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

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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.

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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 macro-prudential 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 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

[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.

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.

A seventh element, the transmission to rents and inflation, is briefly considered in Appendix 2. This concerns the transmission to inflation via real estate (i.e. other than operating through the unemployment rate or the output gap, the traditional ingredients of Phillips curve models of inflation). An example is rents, which are an important component of the cost of living, 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 loan 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, increasing 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 points 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 the 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 Figures 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. Figure 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. Figure 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

[3] Inflation-prone Italy is a brief exception: real house prices rose briefly before following the general downward trend. Figure 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.

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 Figure 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. Figure 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.

[Figures 1, 2 and 3 about here:
Figure 1: Real house prices in 6 Euro area economies.
Figure 2: House prices relative to incomes in 6 Euro area economies.
Figure 3: Four-quarter percentage changes in nominal house prices.***]***

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 Figures 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 Figure 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 Figure 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.

[Figures 4, 5 and 6 about here:
Figure 4: Short-term interest rates in 6 Euro area economies.
Figure 5: Real house prices in Norway, Sweden, Finland and the UK.

[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 eurozone countries involved in a sovereign state bailout/precautionary programme from the 2010 European Stability Mechanism and its predecessor, the European Financial Stability Facility.

Figure 6: Long bond yields in 6 Euro area economies.*]*

Figure 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.

[Figure 7 about here: **Figure 7:** Mortgage interest rates in 6 Euro area economies.***]***

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, Figure 8 shows house price-to-rent ratios, with broadly similar implications for the visualisation of house price cycles to those in Figures 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.

[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.

[Figures 8 and 9 about here:
Figure 8: House prices relative to rents in 6 Euro area economies.
Figure 9: Per capita residential investment in constant prices.***]***

Alongside strongly cyclical house prices, residential investment has proved an extremely volatile component of aggregate demand. Figure 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.

Figure 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 Figure 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.

[Figures 10 and 11 about here:
Figure 10: The ratio to real GDP of residential investment in percentage terms.
Figure 11: Mortgage debt to income ratios in 6 Euro area economies.***]***

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

[9] Mortgage debt data in Italy begin only in 1999. In Figure 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.

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 12 illustrates how these processes operated in the US during the GFC.

[Figure 12 about here: **Figure 12:** The Financial Accelerator in the US Sub-Prime Crisis***]***

The transmission channels from falling real estate prices to the real economy are shown on the left-hand side of Figure 12. 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 12. 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 12.

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 here: **Table 1:** Transmission and amplification of a negative house price shock in the GFC***]***

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

[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.

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 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 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 about here: **Table 2:** Key characteristics of housing finance for Euro area economies***]***

[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 12 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 only two (Ireland and Italy) 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.

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, for example by 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.

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

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 Figure 6 for the

[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."

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 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 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

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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).

[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.

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.

[Table 4 about here: **Table 4:** Pass-through of short-term and long-term rates to the interest rate on housing loans in France***]***

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

[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.

[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.

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 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

[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)).

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

[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 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.

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 for a non-technical explanation. 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-

[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.

price credit availability, i.e., 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 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

[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.

[26] This formulation imposes the constraint that the income elasticity of demand for housing is 1.

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 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, the importance of the nominal mortgage rate especially makes 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.

[27] Note that house price expectations are already embodied in the user cost term.

[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.

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.

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 in 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 Figure 13, while the close correlation with the NPL ratio after 1990 is shown in Figure 14.[29]

[Figures 13 and 14 about here:
Figure 13: Estimated mortgage and consumer credit conditions indices for France.
Figure 14: The NPL ratio was a major driver of French mortgage credit conditions from 1990. ***]***

[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.

The implication of Figure 14 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 6. 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 far 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

[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).

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.

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.

[Table 5 here: **Table 5:** Housing supply elasticities and speeds of adjustment for Euro area economies***]***

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 Figures 9 and 10. The construction industry became more concentrated as many smaller

[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.

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:

$$ln\ inv_t = v_{0t} + v_1 \ln gdp_t + v_2 \ln(hp_t / hc_t) + v_3 interest\ rate_t + v_4\ credit\ conditions_t \quad + v_5\ demography_t \tag{4}$$

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 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

[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.
[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.

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 implication 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 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 about here: **Table 6:** Residential investment model (example using French data).***]***

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^p and wealth *A*. Permanent income, y^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]

$$\ln c_t = \alpha_0 + \ln y_t + \gamma A_{t-1}/y_t + \ln\left(y_t^P/y_t\right) \tag{5}$$

Common versions of the model use the log of wealth but (5) has advantages.[37] The log ratio of permanent to current income $\ln\left(y_t^p/y_t\right)$ reflects expectations of income growth. The long-run solution is typically embedded in an ECM.

[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

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 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,

additive.

[38] Private communication from Robert-Paul Berben.

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 worth 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.

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:

$$\ln(c_t/y_t) = \alpha_{0t} + \alpha_{1t} r_t + \alpha_2 \vartheta_t + \alpha_{3t} \ln(y_t^p/y_t) + \gamma_1 LA_{t-1}/y_t + \gamma_2 DB_{t-1}/y_t + \gamma_3 IFA_{t-1}/y_t$$
$$+ \gamma_{4t} \ln(hp_{t-1}/y_{t-1}) + \gamma_{5t} HA_{t-1}/y_t + \gamma_6 demog_t \quad (6)$$

Here, as in equation (5), c is consumption, y is income, r is a real interest rate, θ is an indicator of income uncertainty, y^p/y is the ratio of permanent to current income, *LA* is household liquid assets and *DB* is household debt debt[39], *IFA* is illiquid financial assets, *hp* is an index of 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 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_{4t} is negative. This coefficient measuring the sensitivity of down-payment requirements to house prices

[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.

relative to income, 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_{4t} would be absent.[40] If access to home equity loans increases, the coefficient, γ_{5t}, 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, 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 lie 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

[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_{4t} as loan-to-income constraints are loosened.

[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.

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]

[Table 7 about here: **Table 7:** Estimates for Germany, France and Italy of a credit-augmented consumption function.***]***

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 home owners 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.

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.

[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).

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 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:

$$\begin{aligned}\ln rmdebt_t = m_0 + m_1 \ln y_t + m_2 MCCI_t + m_{3t} \ln user_t + m_{4t}\, rmr_t + m_{5t} \ln mr_t \\ + m_{6t} E_t \ln(y_t^p / y_t) + m_{7t} \ln(hp_t / y_t) + m_8 demog_t + m_{9t} ln(LA_t / y_t) \\ + m_{10t} \ln(nmdebt_t / y_t) + m_{11} \ln(IFA_t / y_t) \qquad (7)\end{aligned}$$

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.

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

[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.

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 Figure 14 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 well 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 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

[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.

[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.

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 about here: **Table 8:** Recent selected Euro area trends in annual NPLs.***]***

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 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 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.

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[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).

[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.

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 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.

[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.

[55] Rapid loan growth is 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.

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 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.

[Tables 9 and 10 about here:
Table 9: A 4-quarter ahead forecasting model for the NPL ratio (example using French data).
Table 10: An 8-quarter ahead forecasting model for the NPL ratio (example using French data).***]***

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.

[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.

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 more 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.

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 illustrated 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. 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.

[58] These effects are most negative in countries with less easy access to credit.
[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. However, in France, Germany and Italy, house prices do not appear to be very relevant in forecasting models for future income. These findings also have practical implications for assessing the effects of the war on Ukraine on consumer expenditure.

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 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

[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.

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 quite weak or absent 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 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

[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.

(2018)). The moderate contribution of such expectations in France may be due to far lower leverage levels permitted to households by financial regulators. 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 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' macro-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.

There is a welcome exception, however. The ECB's BEAST, the 'Banking Euro Area Stress Test' model, see Budnik et al. (2020), is a major step forward.[63] It takes heterogeneity amongst 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

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[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.

[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.

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 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 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. Moreover, 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.

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[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).

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. As the French study showed, 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.

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 be reflected in a negative effect on the latent variables at the point of application of the policy. This method offers a way of greatly reducing the endogeneity biases often found in 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

[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.

[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.

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." Diereck et al. (2017) point out that according to ECB data for 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, in the 2007-8 crisis, in a few countries, CRE prices fell substantially further than house prices, though of the six countries covered, Figure 15 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 Figure 15 with real house price indices in Figure 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.

Diereck et al. (2016) examined differences between commercial and residential real estate (see table in Diereck et al. (2016), p.20). 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.

[Figure 15 about here: **Figure 15:** Real CRE indices for six Euro area economies.***]***

As Diereck 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. Globally, 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 are 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, 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

[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.

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. Figure 17 shows percentage net tightening and net easing for the Euro area average and the four largest economies compared with three months earlier. It shows a massive tightening of mortgage credit conditions in Spain in 2007-8, tightening was also massive in Ireland (not shown) in 2007-8 and considerable in the Netherlands in 2009 (not shown). 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, 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 is an exception), 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 very cautious in interpreting raw indicators from the bank lending survey as robust measures of lending standards.

[Figure 17 about here: **Figure 17:** Change in credit standards for loans to households (for house purchase).***]***

7.2 How well have macro-prudential policies operated in Euro area countries?

The macroprudential toolkit includes setting countercyclical total and, more recently, sectoral capital buffers or minimum total loan loss provisions on banks, 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

[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.

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 has some responsibility for policies on financial stability, 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.

Bank of England experience with borrower-based macroprudential instruments is of interest here. 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.[71] An advantage of these kinds of

[71] 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

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[72] , 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.

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

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.

[72] 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.

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.

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[73].

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. One of the key points of the present paper is that there are strong interactions

[73] 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.

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 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 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 since 2016 in Germany and now notably exceed the EA average. 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 quite moderate. 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 likely recession beginning to show up in some countries' data for April, 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 major role, in all three countries and equity real price indices also appear. This suggests, not surprisingly, that income expectations 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. 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 rises, 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. Thus, macro prudential policy needs to be relatively tight for these sectors to prevent high-leverage speculation from taking off.

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 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, especially the more vulnerable, from recent energy and food price shocks and other symptoms of economic disruption. At present, the May 2022 ECB FSR points out that little reaction has taken place *so far* in prime real estate 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 Ireland and Italy have equations for NPLs or related measures of bad loans. In these two 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. Moreover, 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. Of course, such booms occur not just because of lower interest rates but also because of financial liberalisation leading to laxer 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 monitoring. Stellar work 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 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 until 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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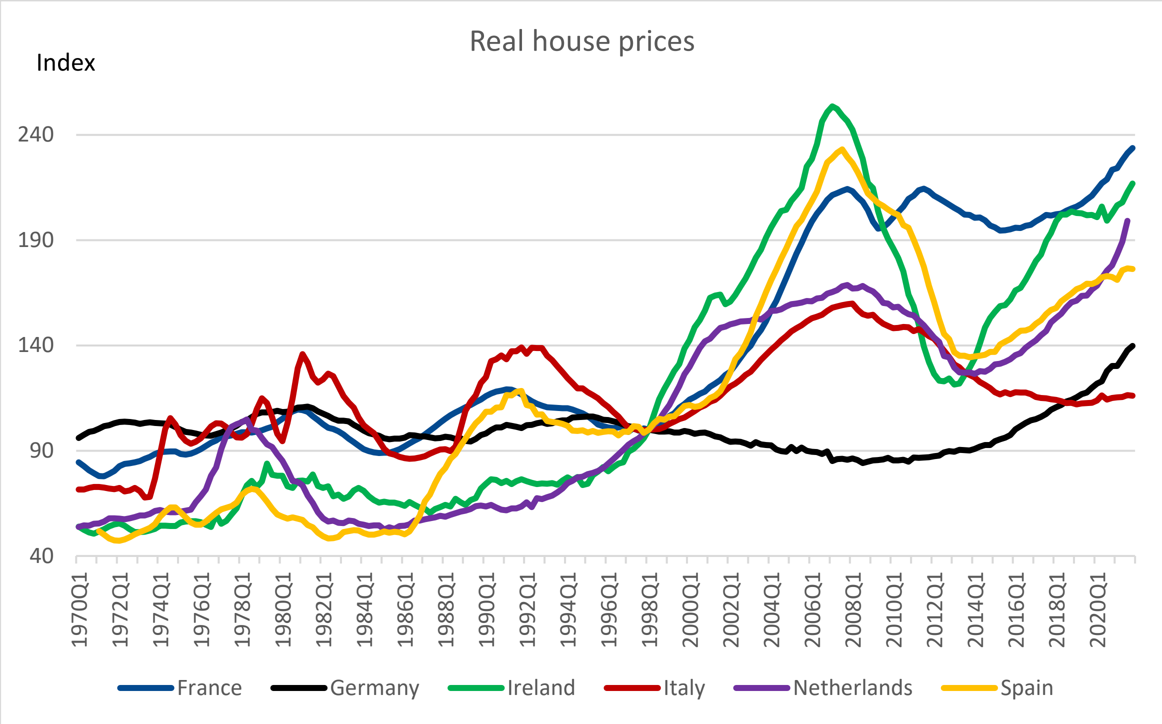
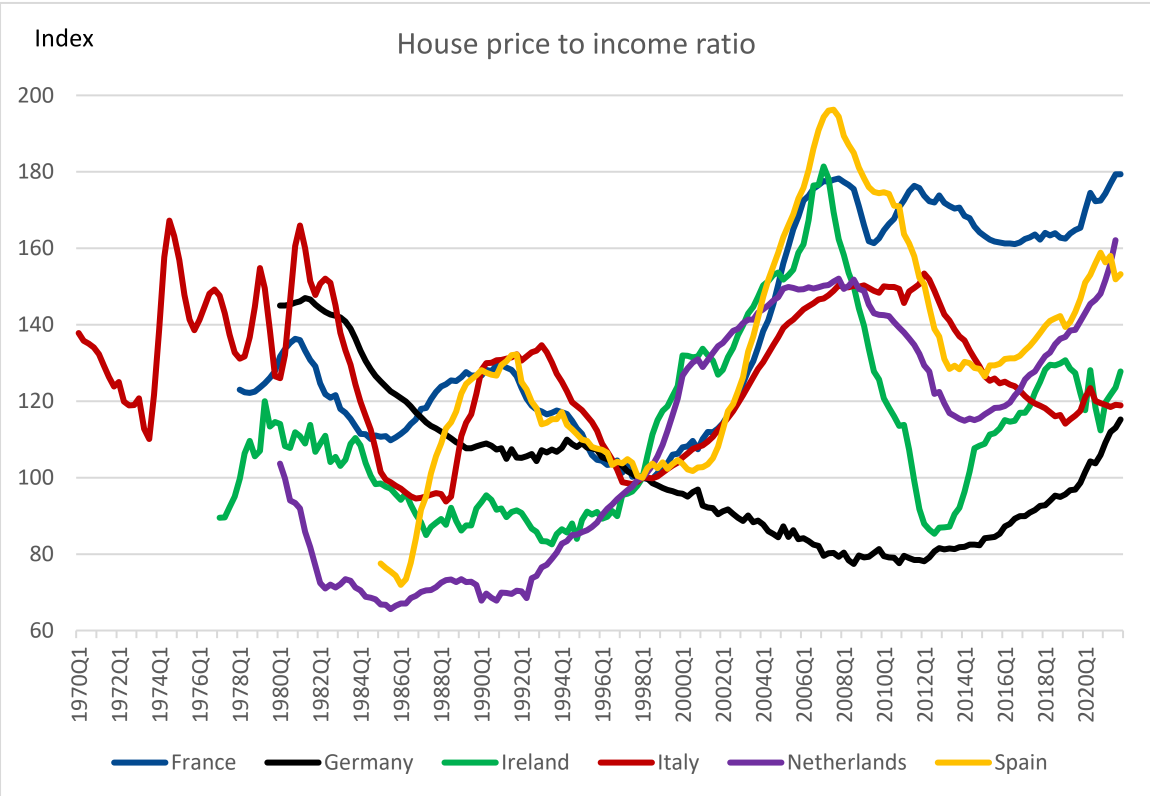
Figure 1: Real house prices in 6 Euro area economies.



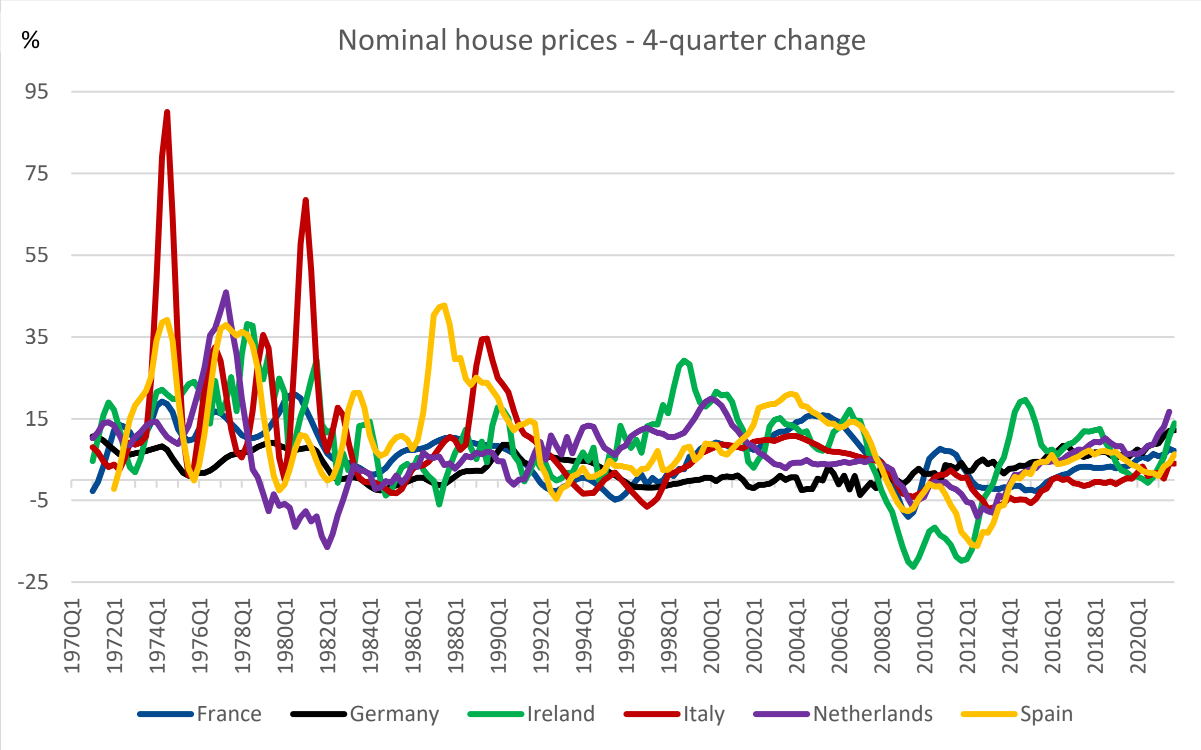
Source: OECD.
Notes: National house price indices are deflated by national consumer expenditure deflators, 1998Q1=100.

Figure 2: House prices relative to incomes in 6 Euro area economies.



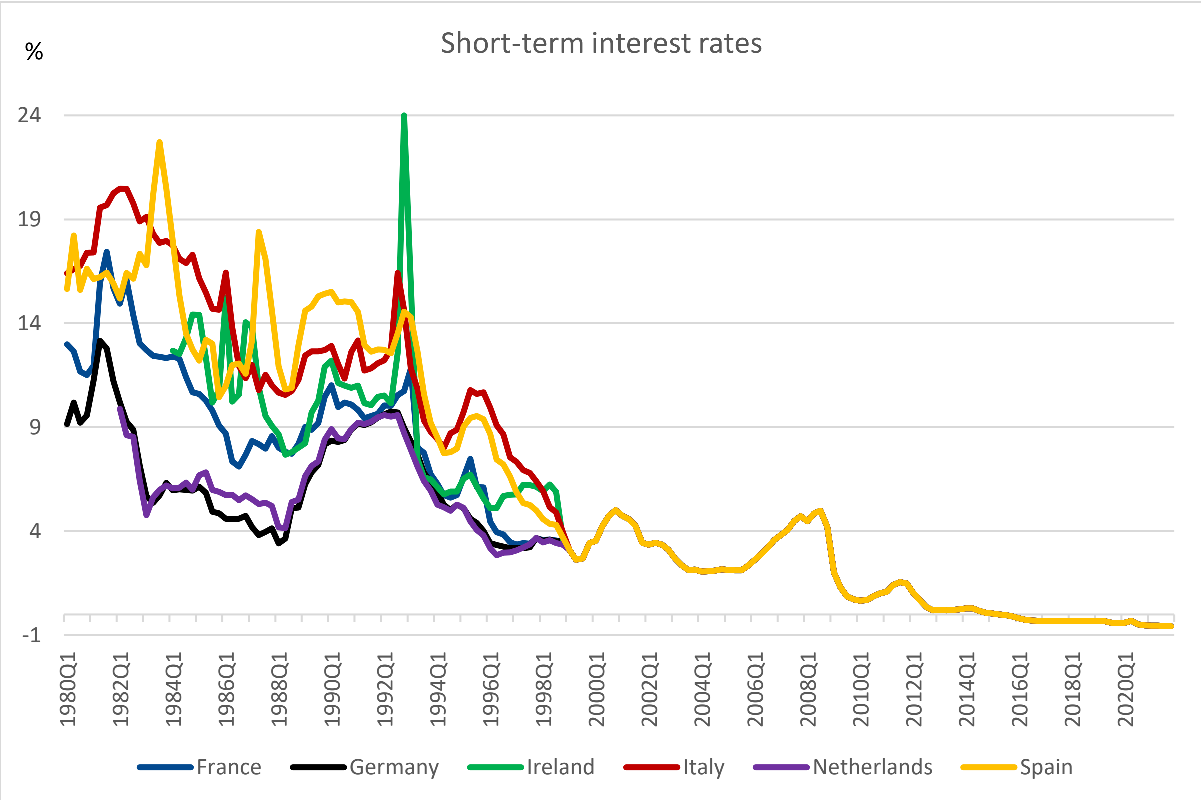
Source: OECD.
Notes: National house price indices are deflated by per capita household disposable income, 1998Q1=100.

Figure 3: Four-quarter percentage changes in nominal house prices.



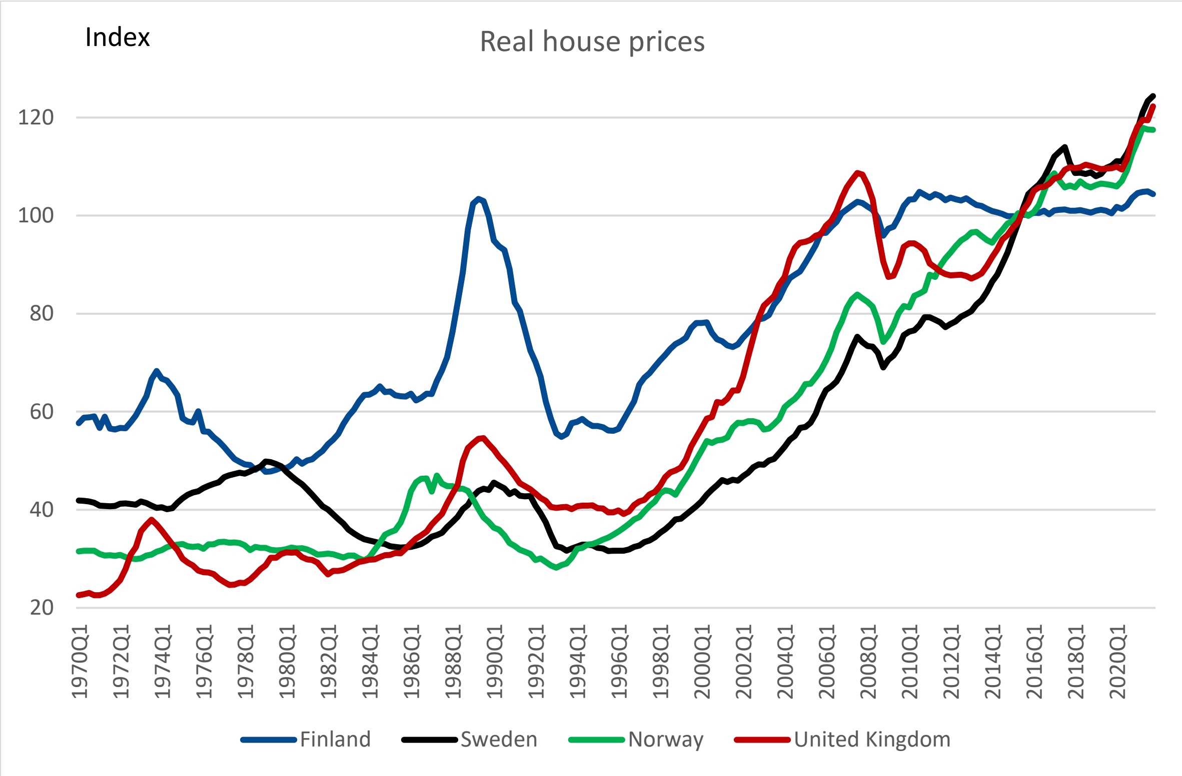
Source: OECD.
Notes: Four-quarter percentage change in national house price indices.

Figure 4: Short-term interest rates in 6 Euro area economies.



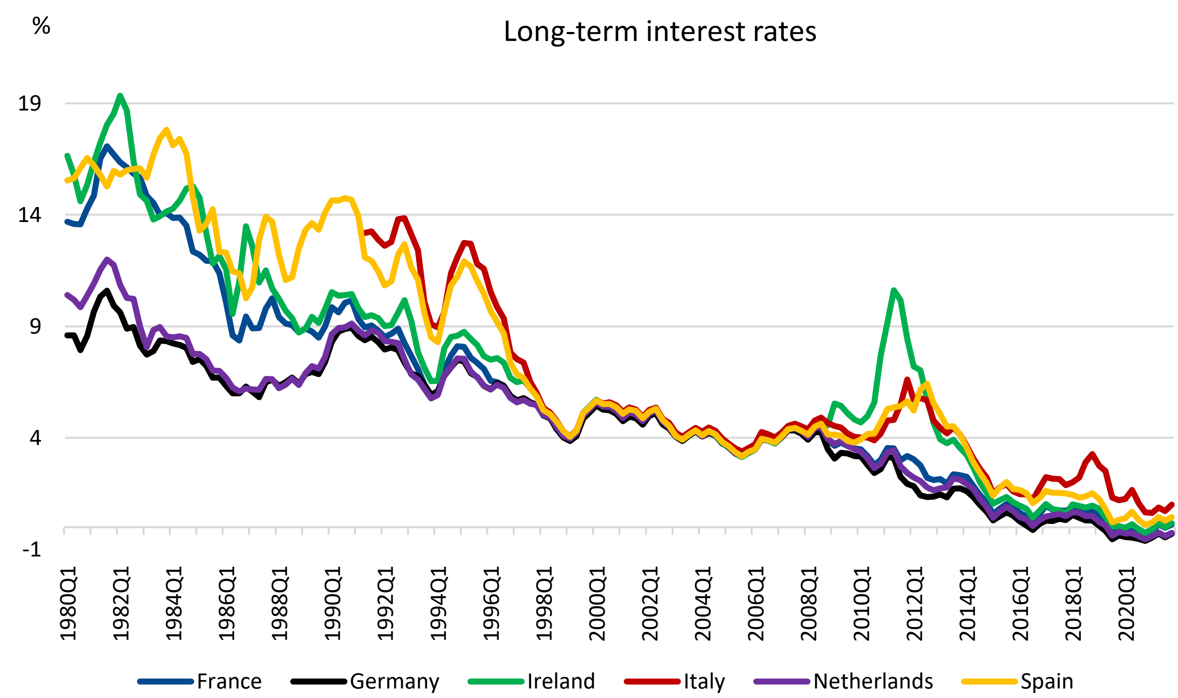
Source: OECD.
Notes: Short-term interest rates are based on 3-month T-bills.

Figure 5: Real house prices in Norway, Sweden, Finland and the UK.



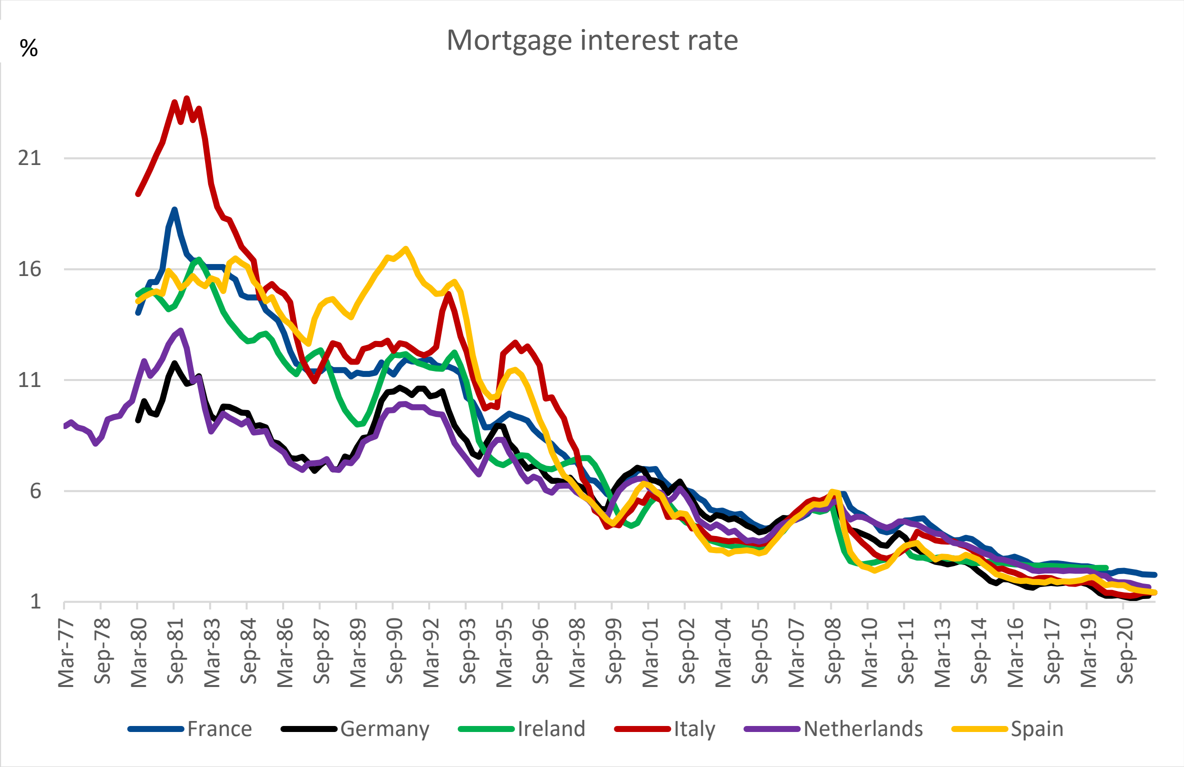
Source: OECD.
Notes:

Figure 6: Long bond yields in 6 Euro area economies.



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

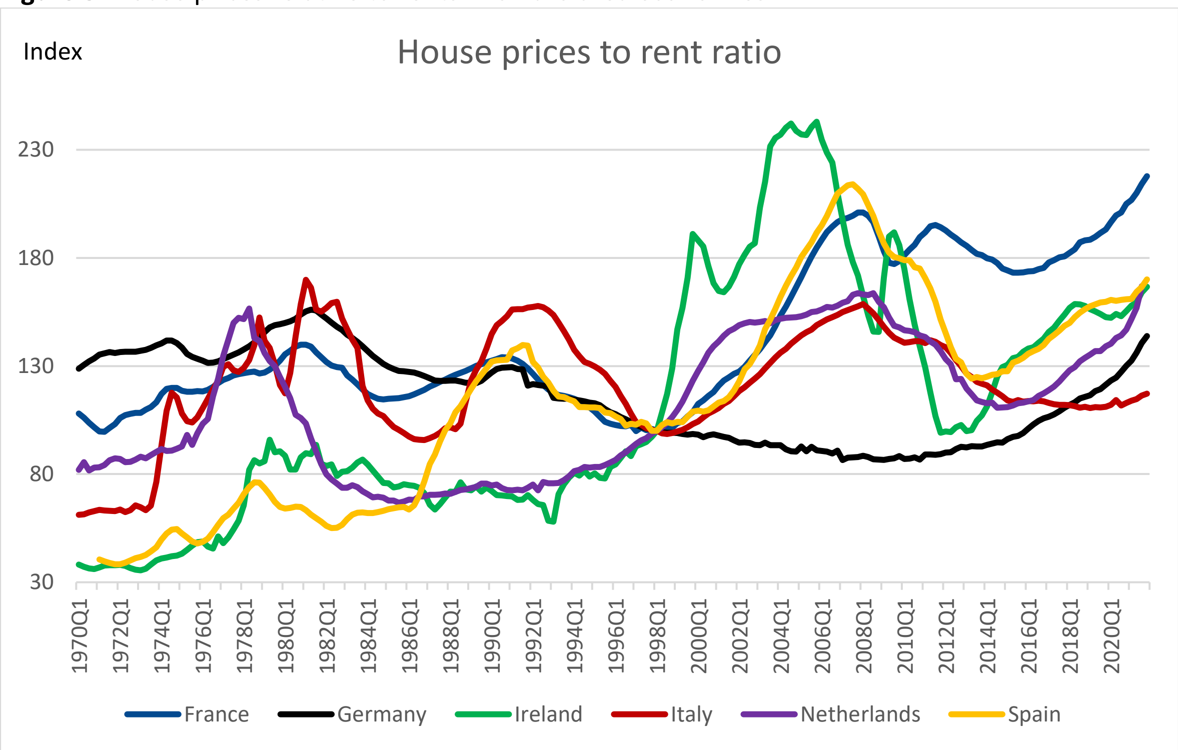
Figure 7: Mortgage interest rates in 6 Euro area economies.



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.

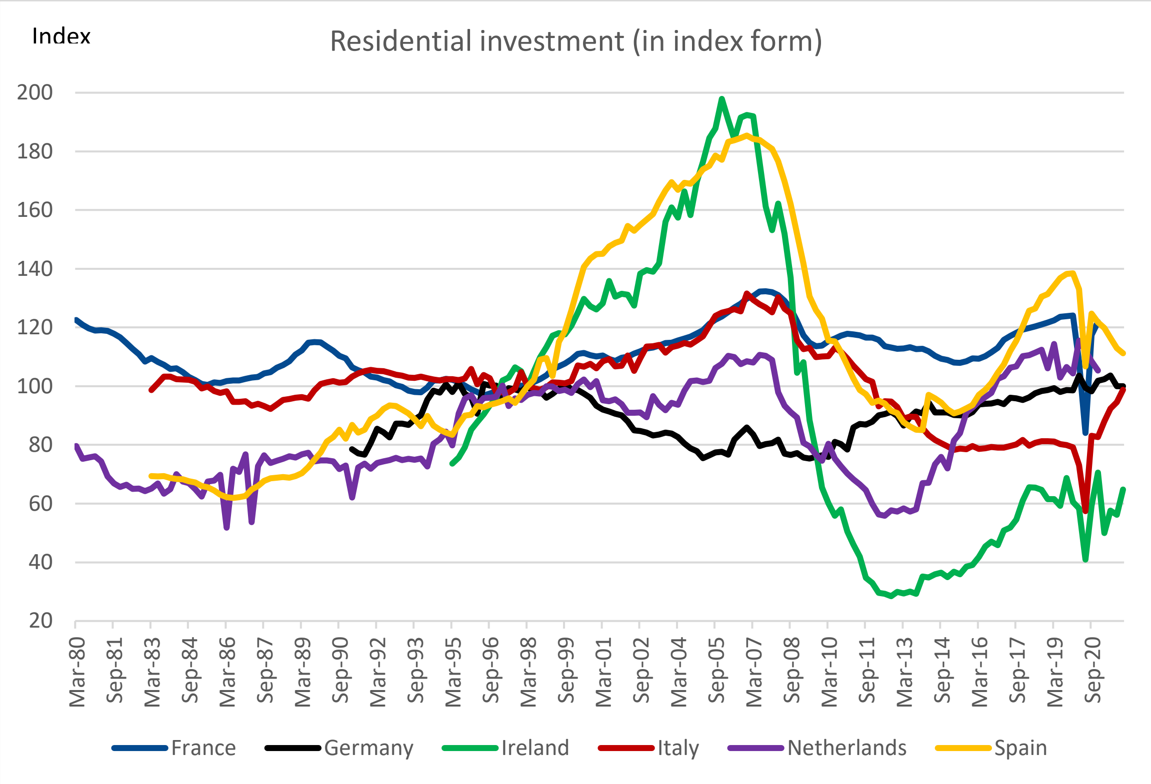
Figure 8: House prices relative to rents in 6 Euro area economies.



Source: OECD.

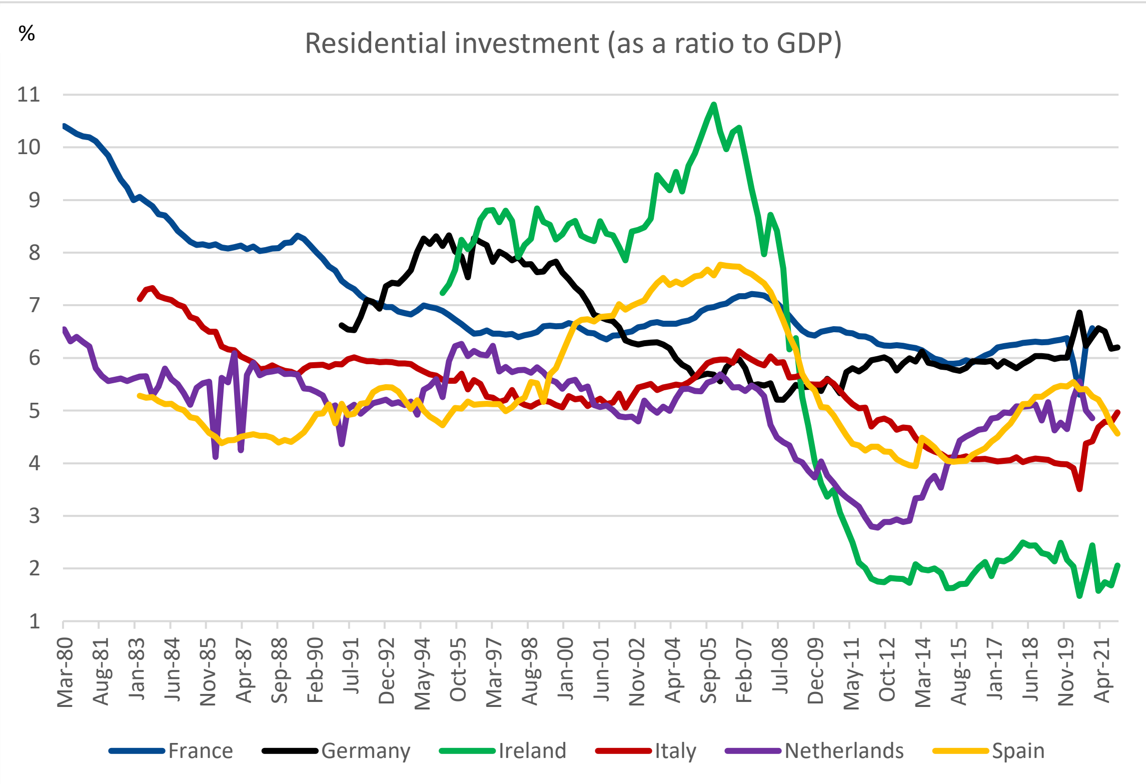
Notes: National house price indices are deflated by OECD indices of rent, 1998Q1=100.

Figure 9: Per capita residential investment in constant prices.



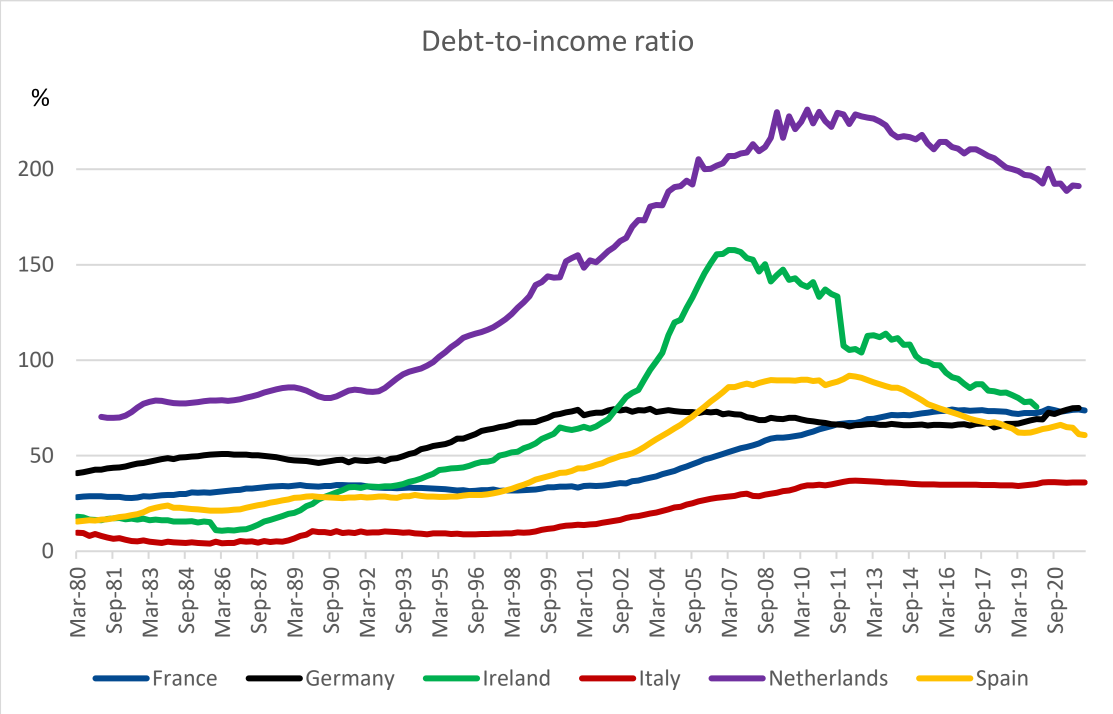
Source: OECD.
Notes: Residential investment in constant prices.

Figure 10: The ratio to real GDP of residential investment in percentage terms.



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

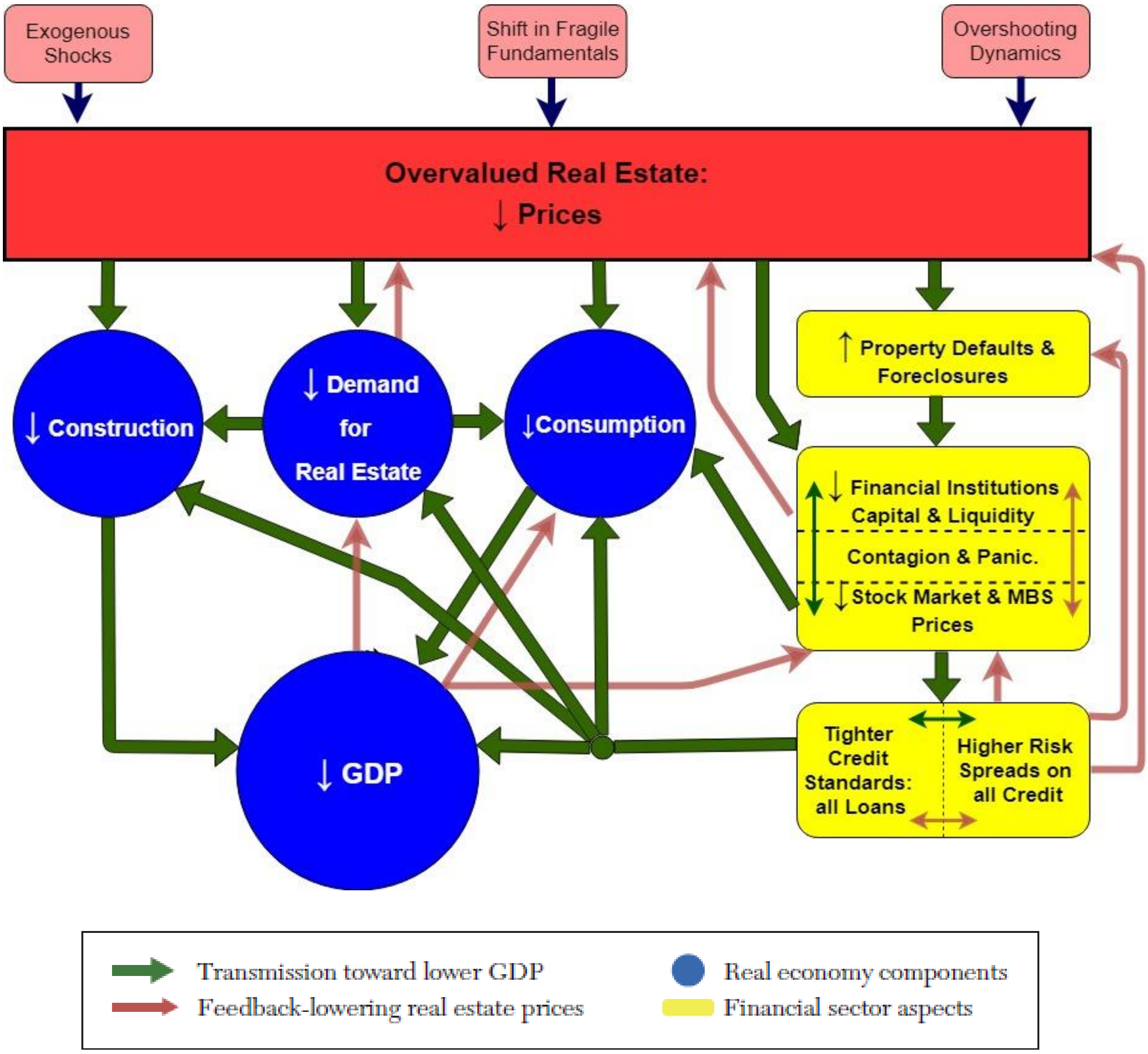
Figure 11: Mortgage debt to income ratios in 6 Euro area economies.



Source: National Central Banks.

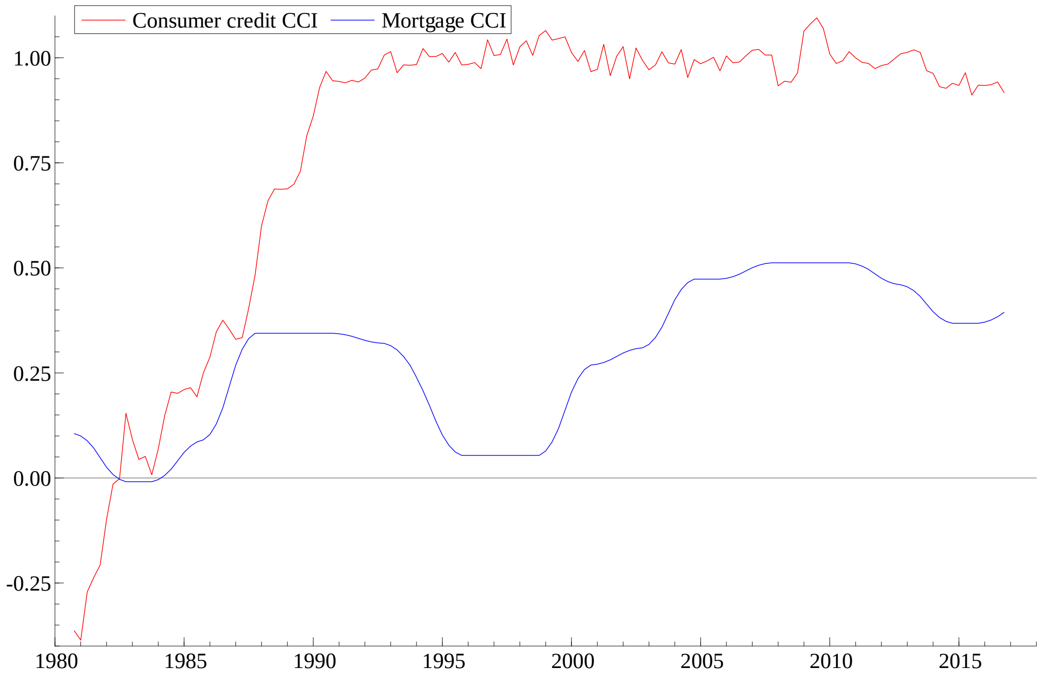
Notes: Pre-1999 data for Italy is spliced to total household debt; and pre-1994 data for Spain is spliced to total household debt. Housing loan data may not always be fully comparable, e.g., in the treatment of securitised debt, which is sometimes deregistered from bank balance sheets.

Figure 12: The Financial Accelerator in the US Sub-Prime Crisis



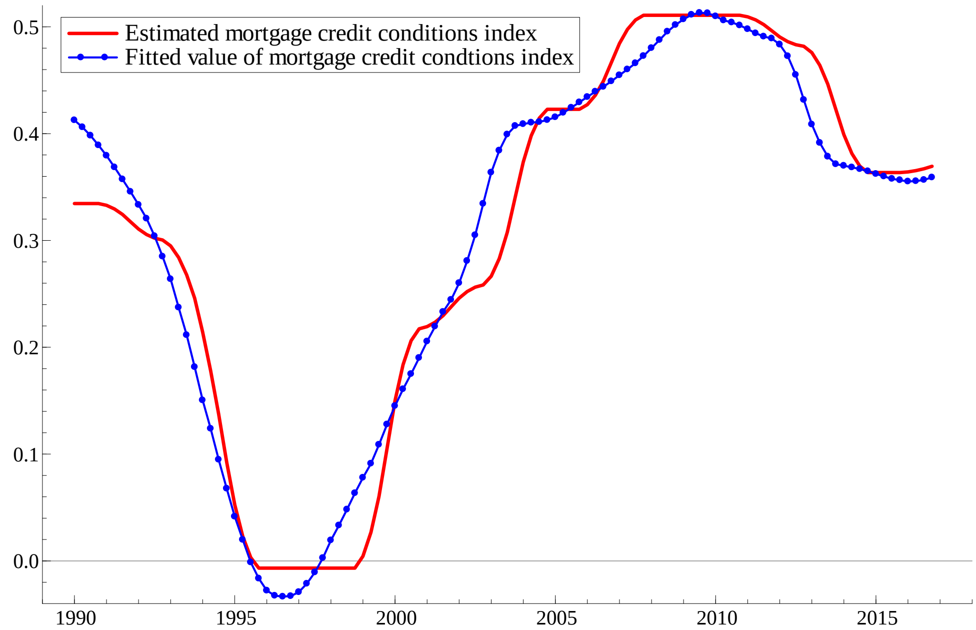
Source: Duca et al. (2021).

Figure 13: Estimated mortgage and consumer credit conditions indices for France.



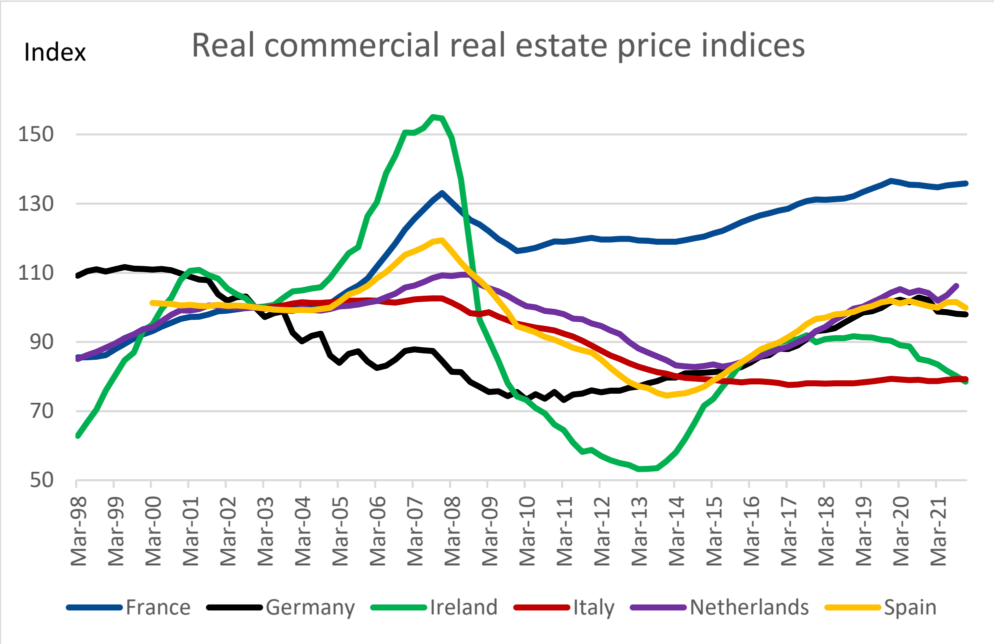
Source: Chauvin and Muellbauer (2018).

Figure 14: The NPL ratio was a major driver of French mortgage credit conditions from 1990.



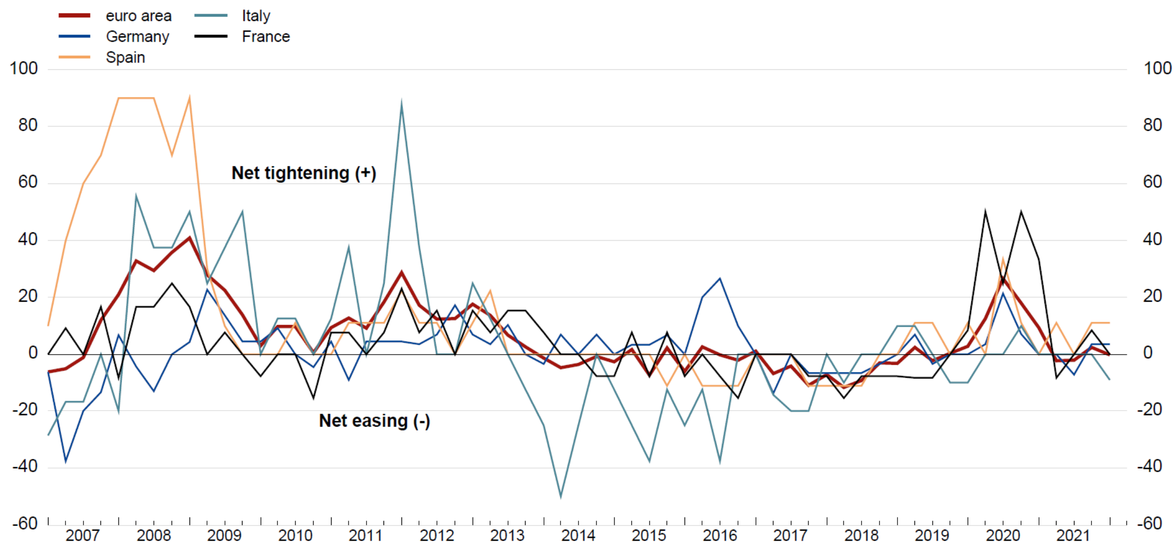
Source: Chauvin and Muellbauer (2018) for the estimated mortgage credit conditions index. The fitted value comes from a regression for 1990Q1 to 2016Q4 of the estimated mortgage credit conditions index on the weighted moving average, with declining weights, of the previous 3 years NPL ratio and on a smooth transition dummy capturing mortgage credit liberalisation in 2002-3 and its reversal in 2012-13.

Figure 15: Real commercial real estate price indices for six Euro area countries



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.

Figure 16: Change in credit standards for loans to households (for house purchase).



Source: ECB.
Notes: Net percentages of banks contributing to the tightening of standards over the previous three months. The last observation refers to the quarter in which the most recent BLS was published.

Source: ESRB Risk dashboard, March 2022.

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.[1]
	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[2], i.e. where the degree of leverage, the presence of maturity transformation poses liquidity problems, the degree of interconnectedness, levels of complexity and the prevalence of mispricing of risk. 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:

[1] The corollary, relevant in 2022, is that when policy rates rise, the impact is faster in floating rate environments.

[2] Adrian et al. (2015) define systemic risk 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".

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).

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*		*Ireland*		*Italy*		*Netherlands*		*Spain*	
		Tick-list	**Comment**	**Tick-list**	**Comment**	**Tick-list**	**Comment**	**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	√	Use a risk premium (modelled as a dynamic process) linked to the expected output gap. There is no ECM.	*NA*	No equation for this element.	√	ECM adjustment coefficient is 0.25. Incomplete pass-through of the T-bill and long bond 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.	√	No information provided on the weights or the ECM adjustment coefficient. Default probabilities drive the risk spread.	√	ECM adjustment coefficient is 0.13.The credit risk indicator is the bank leverage ratio.	√	Low ECM adjustment coefficient (of 0.11).
	Long bond rate	√		*NA*		√		×		×		√		√	
	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)		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*		×	
	House price to construction costs ratio	√	Dependent variable modelled	*NA*	No equation for this element.	×	Residential investment is driven by the	√*	Dependent variable is new	√	ECM adjustment coefficient is	√*	Consumption deflator is	×	Low ECM adjustment

To (real) residential investment **[Section 4.3.2]**	Interest rate	√	as ratio to housing stock. ECM adjustment coefficient is 0.096. Growth of GDP, but not the level, affects residential investment.	*NA*		×	growth of building permits and of GDP. ECM in building permits is driven by changes in house prices and real interest rates.	√	dwellings completions. The long run supply elasticity is around 1.9. the ECM adjustment coefficient is 0.07.	√	0.23, and supply elasticity w.r.t. house prices is 0.7. Includes post-crisis dummies. Controls for property tax.	√	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.	√	coefficient (of 0.034). (Credit access, measured from the bank lending survey was in a previous version.)
	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 worth concept of wealth is used. ECM adjustment coefficient is 0.46. Income is split between labour+transfer and other. The real interest rate is based on the 10-year bond yield.	×	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. Low ECM adjustment coefficient (of 0.076).
	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.	√	Equation for new lending driven by the real mortgage rate of interest, adjusted LTI and LTV ratios	√	The return on housing relative to the long bond yield, the nominal mortgage	√	Ogive dummies for shifts in credit conditions. Disposable income is	√	No income but (housing investment + consumption). ECM adjustment
	Nominal interest rate	*NA*		*NA*		*NA*		×		√		√		×	
	Income	*NA*		*NA*		*NA*		×		√		√		×	
	House price to income ratio	*NA*		*NA*		*NA*		×		×		×		×	

	Credit conditions**	*NA*		*NA*		*NA*		√	for credit conditions. The change in the mortgage stock = new lending – repayments, proportional to stock.	×	interest rate and its spread to the interbank rate. GDP proxies income. The ECM adjustment coefficient is 0.03.	√	before taxes and interest payments. The nominal mortgage rates is tax adjusted. ECM adjustment coefficient is 0.04	×	coefficient is 0.013.
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.	×	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*		*NA*		√		×		*NA*		*NA*	
	Interest rate/s	*NA*		*NA*		*NA*		√		√		*NA*		*NA*	
	House price to income ratio or housing wealth to income ratio	*NA*		*NA*		*NA*		√		×		*NA*		*NA*	
	Credit conditions** (very lagged)	*NA*		*NA*		*NA*		×		×		*NA*		*NA*	
	Bank credit to private sector	*NA*		*NA*		*NA*		√		√		*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.

Table 4: Pass-through of short-term and long-term rates to the French interest rate on housing loans

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
Δ_8 log (real house prices) $_{t-2}$	-0.40	-2.48	-	-	-0.43	-2.53
Δ_8 log (consumer expenditure deflator) $_{t-2}$	-4.79	-4.19	-5.80	-5.27	-3.17	-3.04
Δ_4 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.

Table 5: Housing supply elasticities and speeds of adjustment for Euro area economies

Country	*Supply Elasticity*	*ECM adjustment coefficient*
DEU	0.67	-0.21

	0.16	0.07
ESP	1.17	-0.05
	0.16	0.017
FRA	0.49	-0.1
	0.11	0.041
IRL	1.3	-0.37
	0.14	0.13
ITA	0.55	-0.47
	0.12	0.09
NLD	0.4	-0.2
	0.13	0.071

Source: Cavalleri et al. (2019)

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
Δ_4 log (Consumer expenditure deflator) $_{t-3}$	-0.198	-2.7	-0.222	-3.4	-0.244	-5.2
Δ_4 log (Real disposable income pc) $_{t-1}$	0.168	2.8	0.227	4.1	0.194	4.6
Δ_4 log (Population aged 25-64) $_{t-1}$	0.757	1.0	1.508	4.6	1.501	6.2
Δ_4 Δ_4 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
Δ_4 Δ_4 (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.

Table 7: Estimates of long-run parameters from consumption functions for Germany, France and Italy

Dependent Variable = $\Delta \ln c_t$	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 $\ln(yperm / y)_t$	α_3	0.346***	8.6	0.55***	9.9	0.36***	3.2
Liquid assets$_{t-1}$ / y$_{t-1}$	γ_1	0.09***	4.1	0.14***	4.4	0.08***	8.9
Debt$_{t-1}$ / y$_{t-1}$	γ_2	-0.09***	-4.1	-0.14***	-4.4	-0.17***	3.4
Illiquid financial assets$_{t-1}$ / y$_{t-1}$	γ_3	0.016**	2.5	0.022***	3.3	0.016**	2.2
Housing wealth$_{t-1}$ / y$_{t-1}$	γ_5	0.001	0.1	0.013**	2.2	0.048***	4.3
Log house prices$_{t-1}$/y$_{t-1}$	γ_4	-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.

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 figures using different methodologies and definitions across countries, and these may also change over time within countries.

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
Δ_4 log (Real disposable income pc, 4q-ma) $_{t-1}$	-0.0680	-5.4	-0.073501	-3.4	-0.0719	-4.1
Δ_4 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
Δ_4 (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
Δ_4 (Euro risk spread, 4q-ma) $_{t-2}$	-0.000570	-3.4	-6.15E-03	-1.6	-0.00212	-1.9
Δ_4 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
Δ_4 (Mortgage Credit Conditions Index, 4q-ma) $_{t-1}$	0.0118	3.2	0.0114	2.6
Δ_4 (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
Δ_4 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.

Appendix 1: 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.[74] 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".[75] 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 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

[74] 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.
[75] 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.

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.[76]

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).

[76] 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.

Appendix 2: 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 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 11. 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[77], 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 2021:4 we need a pandemic dummy with a negative coefficient as rents rose less than predicted by the model, in the

[77] 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

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 12, 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 11: 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
Δ_4 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 12: A forecasting model for rents (example using French data).

Dependent variable: Δ_4 (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
Δ_4 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.

Appendix 3: 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.	-	-	-	-
Δ_8 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
Δ_8 log (Consumer expenditure deflator)	Two-year change in the log of the consumer expenditure deflator.	0.0298	0.0157	-0.00379	0.0666
Δ_4 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) $_{t-4}$	*Relative price term:* log of nominal house prices minus the log of the	4.47	0.209	4.17	4.83

	residential investment deflator four 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
Δ_4 log (Consumer expenditure deflator)	Annual change in the log of the consumer expenditure deflator.	0.0215	0.0236	-0.0216	0.125
Δ_4 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
Δ_4 log (Population aged 25-64)	Annual change in the log of the population aged 25-64.	0.00598	0.00454	-0.00209	0.0157
Δ_4 Δ_4 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).	-	-	-	-
Δ_4 Δ_4 (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
Δ_4 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
Δ_4 (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
Δ_4 (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
Δ_4 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
Δ_4 (log of nominal rents)	Annual change in the log of the nominal rent index.	-7.58	0.0767	-7.72	-7.40
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
$\Delta\Delta$ log (Consumer expenditure deflator)	Quarterly acceleration in the log of the consumer expenditure deflator.	0.0118	0.0143	-0.0214	0.0444
Δ_4 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.