expected inflation anchor is today between 3% and 4%, uncomfortably above the 2% target.

The chart shows that there were two key periods in this rise: in the Fall of 2021 and in the Spring of 2022. Looking at the data inputs behind these estimates, in the Fall of 2021 there was an increase in disagreement within households, measured by both standard deviation and skewness, even as the median was only slightly higher. At first, the model puts some weight into this being noise, or an over-reaction. But as soon as the median started rising and, especially, market prices started rising as well, the model revises sharply upwards the view that expected inflation was now higher. In the Spring of 2022, market expected inflation jumped upwards, while disagreement in household surveys fell. The model interprets this as expectations becoming anchored at a higher value.

Chart 4

Five-year ahead expected euro area inflation by German households



Source: Bundesbank online panel of households
Notes: inflation indicators truncated to values in range [-12,12], weighted data.

2.4 Inspecting the distributions and the plausibility of the estimates

Finally, digging a little deeper into the data, chart 4 plots histograms of the Bundesbank online household survey data one year apart, in March of 2021 and March of 2022. Expectations are unanchored in two senses. First, because the distribution in 2022 is more spread out than in 2021. Second, because the distribution has decisively shifted to the right by 1.5% to 2%. The glass half full is that we do not see the elevated disagreement that presages further increases in expectations. The glass half empty is that they seem anchored near 4%.

We already saw how the 1-year ahead expectations of households were sensible and useful over the past 18 months; what about these longer-horizon forecasts? Take the following forecast for the path of inflation between 2022 and 2026: 8%, followed by 5%, then 3%, and finally two years of 2%. Since 8% this year already seems likely, this is a plausible forecast of the persistence of inflation shocks. The corresponding average over 5 years is 4%, precisely what households are expecting.

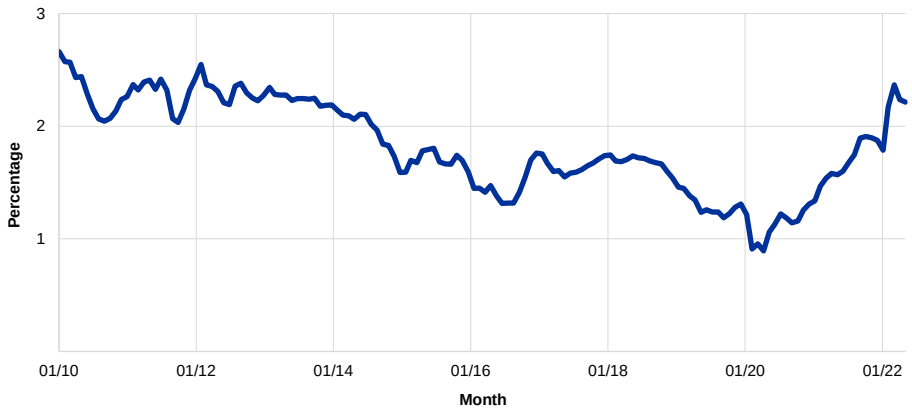
If inflation is 8% this year, then a 4% average may be as good as it gets for a central bank that targets inflation (as opposed to the price level) and that does not want to overshoot the inflation target on the way down. Under the inflation path of the previous paragraph, expectations of 5-year ahead inflation would come down quickly to be back on target by the end of 2023. However, as I noted, in their answers to the surveys, people do not distinguish well between 5-years ahead and 10-years ahead. If they expect 4% inflation on average over, say, the 5-year-5-year period, this would be a disaster for the ECB given its inflation target and it would have lost its credibility. To evaluate if it is so, we must move away from survey data and towards market prices.

2.5 Measuring the credibility of the inflation target

Chart 5 shows a measure of the ECB's credibility, the 5-year-5-year expected inflation from inflation swaps. After 5 years, all transitory effects of current shocks should be gone. In theory, this measure should be close to a horizontal line at 2%, with a variance due solely to changes in the price and quantity of inflation risk. Arguably, it was so before the pandemic, although there was a shift down around 2014, which I would interpret as a slight decline in expectations under the 2% target.

Chart 5

Expected euro area inflation 5-year-5-year ahead



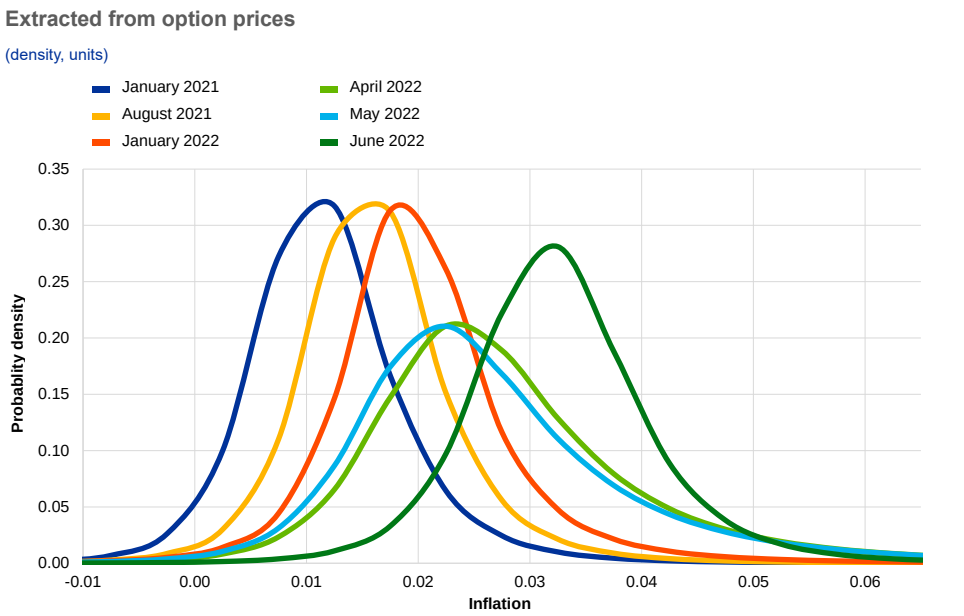
Sources: Bloomberg.
Notes: These are not adjusted for risk compensation.

Throughout the last eighteen months, this measure has risen by 1.2%. Some of it may be welcome, if it involves a re-anchoring at 2%. Some of it is surely an increase in compensation for risk, as even a short period of stagflation became likely. (If so, this should not be treated as noise to filter out, since it has important consequences for monetary policy.) Overall, this figure does not support a panic about inflation, but a moderate concern.

Chart 6 digs deeper by looking at the distributions of outcomes, extracted from option prices in markets. Two large caveats to these numbers are that: (i) because the options are for the 10-year horizon, not 5-year-5-year, they confuse the persistence of the current shock with the credibility of the ECB, and (ii) compensation for inflation risk is included. Still, the shift in the mean mirrors the one in chart 5. More interesting, the shift to the right in the distribution over the last eighteen months came also with an increase in its spread. Uncertainty seems to have risen. From the perspective of the ECB, of particular concern is the right-tail of this distribution.

Chart 6

Probability densities for 10-year-ahead euro area inflation

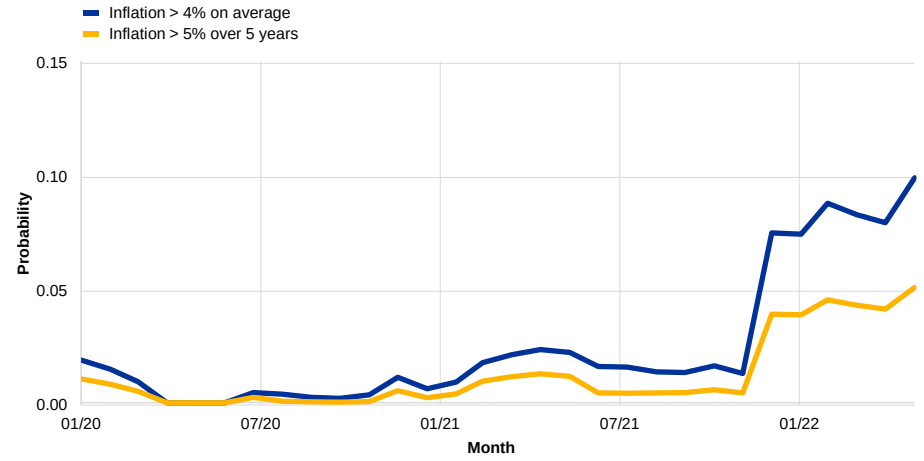


Sources: Bloomberg data on prices of inflation swaption contracts.
Notes: See Hilscher, Raviv, and Reis (2022) for details.

Chart 7 looks at the right tail only and deals with these two caveats by adjusting for horizon and risk using the methods in Hilscher, Raviv and Reis (2022). There was a clear increase in the probability of a high-inflation disaster around December of 2021 and January of 2022, from 0% to around 5-10%. Since then, there has been little change. Month-to-month fluctuations in these estimates of a few percentage points are likely best ignored, given measurement error and liquidity shocks to these markets. Instead, a clear change in regime, almost like a step-function, should be paid close attention to as a sign of cracks in the ECB's credibility. On the one hand, chart 7 is worrying: any self-respecting central bank would want those estimates to be close to zero. On the other hand, with all the shocks of the past twelve months to inflation, maybe 5-10% is as good as one could hope for.

Chart 7

Probability of a 5-year-5-year high-inflation disaster



Sources: Hilscher, Raviv, and Reis (2022).
Notes: See Hilscher, Raviv, and Reis (2022) for details.

2.6 Conclusions from the data

It is unfortunately still too common to dismiss data from household surveys because the data are noisy, and people have little idea of what inflation is or what is going on with monetary policy. Likewise, data from market prices can be dismissed by concerns about the liquidity of markets or about the irrationality of the traders behind them. Yet, the experience of the last year confirms that noise, biases, and inattention may all be present, and yet survey data is very useful. The data gave sensible estimates throughout this period, and points to clear dangers ahead. Even if in normal times, the data adds little to other sources of information, during turning points in inflation dynamics, survey data become invaluable.

Market prices likewise gave sensible estimates in the last twelve months. Combining them with surveys delivered solid estimates of expected inflation. Looking forward, the probabilities of inflation disasters point to people being willing to put money to insure against the possibility that the ECB's inflation target is not credible. For the near future, the data suggests concern, but not panic.

3 Should a central bank act in response to estimates of inflation expectations?

An inflation-targeting central bank should, of course, care about expectations as a measure of its performance. A different question is whether it should change policy in response to these data. Answering it requires a model with which to study policy. This section uses the textbook simple new Keynesian model to do so, although the points I

will make are broad enough that they probably extend to other models of monetary policy.[4]

The model has three equations, a Phillips curve, an Euler equation, and a monetary policy rule:

$$\pi_t = E_t(\pi_{t+1}) + \kappa y_t + z_t$$

$$y_t = \omega_y E_t(y_{t+1}) - \omega(i_t - E_t(\pi_{t+1}) + a_t)$$

$$i_t = \bar{\pi} + \phi(\pi_t - \bar{\pi}) + \phi_y y_t$$

Where the three variables are inflation (π_t), the output gap (y_t) and the nominal interest rate (i_t). There are also two exogenous, mean zero, i.i.d. supply shocks: to productivity (a_t) and to markups (z_t). All parameters are in Greek letters and are positive. A slight change relative to the textbook model is that $\omega_y < 1$, as in TANK models (Bilbiie, 2021). The inflation target is $\bar{\pi}$, and the parameters ϕ and ϕ_y define how policy is conducted, in terms of the policy rate's reactions to inflation and the output gap, respectively.

3.1 Solution under rational expectations

With rational expectations, the solution for inflation is:

$$\pi_t - \bar{\pi} = \frac{-\kappa a_t + \left(\phi_y + \frac{1}{\omega}\right) z_t}{\phi_y + \frac{1}{\omega} + \kappa\phi}$$

Since the supply shocks, a_t and z_t, are short-lived, so is the deviation of inflation from target. Expected inflation, one or many periods ahead, is solidly anchored, equal to the inflation target.

A supply shock that lowers the productive capacity of the economy temporarily (a lower a_t) will raise inflation above target. Central bankers that are very committed to their target, in the sense of being very responsive to rises in inflation in setting interest rates (a very high ϕ), would prevent this increase in inflation. In this model, because of the "divine coincidence," this would also keep the output gap close to zero. Tighter monetary policy lowers output, but since potential output is also lower, both stay in line.

A supply shock that instead raises the gap between the efficient and the potential output in the economy (a higher z_t) also raises inflation above target. However, it comes now with a recession, a negative y_t. The key parameter is ϕ_y on how dovish the central bank is. A higher ϕ_y, or a more output-focused central bank, will keep interest

[4] See Eusepi and Preston (2018) and Angeletos and La'O (2020) for studies of the interaction between inflation expectations and optimal monetary policy.

rates close to unchanged, and let inflation rise almost one to one with the shock, while output stays high, near potential. A hawkish central bank instead would tighten, keeping inflation nearer the target but with a potentially large recession.

From the lenses of rational expectations, the ECB's choice to keep interest rates unchanged over the last year would reflect both: (i) being very resolute that the supply shocks hitting the economy are of the z_t kind, and (ii) being exceptionally dovish.[5] But expectations play no role in this story, because this is what rational expectations dictates: only fundamental shocks matter.

3.2 Expectations affect policy but do not drive the private sector

Consider now instead the case where there is a measure of inflation expectations, call it π_t^e, and that the central bank responds to it. The monetary policy rule is now:

$$i_t = \bar{\pi} + \phi(\pi_t - \bar{\pi}) + \phi_y y_t + \theta(\pi_t^e - \bar{\pi})$$

Where the new policy parameter is $\theta > 0$. If our measurements of expectations were perfect, then this new term would always be zero in the economy with rational expectations. However, it is surely the case that the measurement of inflation expectations discussed in the previous section are not perfect and are contaminated by, at least, some i.i.d. measurement errors. Policy in this economy with rational expectations is therefore responding solely to noise in measurement. Worse, this noise is not affecting the choices of households or firms, as it does not show up in the other two equations in the model. Therefore, responding to it is clearly a poor policy, and policy should set $\theta = 0$.

How poor is it doing otherwise is shown by the equation:

$$\frac{\partial \pi_t}{\partial \pi_t^e} = -\frac{\kappa\theta}{\phi_y + \frac{1}{\omega} + \kappa\phi}$$

If the central bank responds to an increase in these noisy measures of inflation expectations, then it will tighten, and deliver too low inflation. Ignoring the expectations data is the right thing to do.

3.3 Expectations that drive the private sector

However, consider instead the case where expectations affect the private sector. People may be wrong, misguided, or foolish in their expectations, but these are the same people who then choose how much to spend, work, and charge. In that case the model can be modified to have:

[5] Reis (2022) discusses the monetary policies that contributed to the rise in inflation in 2021 and 2022.

$$\pi_t = \pi_t^e + \kappa y_t + z_t$$

$$y_t = \omega_y E_t(y_{t+1}) - \omega(i_t - \pi_t^e + a_t)$$

$$i_t = \bar{\pi} + \phi(\pi_t - \bar{\pi}) + \phi_y y_t + \theta(\pi_t^e - \bar{\pi})$$

Starting with the first equation, if people now expect higher inflation, then workers demand higher wages, and firms choose higher prices, both leading to higher inflation. Turning to the second equation, if some consumers perceive higher inflation, they think the returns to savings are lower, and spend more, which the other hand-to-mouth consumers then amplify.

Now the response of inflation to a rise in measured inflation expectations is:

$$\frac{\partial \pi_t}{\partial \pi_t^e} = -\frac{\phi_y + \frac{1}{\omega} + \kappa(1-\theta)}{\phi_y + \frac{1}{\omega} + \kappa\phi}$$

The central bank wants to pay close attention to measured inflation expectations. If it ignores them ($\theta = 0$), then inflation will rise when expectations rise. In that case the Taylor principle plays an important role. If it is not satisfied ($\phi < 1$) then an increase in π_t^e raises π_t by more than one-to-one. This validates the exogenous increase in expectations (animal spirits), and potentially leads to a spiral of self-validating higher and higher inflation. With the Taylor principle, then expectations rising by 1% increases actual inflation by less than 1%.

To stabilize inflation further, the central bank would want to set θ above zero. By how much would depend on the weight that the central bank puts on stabilizing inflation versus output. But the more important lesson is that even if households are forming expectations with biases, inattention, and over-reactions, and even if market prices reflect liquidity shifts or herding, these are still the prices and beliefs that determine how people behave, so they are a source of shocks to inflation that the central bank cannot afford to ignore.

3.4 Over-reaction of expectations to supply shocks

Another valid criticism to measures of inflation expectations is that they are an over-reaction to supply shocks. People fixate on the price of gas at the pump, or on the prices of bread and beer, and these have moved more than the overall price index, leading to too volatile expectations. Imagine then that:

$$\pi_t^e = \beta z_t$$

Where $\beta > 0$, so what drives and distorts inflation expectations from the rational-expectations target is this over-reaction to supply shocks. In that case, the responsiveness of inflation to the supply shocks is now:

$$\frac{\partial \pi_t}{\partial z_t} = -\frac{(\phi_y + 1/\omega)(1+\beta) + \kappa(1-\theta)\beta}{\phi_y + \frac{1}{\omega} + \kappa\phi}$$

Compared with the solution with rational expectations, there is now an extra positive effect on inflation from the supply shocks because of the over-reaction of expectations.

Policy can fight that extra push again by having a positive θ. Even in the dovish limit, where policy wants to keep the output gap unchanged after the shock, θ has to equal β. A higher θ will trade off some recession for a less dramatic increase in inflation. Therefore, θ should be, not only positive, but at least as high as the over-reaction of expectations. More, this over-reaction leads policy to respond more to the expectations, rather than dismiss them. Central banks operate in the real economy and must adjust to it: if people over-react, so should the central bank, not because of irrationality, but because the shocks hitting the economy are amplified.

3.5 Expectations and credibility

Finally, consider the use of measures of credibility, like the 5-year-5-year measures shown in chart 7. To analyse these more clearly, consider a special case of the model where: $\kappa = \phi_y = z_t = a_t = 0$. In other words, assume away an inflation-output trade-off, so as to focus solely on inflation, and assume away shocks, so we can focus solely on keeping inflation exactly on target. The model therefore reduces to two equations to solve for nominal interest rates and inflation.

$$E_t(\pi_{t+1}) = i_t = \bar{\pi} + \phi(\pi_t - \bar{\pi}) + \theta(\pi^e - \bar{\pi})$$

To study credibility, assume now that expected inflation is given by the equation:

$$E_t(\pi_{t+1}) = (1-\delta)\pi_{t+1} + \delta\pi_t^e \;\; with \lim_{j\to\infty} \pi^e_{t+j} = \bar{\pi}$$

Rational expectations map to the case where $\delta = 0$, since without shocks, expectations match realisations, and the unique determinate equilibrium would then be inflation equal to $\bar{\pi}$ at all dates. In contrast, setting $\delta > 0$ captures the doubts that private agents might have about the inflation target, and which the noisy measures of expected inflation π_t^e will reflect. These doubts dissipate over time, but they persist, as it takes time to earn credibility.

The solution of the model is given by:

$$\pi_t = \bar{\pi} + \left(\frac{\delta - \theta}{\phi}\right) \sum_{j=0}^{\infty} \left(\frac{\delta - \theta}{\phi}\right)^j \left(\pi^e_{t+j} - \bar{\pi}\right)$$

Inflation can deviate very significantly from target, and by much more than the initial drift of expected inflation if the loss of credibility persists over time. The central bank is always fighting through its Taylor coefficient ϕ to keep inflation on target but while it takes time for people to believe it, inflation will stay stubbornly high. A higher ϕ lowers these deviations, but such aggressive raise in interest rates for many years would surely have side effects.

Instead, the central bank can respond to the drift up in credibility by raising interest rates by $\theta = \delta$, that is by as much as it thinks that doubts on the credibility of the inflation target will persist. This may well be a modest amount. But if it is done right, through what appears like excessively hawkish policy that raises interest rates more aggressively in a pre-emptive way, above their neutral long-run values, it will succeed in keeping inflation on target right away and forever after. Responding decisively to any doubts about credibility as measured in inflation expectations is what is required of a central bank that wants to succeed.

3.6 Conclusion: policy responses to higher measurements of expected inflation

Table 1 lists the different cases considered above for the central banker who sees measures of expected inflation rising, as documented in section 2. If the central banker strongly believes that the measures of expected inflation in the first part of this piece are complete noise, which affects no one's economic choices, then they should ignore them. That would be a drastic choice and, dare I say, a reckless one. In every other case, policymakers should adjust the path for interest rates upwards in response to the current expectations data. Sometimes it should change the path for policy only by little, sometimes by a lot. But, higher expected inflation data should almost always lead to tighter monetary policy even if the policymaker, from her highchair, thinks people are foolish to hold these beliefs in the first place.[6]

Table 1

Response of policy rates to higher measured expected inflation suggested by theory

Source of rise in expectations	Policy for interest rate
Just noise	Ignore
Noise that drives people's actions	Tighten
Noise from over-reaction to supply shock	Tighten beyond over-reaction
Doubts about credibility	Tighten pre-emptively and aggressively

[6] The model above leaves several other mechanisms out. To name two, Pfauti and Seyrich (2022) find that the interaction of precautionary savings and cognitive discounting justify an even stronger response of interest rates to a supply shock, and Gallegos (2022) suggest that if this spike in inflation might make economic agents more attentive in their beliefs, which would make inflation more persistent and the Phillips curve steeper, this would also call for tighter monetary policy.

4 Conclusion

Taking the perspective of the challenge facing the ECB to control inflation in 2022, this note provided some answers to four more general questions:

1. Can we measure expected inflation accurately?

No, measures are riddled with noise, biases, and conflicts between different sources of data. And yet, both household surveys and market prices give a coherent account of the drift in inflation over the last 12 months. Unlike professionals or many econometric models, the measures of expected inflation did well in seeing the inflation coming.

2. What is the best measure of expected inflation?

None of them, but that is the wrong question to ask. It is better to combine them, so as to correct each measure for its flaws, and extract as much as possible of the signal from each one. From this perspective, expected inflation over the next 5 years in the euro area today is around 4%. On the one hand, that is a plausible forecast, that would reflect the very high inflation of 2022, as well as a view that it will take two to three years for it to come down. On the other hand, it is worrying that it is so above the 2% target, giving little room for the ECB to tolerate any further upward shocks to inflation.

3. At longer horizon, is the ECB inflation target still credible?

Yes, as the 5-year-5-year-ahead expected inflation is still quite close to 2%, and the probability of a disaster is still not too high. At the same time, that probability went from 0% to somewhere between 5% and 10% in January of 2022 and it has stayed there. This right-tail probability has to be a source for concern.

4. Should a central bank respond to noisy upside risk in measured expected inflation?

Yes, unless it is very confident that the increase in the measure of expected inflation is purely noise that not even the respondents will act on. Otherwise, the central bank should respond by raising interest rates, with differing vigour depending on what it thinks is driving the measures up.

More generally, the main point in this article is that measured expectations matter for monetary policy. They were useful in detecting the turning point in inflation dynamics in 2021-22, they point to clear dangers in the year ahead, and they give guidance on how to change interest rates in response.

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For specific terminology please refer to the ECB glossary (available in English only).

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