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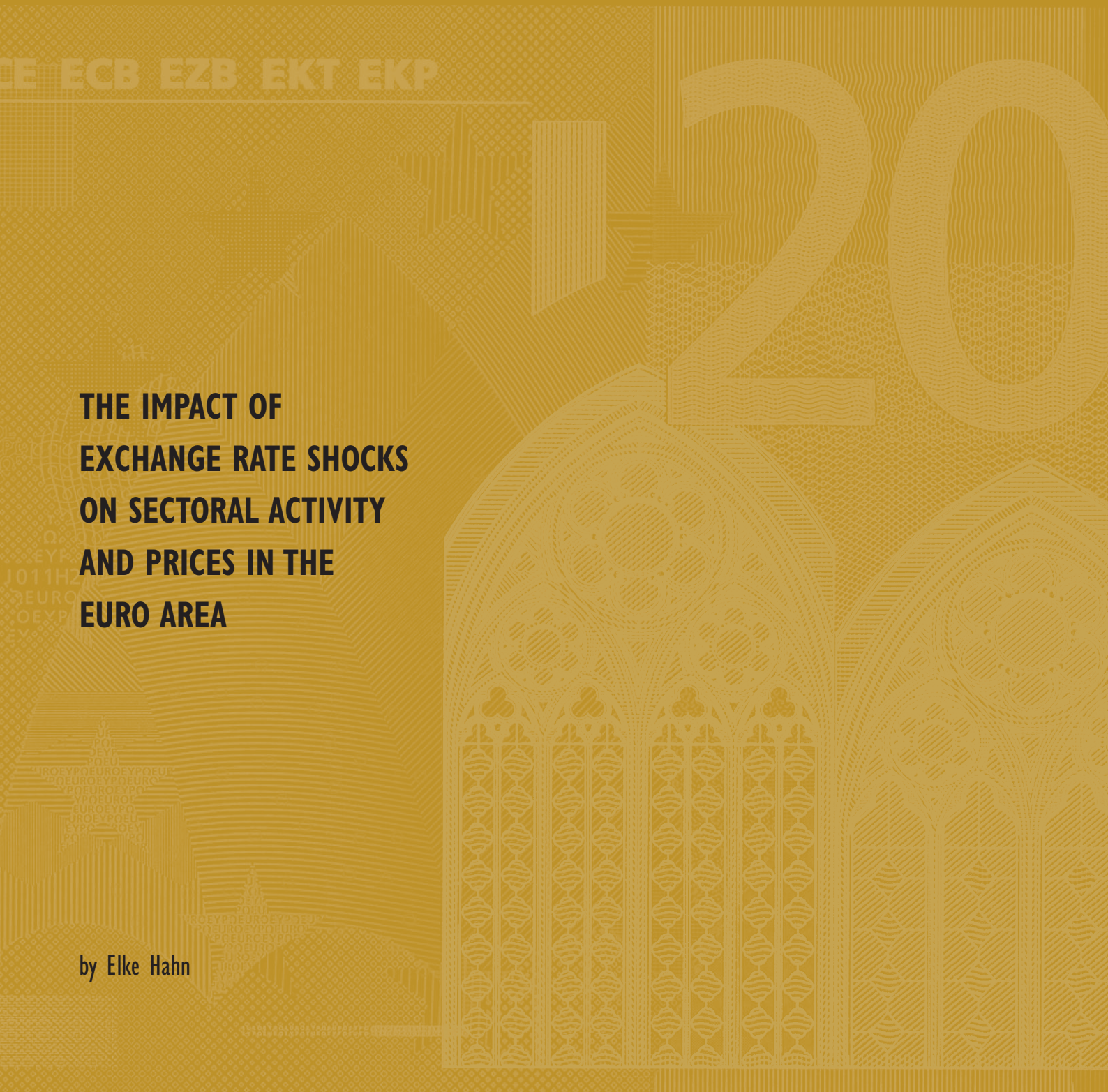

THE IMPACT OF EXCHANGE RATE SHOCKS ON SECTORAL ACTIVITY AND PRICES IN THE EURO AREA

by Elke Hahn

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1 The views expressed in this paper are those of the author and do not necessarily represent those of the European Central Bank.
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Abstract

This paper investigates the impact of exchange rate shocks on sectoral activity and prices in the euro area. Using a VAR framework it provides evidence on the magnitude and speed of the impact of exchange rate shocks on activity in all main euro area sectors and on activity and producer prices in a large set of sub-sectors of industry (excluding construction). Substantial heterogeneity in the impact of exchange rate shocks across sectors is identified as regards both activity and prices. According to our results, among the main euro area sectors an exchange rate shock has the strongest impact on value added in industry (excl. construction) and trade and transportation services. Within industry (excl. construction), among its main sub-sectors all of the impact on production comes via manufacturing, while among the main industrial groupings (MIGs), capital and intermediate goods production respond most strongly. As regards the impact on prices, among the sub-sectors of industry (excl. construction), the impact is largest on producer prices in electricity, gas and water supply, and in line with this producer prices in MIG energy are most sensitive to an exchange rate shock.

JEL Classification: C32, E31

Keywords: Exchange Rate Pass-Through, Sectoral Activity and Prices, Euro Area

Non-technical summary

Since its introduction the exchange rate of the euro has been subject to substantial fluctuations vis-a-vis the euro area's main trading partners. Empirical analysis suggests that such pronounced exchange rate changes may strongly impact both inflation and activity in the euro area. While the empirical evidence for the euro area has so far focused mainly on the effects on aggregate inflation and output, differences in sector structures suggest that the impact could vary substantially across sectors. In this case, detailed knowledge of the sectoral dimension of the effects is essential in order to fully understand the propagation of exchange rate shocks across the euro area economy and this information would also benefit conjunctural and price analysis as well as forecasts for the aggregate euro area economy. Against this background, the purpose of this study is to extend the empirical evidence on the effects of exchange rate shocks in the euro area to the sectoral level. Using a Vector Autoregression (VAR) framework, a detailed sectoral analysis of the magnitude and speed of the impact of exchange rate shocks on activity in all main euro area sectors and on activity and producer prices in a large set of sub-sectors of industry (excluding construction) is conducted.

Substantial heterogeneity in the impact of exchange rate shocks across sectors is identified as regards both activity and prices. Important factors that are likely to account for these differences include the openness of a sector, i.e. the share of production that is exported, the degree of import competition and the share of imported inputs, product characteristics such as the degree of product differentiation, demand characteristics such as the price elasticity of demand, and other factors that affect the degree of competition in the market. Our results for the real side of the economy show the highest response of activity to an exchange rate shock in the industrial sector, but also value added in trade and transportation services displays a significant impact. Within the industrial sector, among the main sub-sectors, all of the impact comes via manufacturing, while among the main industrial groupings (MIGs) capital and intermediate goods production respond most strongly. At the same time, production is adjusted fastest in MIG energy and also the adjustment of intermediate goods production is quick. There is also a high degree of

heterogeneity in the impact on individual manufacturing sub-sectors, which ranges from a zero response of "food" production to a very high response in manufacturing of "machinery and equipment". On the price side, the exchange rate pass-through is largest on producer prices in the main sub-sector "electricity, gas and water supply", and in line with this, among the MIGs, producer prices in energy show the strongest response, followed by producer prices of intermediate goods. Among the manufacturing sub-sectors, the pass-through varies between the extreme cases of an insignificant impact on "tobacco" producer prices to a very strong effect on producer prices in the "fuel" sector. Moreover, in line with the evidence for production, also prices seem to be adjusted fastest in the MIG energy and intermediate goods sectors.

Overall, a general characteristic that emerges from the sectoral output and price responses is an inverse relationship between the magnitude of the price and the output effects in a sector. That is, in line with economic reasoning, sectors that show a larger price response appear to display a smaller output effect and vice versa. Moreover, also the combined output and price sensitivity to an exchange rate shock differs across sectors and seems to be above average for instance in the MIG capital and intermediate goods sectors and below average in the consumer goods sector.

Finally, the high degree of heterogeneity in the sectoral effects of an exchange rate shock on activity and prices suggests changes in the sector composition as a potential source of changes in the impact of exchange rate shocks on the aggregate economy over time. Data availability, however, limits the analysis on this "composition effect" to a relatively short time horizon and it turns out that during this period the "composition effect" appears to have been rather limited for both prices and activity. It cannot be excluded, though, that these effects might be more pronounced once a longer time period is taken into account. This highlights that despite progress in this paper in the understanding of the effects of exchange rate shocks across the euro area economy interesting and important aspects of this topic remain open for future research.

1 Introduction

Since its introduction the exchange rate of the euro has been subject to substantial fluctuations vis-a-vis the euro area's main trading partners. Empirical analysis for the euro area generally suggest that such pronounced exchange rate changes may strongly impact both inflation and economic activity (see e.g. *Anderton (2003)*, *Hahn (2003)*, *Faruqee (2004)* and *Angeloni, Kashyap, Mojon and Terlizzese (2003)*). Empirical evidence for the euro area has so far focused mainly on the effects of exchange rate shocks on aggregate output and prices. On account of structural differences across sectors such as in the degree of openness, in the degree of product differentiation or in the price elasticity of demand the exposure and vulnerability to exchange rate shocks is, however, likely to vary substantially across sectors. It is most likely that some sectors are affected heavily, while others may not respond at all. The same applies to the timing of the effect, which may be immediate in some sectors and very delayed in others. As a result, in order to fully understand the propagation of exchange rate shocks across the economy detailed knowledge of the sectoral dimension of the effects is essential. Such sector information should also benefit conjunctural and price analysis as well as forecasts for the euro area economy. This is not only the case in order to explain sector-specific developments or divergences across sectors, but also in order to be able to focus the analysis for the aggregate economy on the sectors that contribute most strongly to the aggregate effects and to ensure that emerging exchange rate effects on inflation and real activity are detected at the earliest possible stage by also exploiting the likely heterogeneity in the timing of the impact across sectors. Information about the sectoral heterogeneity of the effects might also provide some input into the discussion of a possible change in the exchange rate pass-through over time, as the ongoing structural shifts between euro area sectors may be an important source of such changes.

Against the background of these arguments, the purpose of this study is to extend the empirical evidence on the effects of exchange rate shocks on the euro area economy to the sectoral level. While a few studies have already looked into the sectoral dimension

of the exchange rate pass-through on euro area import prices,[1] this paper focuses on the effects of exchange rate shocks on both euro area activity and prices at the producer level. A Vector Autoregressive (VAR) framework is used to model the impact. This approach appears particularly well suited for this kind of analysis, as it allows for potential and highly likely endogeneity between the variables of interest and also provides the tools to trace out the dynamic responses of the variables to exogenous shocks. A separate VAR model is estimated for each sector. Impulse response analysis is used to investigate and compare the magnitude and the speed of the impact of an exchange rate shock across sectors. The paper aims to provide a complete overview of the the impact across all sectors of the euro area economy. Determined by data availability, the sector coverage and the depth of the sectoral breakdown at which the analysis are conducted varies quite substantially across the euro area sectors though.

The structure of the paper is as follows: Section 2 illustrates the sectoral breakdown of the euro area economy and introduces the available sectoral output and price data that provide the basis for the analysis. In section 3 the modelling framework is discussed. Section 4 discusses characteristics that may account for differences in sectoral output and price responses to an exchange rate shock. Section 5 presents the empirical results and Section 6 concludes.

2 The sector structure and data of the euro area

The sector analysis aims to provide a complete picture of the impact of exchange rate changes on activity and prices across the euro area economy. As a background and in order to be able to appropriately interpret the results, it is helpful to have a clear idea of the sector structure of the euro area economy and of the data that are available on the sectoral level.

Starting with the overview on the real side of the economy, the sector breakdown of the euro area economy by real gross value added shown in Table 1 illustrates that activity in

[1] See *Campa, Goldberg and Gonzalez-Minguez (2005)* and *Osbat and Wagner (2006)*.

the euro area economy can be broken down in four main sectors of very different size. The by far largest sector is the services sector which has a share of roughly 71 percent of value added in the euro area. Industry (excluding construction) is much smaller, accounting for only about 21 percent of value added. The construction and agricultural sectors are, with shares in value added of 6 and 2 percent, respectively, very small. A deeper sectoral breakdown of euro area value added data at a quarterly frequency is only available for the services sector. This sector can be further decomposed into three sub-sectors: trade and transportation services (21 percent), financial and business services (28 percent)and a sector that includes mainly government related services (23 percent).

More detailed sectoral information on activity is provided by production data, albeit only for the industrial sector. These data are available for individual industries and for the main industrial groupings (MIGs), which represent classifications of the industries according to the purpose of use of the goods, i.e. energy, intermediate, capital and (durable and non-durable) consumer goods producing industries. Table 2 provides an overview of the individual sub-sectors of industry and the MIGs together with their weights in euro area industrial production (excluding construction), where available. It shows that industry (excluding construction) in the euro area comprises mainly manufacturing, which has a share of 90.5 %, but also electricity, gas and water supply and mining and quarrying. As regards manufacturing also a very detailed breakdown by individual industries is available. Large sub-sectors are for instance "machinery", "chemicals" and "food". As regards the MIGs, Table 2 shows that the industries producing intermediate goods have the largest share in euro are industrial production (excluding construction) followed by the capital and consumer goods producing industries and the smaller energy sector. Within the consumer goods sector, the durable consumer goods sector is much smaller than the non-durable consumer goods sector. The availability of the production data for the sub-sectors of industry (excluding construction) displayed in Table 2 is almost complete. The only two sub-sectors for which no data are available are "mining and quarrying" and "recycling" both of which are relatively small.

Moving to the price side, ideally, the sectoral analysis of the impact of exchange

rate shocks should cover the same sectors for prices as for activity. But while data availability has already restrained the detailed analysis of activity of individual sectors to industry (excluding construction), it is even more confining as regards price developments. The appropriate price measure to capture the impact of exchange rate shocks at the sectoral producer level are the respective producer prices. Exchange rate shocks may affect a domestic firm's input prices of imported input goods directly and those of other inputs indirectly and could also affect wages if second round effects occur. Together with a possible adjustment of profit margins these effects determine the impact on a firm's producer price. The main channels of an exchange rate shock to affect producer prices are likely to be the direct and the indirect effects which may be mitigated if profit margins are adjusted. Unfortunately, producer prices are not available for big parts of the euro area economy. The only price measure that would basically be available for all four main sectors of the euro area economy are the value added deflators. Value added deflators, however, are no appropriate price measures for the purpose of our analysis as they would capture only the less likely second round effects and possible adjustments in profit margins and, hence, miss the probably most important parts of the price effects from exchange rate changes.[2] This leaves us with the use of producer prices and, hence, restrains the analysis of the effects of exchange rate shocks on sectoral prices at the producer level to the industrial sector for which euro area producer prices are available. On the positive side, the breakdown for producer prices in the industrial sector follows the same classification system as that for industrial production and the data are available for the same sub-sectors, which at least ensures a consistent analysis for activity and prices in this sector. The domestic turnover weights of individual sectors' producer prices in the total producer price index for industry (excluding construction) are in most cases similar, albeit generally not identical, to the value added weights used in the production index (see Table 2).[3]

[2]The inappropriateness of this price indicator for the purpose of our analysis becomes also apparent when looking at the problem from the different angle of the expenditure concept. As a weighted average of the deflators of the expenditure components, contrary to other standard domestic price indicators, initially the GDP deflator shows a negative response to price pressures from external sources such as exchange rate movements.

[3]Differences between these weights reflect differences in the relative prices between the sectors.

3 The model framework

The sectoral analysis of the impact of exchange rate shocks is based on a set of vector autoregressive (VAR) models. This framework takes account of possible endogeneity and time lags in the interrelationships among the variables of the system. A separate VAR model is estimated for each sector. The choice of the variables included in the VAR models is based on the following considerations: In view of the aim of the analysis to determine the impact of exchange rate shocks on sectoral activity and prices, a sector variable, denoted by s_t, and the exchange rate, e_t, have to be included in the system. The effect on sector price and activity variables is investigated separately as this allows to estimate a more parsimonious model which appears appropriate given the partly relatively short sectoral data samples.[4] The included exchange rate variable is the nominal effective exchange rate of the euro. In order to control for repercussions of the macroeconomic environment on sector developments, euro area-wide output and price variables, represented by real GDP (y_t) and the HICP ($hicp_t$), are incorporated in the model. The impact of monetary policy is modelled by a short term interest rate (i_t). To account for external demand and price impacts, world GDP and producer prices were initially added to the system. As block exogeneity tests rejected the inclusion of these variables, they were dropped in the final sector models, which, hence, consist of the above mentioned five endogenous variables.

In addition to the sector models a benchmark model for the aggregate euro area economy is estimated. This model differs from the sector models with regard to the exclusion of the sector variable. It is used to capture the effects of exchange rate changes on total euro area GDP and the HICP. These results could basically also be derived from the sector models, but as these models are estimated separately, theoretically, the results could differ between them.[5] The benchmark model serves two purposes. First, the results on the aggregate euro area variables can be compared to the available empirical evidence for these variables and, hence, offer a basis to examine the plausibility of the achieved

[4]However, including both the sectoral output and price variable at the same time in the model did not significantly change the results.

[5]The empirical results showed, however, that the impact on GDP and the HICP was almost identical across the different models.

results and of the overall setup of the VAR models. Second, the aggregate results provide a useful benchmark for the evaluation and interpretation of the sectoral effects.

Identification of the structural shocks of the VAR models is achieved by applying a standard recursive identification scheme to the contemporaneous impact matrix of the structural shocks. Such a recursive identification scheme implies that a shock to a variable has a contemporaneous impact on the corresponding variable and on variables that are ordered subsequently in the system, while the contemporaneous impact on preceding variables is restricted to zero. Accordingly, in this identification scheme the structure of the economy is imposed by the ordering of the variables.

As our analysis focuses on the impact of exchange rate shocks on the economy the ordering of the exchange rate variable relative to the other variables is of most importance. In fact, given the focus of our analysis, once the ordering of the exchange rate variable is decided, the relative position of the other variables is not of relevance for our purposes. The literature, however, provides no clear guidance on where to order the exchange rate. Different orderings appear plausible, all of which offer some advantages, but also some drawbacks.

One reasonable possibility is to order the exchange rate first. This ordering is appealing as it does not ex ante restrict the impact of exchange rate shocks on any of the other variables to zero. It is justified from the point of view that the exchange rate may be strongly influenced by external developments, but appears to some extent contemporaneously exogenous to the domestic variables taking in particular into account factors such as the partly quite substantial publication lags of data such as GDP. The vector of endogenous variables included in the model may then be represented by $x_t = (\triangle e_t, \triangle y_t, \triangle hicp_t, \triangle s_t, \triangle i_t)'$.

While the exchange rate might be strongly influenced by external developments, in particular, changes in the domestic interest rate might be quickly incorporated in the exchange rate as well. As a result, another plausible ordering of the variables is to order the interest rate first, followed by the exchange rate, while keeping the ordering of the other variables unchanged. This ordering, however, incorporates the drawback that the

contemporaneous impact of the exchange rate on the interest rate is ex ante imposed to be zero. Nevertheless, restricting this impact to zero might be justified as monetary policy in a large and relatively closed economy such as the euro area is likely not to respond immediately to changes in the exchange rate. In this alternative case the vector of endogenous variables can be described as $x_t = (\triangle i_t, \triangle e_t, \triangle y_t, \triangle hicp_t, \triangle s_t)'$.

A third ordering, that shall be taken into account here, is to place the exchange rate last. While this entails the substantial drawback that the contemporaneous impact of the exchange rate on all other variables is ex ante restricted to zero and therefore appears less suited as the baseline case in an analysis of the effects of exchange rate changes, it is appealing as it takes into account that the exchange rate as a financial variable is likely to adjust quickly to all kind of new information, including, in particular, changes in policy rates. In this case the vector of endogenous variables is given by $x_t = (\triangle y_t, \triangle hicp_t, \triangle s_t, \triangle i_t, \triangle e_t)'$.

The results were generally similar and not significantly different for the different orderings of the variables. This applies in particular to the results of the first and second suggested orderings. Those for the third suggested ordering showed in some cases somewhat bigger deviations, which resulted often from deviations in the first quarter impact. This could indicate that the imposed zero restriction on the contemporaneous impact of exchange rate shocks on the other variables might be too restrictive, providing some support for the other two identification schemes. As a result, the empirical results reported in Section 5 refer to the ordering, in which the exchange rate is placed first, allowing for a contemporaneous impact on all other variables.

Finally, turning to specification issues, all VAR models are estimated in the first differences of the variables. This decision reflects the fact that all variables appear to contain a unit root,[6] while evidence on cointegration among them is very limited. The number of lags included in the VAR models is determined according to information criteria and cross-checked by residual tests (see Tables 1 and 2). The analysis is based on quarterly

[6]For the HICP the results were less clear cut. As is well known, the HICP rather seems to be a borderline case between an I(1) and an I(2) process, which we decided to treat in a similar way as the other price variable, as in the framework of a stability-oriented monetary policy strategy inflation should be stationary.

data. All data series, except for the interest rate and the exchange rate, are seasonally adjusted. The sample period of the sector models is chosen according to data availability of the sector variables in order to ensure the highest possible precision of the estimates for each sector and, hence, differs somewhat across the models (see Tables 3 and 4).

4 Characteristics that might account for differences in the sectoral output and price responses

An exchange rate shock may have a very different impact on activity and prices in different sectors. Generally, an appreciation of the exchange rate should be expected to affect domestic production negatively as domestically produced goods become relatively more expensive to those produced abroad and domestic producer prices should decline on account of favourable price effects from imported inputs. The degree to which these effects materialise, however, is likely to be shaped by a multitude of factors, which may differ across sectors. Important factors that are likely to determine the magnitude and speed of adjustment of output and prices in a sector to an exchange rate shock include the openness of the sector, i.e. the share of production that is exported, the degree of import competition and the share of imported inputs, product characteristics such as the degree of product differentiation, demand characteristics such as the price elasticity of demand, and other factors affecting the degree of competition in the market such as the degree of market segmentation, the existence of oligopolistic market structures or trade barriers.[7]

In the following we try to provide a rough overview of the importance of these factors across euro area sectors. This information is, however, not readily available for most of the above mentioned categories. Quantitative information can only be computed as regards the openness indicators (see Tables 1 and 2). For the other categories economic reasoning can provide some qualitative assessment. However, also this proceeding proves difficult for very broad and rather heterogeneous sectors. Table 5 therefore provides a qualitative assessment of the importance of the different factors across the more homogeneous MIGs

[7] See e.g. *Menon (1995)* for an overview of theoretical explanatory approaches on the exchange rate pass-through on prices.

of the industrial sector.

As regards the magnitude of the impact of an exchange rate shock on activity, in general, the higher the export share of a sector, the higher the share of imported competitor goods and the higher the price elasticity of demand, the stronger the output response that can be expected for that sector. By contrast, a higher share of imported inputs (via the cost effects involved), a higher degree of product differentiation (due to lower substitution effects) and generally factors that seem to reduce the degree of competition in the market (such as a higher degree of market segmentation) should tend to reduce the output response of a sector. As individual sectors are likely to combine amplifying and mitigating factors a clear conclusion as regards the actual strength of the effect can not always immediately be derived. Looking at the main economic sectors, the high export share and the high share of imported competitor goods of industry suggests a higher output response in that sector than in the other main economic sectors. As regards the MIGs, again the high export share and the high share of imported competitor goods would point to a large output effect in the capital goods sector, while the degree of product differentiation would suggest a lower output response for capital and consumer goods, but a higher reaction of intermediate and energy production. As regards the latter sector, however, also strong offsetting forces seem to be at play arising from the low export share, the low share of imported competitor goods, the high share of imported inputs and the low price elasticity of demand. On the price side, the magnitude of the exchange rate pass-through should be expected to be positively correlated for instance with the share of imported inputs in production and negatively with the degree of product differentiation and the price elasticity of demand. This would generally suggest a high exchange rate pass-through on producer prices in the energy and intermediate goods sectors and a low pass-through on capital goods producer prices.

With regard to the speed of adjustment of prices and production to an exchange rate shock, generally, it should be expected that the adjustment is faster for sectors with a highly exchange rate sensitive cost structure (i.e. a high share of imported inputs) and a lower degree of product differentiation. The degree of product differentiation could play

a role via several channels: First, more homogeneous products might generally be more easily substituted by foreign products and this implied higher degree of competition could imply faster price and output adjustments. Faster adjustment could also be related to the fact that prices for more homogeneous goods such as energy or intermediate goods are more strongly related to world market prices, which are adjusted at high frequency. Moreover, menue costs may generally be lower for our considered categories of more homogeneous products. Finally, offers and orders for these products may take place basically contemporaneously such that changes in the exchange rate may be quickly incorporated in contracts, which may not be the case in our categories of more differentiated products such as capital goods and, in particular, big ticket items, where large time lags between the offer of a product at a fixed price and the final order may exits. As a result, one might expect price and output adjustment to be fast in the energy and intermediate goods sectors and rather on the slow side in the capital goods sector.

5 The empirical results

In the presentation of the empirical results we take a general to specific approach. That is we first present the results on the aggregate variables and on the main euro area sectors (see Section 5.1) and then go as far to the sectoral details as the data availability allows. As regards the sub-sector results we first present those on activity (Section 5.2) and move to the impact on prices thereafter (Section 5.3). Finally, we compare the output and price responses across sectors (Section 5.4) and try to assess whether changes in the sector composition may have contributed to changes in the magnitude of the impact of exchange rate shocks on aggregate prices and output in the euro area (Section 5.5).

5.1 The impact on GDP, the HICP and value added in the main euro area sectors

This section reports the results of the impulse response analysis of an exchange rate shock on the HICP and GDP derived from the baseline model and on value added in the main

euro area sectors. The impact of a one percent appreciation of the nominal effective exchange rate of the euro on these variables is summarised in Table 6 for different time horizons. According to our findings, the appreciation of the euro is passed-through to the HICP by around 3 percent within the same quarter and by 7 and 14 percent after one and two years, respectively. The transmission to GDP is estimated to be somewhat faster. While the impact in the first quarter appears to be relatively limited, most of the effect occurs within the first 4 to 5 quarters. Overall, a one percent increase in the exchange rate of the euro is estimated to reduce GDP by around 0.14 percentage point in the longer-term, which for the purpose of our analysis is defined as the impact after two years. These results are very similar to previous estimates for the euro area (see e.g. *Hahn (2003)* for estimates on the impact on the HICP and *Angeloni et al. (2003)* for estimates on the HICP and GDP).

As regards value added in the main euro area sectors, as expected on account of its high export share and the high share of imported competitor goods, the impact is strongest on industry (excluding construction). The response of activity in this sector shows a hump-shaped pattern, declining by 0.3 percentage point after one year and by 0.2 percentage point after two years following a one percent appreciation of the exchange rate.[8] A significant decline (-0.17 percentage point after two years) is also found for the services sub-sector trade and transportation, which is also characterised by a relatively high export share. The speed of adjustment of value added to an exchange rate shock apears to be relatively fast for both industry (excluding construction) and trade and transportation services (see Table 6).[9] Also for the remaining sectors some decline in value added is recorded. Among these sectors the point estimates show the highest response for financial and business services and the smallest for construction and government related services, but none of these effects appears to be significant.

[8]For some sectors a hump shaped form of the impulse response is detected. This was in particular the case for sector estimates, which are based on relatively short sample periods. Overall, this seems to suggest that the hump shaped form is not based on economic grounds, but displays some uncertainty in the estimates, which is also confirmed by the error bands of the estimates.

[9]The adjustment speed is defined here as the share of the impact that has materialised over different time horizons in relation to the total impact, which we define as the impact after two years.

5.2 The impact on activity in sub-sectors of industry (excluding construction)

In this section the impact of exchange rate shocks on activity in industry (excluding construction) is explored in more detail using the sectoral breakdown of the industrial production data by MIGs and by individual sectors. Starting with the effect on the aggregate, following a one percent appreciation of the exchange rate of the euro, industrial production (excluding construction) is estimated to decline by 0.3 and 0.4 percentage point after one and two years, respectively (see Table 7). These effects are somewhat higher than those estimated for value added in industry (excluding construction), in particular over the longer-term, as they don't show a hump-shaped pattern.[10]

The results for the MIGs show that in the longer term a change in the exchange rate has the strongest impact on activity in industries producing capital goods (see the lower part of Table 7). A one percent appreciation of the exchange rate of the euro is estimated to reduce production of capital goods by 0.6 percentage point after two years. A slightly smaller albeit still substantial impact is estimated for production of intermediate goods (-0.5ppt). The impact on consumer goods production is much smaller (-0.2ppt). This seems to be in particular on account of a low response of production of non-durable consumer goods (-0.17ppt) and to a lesser extent due to that of durables (by -0.30pt). Finally, energy production shows a slightly positive, albeit insignificant, response to an appreciation of the euro.

As already envisaged, factors that are likely to account for the high sensitivity of euro area capital goods production to an exchange rate shock are the strong export orienta-

[10]These differences are to some extent the result of the different data sources, but they are also related to differences in the data sample. Both data sources aim to capture developments in activity in industry (excluding construction) on the basis of similar statistical concepts (in particular both measure output net of inputs used in production). However, they differ with respect to the country coverage that is used to derive the euro area figure and seasonal adjustment procedures. These differences are also reflected in occasionally quite significant deviations in the short-term pattern of the two series. With regard to the differences in the sample period, as discussed in the previous section, the largest available data sample is used for each sector model to ensure the most precise estimates possible, which, however, potentially entails the cost of some loss of comparability as the possibility of some changes in the impact over time cannot be ruled out. In fact, when shortening the data sample of industrial production (which includes seven more years) to that of value added, the effects are more similar. Given the limited length of this data sample, we are, however, more inclined to interpret the industrial production results for the whole sample as the "true" effect on industry (excluding construction).

tion and the high degree of import competition of this sector (see Table 2). The export and import shares of the intermediate goods sector are somewhat lower than that of the capital goods sector, but similar to that of the consumer goods sector. The relatively high output response of the intermediate goods sectors is likely to be particularly related to the relatively low degree of product differentiation and subsequently high degree of substitutability and competition between domestic and foreign production. The much more muted impact on consumer goods production, despite similar export and import shares, might likewise be related to its higher product differentiation, but also a relatively low price elasticity of demand for non-durable consumer goods such as food may have added to this relative resilience. The slightly positive albeit insignificant impact of an appreciation of the euro on euro area energy production may be explained by a number of special characteristics of this sector. The strong focus of euro area energy production on the domestic market, low import competition, a high degree of international market segmentation and oligopolistic market structures in some parts of the euro area energy sector such as electricity together with relatively inelastic demand for energy are likely to be factors that contribute to the limited response of domestic energy production to changes of the euro exchange rate. In addition, substantial favourable input price effects may make it particularly profitable to actually raise production at times of an appreciation of the exchange rate. Energy inputs (e.g. crude oil) play a significant role in the production process in the energy sector and as the euro area has only limited domestic energy resources, most of these inputs need to be imported. In fact, with 33 percent the share of imported inputs in domestic production in the energy sector is much higher than that of all other MIGs (see Table 2). By raising the production when the euro appreciates windfall profits may be gained by delaying the full propagation of these favourable price effects in the distribution chain, which should be facilitated given the relatively high degree of concentration in this market.

As expected there are also significant differences across sectors with regard to the adjustment speed of production following a change in the exchange rate (see Table 7). The adjustment is estimated to be fastest in the energy sector, where most of the changes

in production appear to take place immediately, i.e. within the first quarter. Also the impact on intermediate goods production is estimated to materialise quite fast and, in fact, much quicker than in the consumer and, in particular, in the capital goods industries. The immediate response of energy production to a change in the exchange rate is likely be related to the high exchange rate sensitivity of the cost structure of production in large parts of this sector, which is most likely to be affected very quickly as energy inputs such as oil are priced on a daily basis. Only a prompt response would allow firms to take advantage of possible temporary windfall profits in the case of an appreciation. The also quite fast response of intermediate goods production might be due to the fact, that on account of, first, the relatively low product differentiation and, hence, higher competition with foreign products and, second, the fact that offers and orders for these goods may take place basically contemporaneously, exchange rate changes are quickly incorporated in new contracts and, hence, production. At the contrary, capital goods are generally highly differentiated and specific goods for which, in particular in the case of big ticket items, orders are based on advanced offers at fixed prices, which suggests that exchange rate changes are included in new contracts with some delay. In view of the large diversity of consumer goods, the production of consumer goods is likely to contain features of both of these more "extreme" cases, which might explain its intermediate case responding relatively quickly in the very short run (i.e. after one quarter) but more slowly after one year.

When moving from the breakdown of industry (excluding construction) according to the purpose of use of goods to that by kind of goods, as mentioned earlier, as regards the main sub-sectors, data are only available for manufacturing and electricity, gas and water supply. An exchange rate shock is estimated to impact domestic production in these two sectors very differently (see Table 7). While there is basically no impact on electricity, gas and water supply, the impact on manufacturing is substantial (0.45 percentage point after two years).

An even higher degree of diversity is found as regards the impact of exchange rate shocks on activity in individual manufacturing sub-sectors (see Table 7). The longer-

term impact ranges from zero in the "food" sector to a 0.8 percentage point change in "machinery and equipment". In order to facilitate the interpretation of the results for the available 22 sub-sectors of manufacturing, we classify them in Table 8 according to the strength of the longer-term impact in three groups, a low-impact group (effect up to 0.2ppt), a medium-sized-impact group (0.2 - 0.5ppt) and a high-impact group (more than 0.5ppt). Consistent with the results for the MIGs, the low-impact group contains mainly non-durable consumer goods and energy ("food", "fuel"[11] and "publishing"), while the medium-sized impact group consists, in particular, of durable consumer goods and intermediate goods (such as "furniture" and "chemicals") and the high-impact group encompasses mainly capital goods (e.g. "motor vehicles" and "machinery and equipment"). A common characteristic of the sectors of the first group seems to be a relatively low price elasticity of demand. Otherwise, in particular, the export share and the degree of import competition seem to be important determinants of the size of the effects, rising clearly from group one to three.

Also the results on the adjustment speed of production in individual manufacturing sectors to an exchange rate shock confirm those of the MIGs. Slow adjustment is a common feature of the vast majority of capital goods producers (e.g. "machinery and equipment" and "office machinery and computers"), while fast adjustment is shared by basically all intermediate goods producing industries (e.g. "pulp" and "basic metals"). The adjustment speed appears to be quite diverse across the consumer goods producing sectors being for instance very fast in "publishing" but more slowly in "wearing apparel". As regards energy production, the response of the sector "fuel" is immediate but short-lived, and, hence, shows a completely different adjustment pattern to those of the other sectors.

[11] Production in the "fuel" sector displays a small longer-term response, but a strong increase in the short-term following an appreciation of the exchange rate. The strong positive short-term effect of an appreciation on production in the "fuel" sector represents the missing ingredient to understand the positive impact of an appreciation on MIG energy production, as the main sector electricity, gas and water supply, which accounts for the bulk of MIG energy in terms of value added, displayed only a very small short-term increase in production (MIG energy is composed of the NACE Rev. 1 classifications 10, 11, 12, 23, 40 and 41). As already mentioned, a possible explanation for this behaviour might be that favourable price effects of imported inputs, which have a very large and in fact the largest share in domestic production in the "fuel" sector (64 percent) among all manufacturing sub-sectors, are passed on in the pricing chain and to consumers only with some delay, implying some additional profits of production in the short-term.

5.3 The impact on producer prices in sub-sectors of industry (excluding construction)

Empirical evidence on the impact of exchange rate shocks on domestic prices in the euro area at the producer level is still rare. The only studies that provide estimates on the exchange rate pass-through on euro area producer prices are *Hahn (2003)* and *Faruqee (2004)*. *Hahn (2003)* estimates the impact of exchange rate shocks of the euro on the PPI in manufacturing and *Faruqee (2004)* explores the impact on the PPI in industry excluding construction and energy. *Hahn (2003)* also shows that both the size and the speed of the pass-through decline along the pricing chain, i.e. the pass-through is largest and fastest on import prices, followed by producer prices and the HICP. A complete picture of the impact of exchange rate shocks on producer prices in industry (excluding construction) and its breakdown in terms of both the MIGs and individual manufacturing sub-sectors, which is the main focus of this analysis, is still missing though.

The results on the exchange rate pass-through on euro area producer prices in industry (excluding construction) and its breakdown are summarised in Table 9. A one percent appreciation of the euro is estimated to be passed on to producer prices in industry (excluding construction) by 5 percent within the first quarter and by 26 percent after two years. Most of this impact appears to come through within the first year. As already envisaged by *Hahn (2003)* the impact is stronger on the PPI than on the HICP.

As regards the MIGs, the exchange rate pass-through is estimated to be strongest on producer prices of energy with a significant fraction of the impact coming through already within the first quarter (23 percent pass-through) and a total pass-through of 68 percent. The second largest, albeit much smaller, impact is recorded for producer prices of intermediate goods, which displays a slightly hump-shaped pattern and a longer-term pass-through of about 17 %. The long-run pass-through on producer prices of consumer goods is with 16 percent only marginally lower. Finally, the longer-term impact is smallest, and not significantly different from zero, for producer prices of capital goods (4%). A number of factors are likely to account for the high pass-through of exchange rate shocks on producer prices in MIG energy. First, as already mentioned, the cost

structure of energy production displays a much higher exchange rate sensitivity than that of the other MIGs. Moreover, a high pass-through on prices seems very plausible for homogeneous products in a highly transparent market such as for instance the oil market, where prices are adjusted and published on a daily basis. In such a market arbitrage activity should ensure that the law of one price holds when abstracting from distribution costs. In addition, the inelastic demand for energy generally implies relatively larger price changes for these goods. As regards the other MIGs, their lower share of imported inputs in production is likely to account for (part of) their lower price responses compared with MIG energy, but as the share is similar across them, it cannot explain the differences in pass-through between them. These are likely to be again related to differences in the degree of product differentiation between the MIGs, which is, as already mentioned, low in the intermediate goods sector and higher in the consumer and capital goods sectors.

As regards the adjustment speed of producer prices to an exchange rate shock, the pass-through is estimated to be fastest for the MIG categories energy and intermediate goods. A significant fraction of the impact on the prices of these goods occurs already within the first quarter and after one year most of the adjustment has already taken place. Producer prices of consumer goods are adjusted somewhat slower. The prices of non-durable consumer goods appear to be adjusted faster than those of durables. Finally, capital goods producer prices are not only adjusted the least, but also the slowest. The reasons for the observed differences in the adjustment speed of producer prices across sectors are closely related to those mentioned before for production. The quick adjustment of producer prices of energy and intermediate goods is likely to be related to the fact that the prices of these more homogenous and comparable goods such as raw materials are significantly affected and determined by frequently adjusted world market prices. Also relatively low menu costs and no long time difference between offers and orders for these products suggest that new contracts quickly incorporate price changes due to exchange rate shocks. Again, the opposite should hold for the more heterogeneous capital goods, with a high share of value added. Their prices are less comparable and transparent and price changes are likely to be subject to higher menu costs implying less frequent

adjustments and price adjustments (e.g. to exchange rate changes) may also be delayed on account of advanced offers at fixed prices, which may be valid for some time. Again, the adjustment speed in the consumer goods sector may be in between those of the other sectors due to the diversity of the characteristics of these goods.

Among the main sub-sectors of industry (excluding construction), the pass-through is very high on producer prices in electricity, gas and water supply (around 70 percent after two years) and much more muted in manufacturing (around 20 percent), but manufacturing prices appear to be adjusted faster than those of electricity gas and water supply. The results for producer prices in manufacturing are slightly smaller than those of *Hahn (2003)*, who found a pass-through of 28 percent after two years.[12]

Turning to manufacturing sub-sectors, the effect varies between the extreme cases of an insignificant increase in producer prices in the "tobacco" sector to a pass-through of 63 percent on prices in the "fuel" sector (see Table 9). When ordered again according to the strength of the effects in groups, it turns out that the majority of sectors have a rather low pass-through (see Table 10). Consistent with the results of the MIGs, this low-impact-group contains the majority of the capital and consumer goods producing sectors, while the medium sized impact group contains, in particular, intermediate goods sectors and the high impact group is composed of the energy sector "fuel". Many low pass-through sectors seem to be characterised by a relatively high degree of product differentiation also related to brands such as in the "tobacco" and "motor vehicles" sectors. Moreover, generally, the pass-through seems to rise with the share of imported inputs in production. The results concerning the speed of price adjustment generally again confirm those of the MIGs, with prices being adjusted fastest in the energy sector "fuel", also generally quick for intermediate goods and somewhat slower in some consumer and capital goods sectors.

[12] A perfect comparison of our results to those of *Faruqee (2004)* is not possible, as he uses producer prices in industry excluding construction and energy, which differ compared to producer prices in manufacturing with respect to the inclusion of mining and quarrying and the exclusion of the energy sub-sector manufacturing of coke, refined petroleum products and fuel. The results of both studies seem to be broadly consistent though, as the exclusion of the "fuel" sector, which, as will be shown later is subject to a particularly high exchange rate effect, should lead to a smaller exchange rate pass-through in line with the results of *Faruqee (2004)*, who found a pass-through of 17 percent after one and a half years.

5.4 Comparison of the output and price responses across sub-sectors of industry

A comparison of the magnitude of the longer-term output and price responses across sectors to an appreciation of the exchange rate helps to summarise and highlight general characteristics of the effects across sectors as well as special features of individual sectors and groups of sectors (see Figure 1).

A general characteristic that becomes evident from Figure 1 is the negative relationship between the size of the output and price responses of a sector. That is, sectors that show a larger price response appear to display a smaller output effect and vice versa.[13] The negative relationship, however, also hinges to some extent on the inclusion of e.g. the energy sectors, for which such effects may be particularly pronounced. An inverse relationship seems plausible on economic grounds, as the stronger the response of domestic producer prices[14] to an appreciation of the exchange rate rate the smaller the decrease in price competitiveness of domestic production compared with foreign production and, hence, the smaller the output response. This reasoning applies directly only to the part of production that is sold domestically, but the sectoral export shares indicate that this represents the bulk of production for most euro area sectors.

Figure 1 also highlights, that besides the negative relationship between the magnitude of the price and output response of the sectors, the combined output and price sensitivity to an exchange rate shock seems to differ across sectors. The two big ellipses in Figure 1 indicate groups of sectors showing a below or above average output and price response combination, respectively. Below average impact combinations are found for the MIG consumer goods sector and individual sectors such as "printing" and "food". Above average response combinations are given for the MIGs intermediate and capital goods as well as for example for the sub-sectors "basic metals" or "machinery". As is already evident from the previous analysis, the energy sectors shows a very peculiar behaviour,

[13] This is in contrast to what has been found as regards the adjustment speed. In line with expectations, the speed of adjustment of prices and output is similar within a sector, i.e. if, for instance, prices are adjusted quickly, this is also the case for production.

[14] Domestic producer prices include only the prices of domestically produced goods and also refer only to goods sold on the domestic market.

which is highlighted in Figure 1 by the small ellipse on the left-hand side, which includes the MIG energy sector as well as its sub-sectors "electricity, gas and water supply" and "fuel". All energy sectors are characterised by a particularly high response of producer prices, but basically no output effects. All in all, these results suggest an above average degree of sensitivity to exchange rate changes in the MIG capital and intermediate goods sectors possibly related to the relatively high degree of openness or competition in these markets and an overall below average sensitivity in the MIG consumer goods sector. While the latter might also apply to the energy sector, it could also be interpreted as responding extreme in terms of the composition of output and price responses, but still in line with average behaviour given by the regression line.

5.5 Have shifts in the sector composition changed the impact of exchange rate shocks on the aggregate economy?

The sector results may also provide an interesting ingredient to the discussion of a potential decline in the exchange rate pass-through on aggregate domestic prices over time, which has recently been demonstrated for a number of countries (see. e.g. *Gagnon and Ihrig (2002)*, *Olivei (2002)*, *Marazzi, Sheets, Vigfusson, Faust, Gagnon, Marquez, Martin, Reeve and Rogers (2005)*, *IMF (2006)*). A decline in the exchange rate pass-through has important implications for monetary policy, as exchange rate shocks would have a smaller bearing on domestic prices than before. There are a number of reasons why the exchange rate pass-through might have declined in the recent past in the euro area as well. These include the move to a lower and more stable inflation environment, an argument which has been suggested by *Taylor (2000)*, a rise in the share of intra euro area trade and possibly an increased share of extra euro area imports denominated in domestic currency on account of the creation of the euro.

So far only few studies have tackled this issue for the euro area, most likely on account of the limited data availability, and among the available studies the evidence on a decline in the exchange rate pass-through appears to be rather mixed so far. As already mentioned briefly, estimating her model over two different sub-periods, *Hahn (2003)* did not find

evidence of a decline in the exchange rate pass-through to either import prices, producer prices in manufacturing or the HICP. Also the stability tests of *Osbat and Wagner (2006)* do not point to a change in the impact of exchange rate shocks on euro area import prices in manufacturing or its sectoral breakdown. By contrast, *Campa et al. (2005)*, who focus on euro area countries, detect a decline in the point estimates of the exchange rate pass-through in two third of the euro area industries they look at, but this decline is only statistically significant for import prices in manufacturing industries. A comparison of our results on the exchange rate pass-through on producer prices in manufacturing to those of *Hahn (2003)*, who used a fairly similar model but a less up to date sample period, might tentatively point to some decline in the impact over time and, in particular, over the most recent years.

In addition to the arguments of a potential change in the exchange rate pass-through in the euro area over time mentioned above, the sectoral heterogeneity of the exchange rate pass-through identified in this paper, suggests changes in the sector composition over time as a further potential source of changes in the exchange rate pass-through. By computing the aggregate effects as a weighted average of the pass-through effects for sub-sectors based on the sector weights for different time periods, the impact of a change in the sector composition can be identified. This proceeding of course is a partial analysis as it might only detect changes in the effects due to changes in the sector composition, but neglects possible changes in the exchange rate pass-through within the sectors over time. Unfortunately, the analysis of the "composition effects" for the euro area is limited to a 5 year horizon between the two years 1995 and 2000 as euro area turnover weights are only available for these two dates.

It turns out that within these five years the "composition effect" by itself has, in fact, led to a slight increase in the longer-term exchange rate pass-through to producer prices in manufacturing by about one percentage point. This is on account of an increase in the turnover weights for the sub-sector "fuel", which is subject to the largest exchange rate pass-through among all manufacturing sub-sectors. The increase in the turnover weights for this sector is likely to be related to the strong surge in oil prices which amounted to

about 116 percent during this period. While no turnover weights are available for more recent years, the further significant rise in oil prices since 2000 suggests that the weight of this sector is likely to have risen further and the "composition effect" by itself, hence, might have had a further upward impact on the exchange rate pass-through to manufacturing producer prices. As regards producer prices in industry (excluding construction) the "composition effect", however, points to a slight decline in the exchange rate pass-through between 1995 and 2000 by one percentage point. This is on account of a decline in the weight of the sub-sector electricity, gas and water supply, which shows an even higher pass-through than the "fuel" sector. Overall, while some of the most recent empirical analysis in line with macroeconomic reasoning tends to provide some tentative evidence in favour of a decline in the overall impact of exchange rate shocks on domestic euro area prices over the recent past, the above computations on the "composition effect" highlight that also converse forces are at play and that also the impact of structural factors should not be neglected. While the computed effects appear to be relatively limited over the considered five year period, they might be more pronounced over longer horizons though. Moreover, the above computations highlight that despite close relationships between different price indices the changes need not go in the same direction pointing to the need for a careful analysis and good understanding of the underlying structural features.

Finally, in line with the overall more limited evidence in the literature on the impact of exchange rate shocks on euro area activity, also possible changes in the exchange rate impact on the real side of the economy have to our knowledge not been explored before. As regards the "composition effect", our results indicate that shifts between the main euro area sectors between 1991 and 2006 may have had a downward impact on the exchange rate effects on GDP, which, however, appears to be very small. No changes can be detected as regards the impact on production in the manufacturing sector between 1995 and 2000, as the shifts in manufacturing sub-sectors were balanced between highly responding and low responding sub-sectors. At the same time, the impact appears to have increased somewhat on production in industry (excluding construction) on account of a relative increase in the weight of the more exchange rate sensitive manufacturing sector. In sum,

also the "composition effects" on activity seem to be rather small and heterogeneous across sectors such that no strong overall conclusions can be drawn.

6 Conclusions

This paper extends the empirical evidence on the impact of exchange rate shocks on the euro area economy to the sector dimension. A detailed set of estimates concerning the magnitude and speed of adjustment of sectoral activity and prices in the euro area to an exchange rate shock is provided. The results suggest a high degree of heterogeneity in the exchange rate sensitivity across both sectoral activity and prices in the euro area.

Besides helping to advance the analysis of sectoral developments in the euro area, these results have also important implications as regards our understanding of the aggregate euro area economy. First, they improve our knowledge of the transmission mechanism of exchange rate shocks across the euro area economy on both prices and real activity. Second, they provide a valuable tools for euro area conjunctural and price analysis and forecasts. In that respect, in particular, they help to focus the attention on those sectors that might account for the bulk of the exchange rate effects and those that respond most quickly to these shocks, which contributes to a more efficient analysis of the impact of exchange rate shocks and may help to identify early signs of emerging exchange rate effects on the euro area economy. Finally, the sector results also deliver some input into the discussion on potential changes in the effects of exchange rate shocks on the euro area economy over time, by providing estimates of the changes in the impact arising from shifts in the sector structure.

Overall, the sector results suggest the following macroeconomic implications for the aggregate euro area economy: The two sectors industry (excluding construction) and trade and transportation, appear to contribute a large fraction (almost 70 percent) of the overall impact of an exchange rate shock on euro area GDP. Within industry (excluding construction), the MIGs capital and intermediate goods account for almost all of the impact on production (around 90 percent), while among the main sub-sectors the whole impact comes via the manufacturing sector. Moreover, within manufacturing, the by far

largest contributor is "machinery" and, taken together, a few manufacturing sub-sectors can explain a very large share of the overall impact on industry (excluding construction). The adjustment speed of activity seems to be quick for both industry (excluding construction) and trade and transportation and among the MIGs production is adjusted fastest in the energy and intermediate goods sectors.

On the price side, the most important contributor to the effect on producer prices in industry (excluding construction) among the MIGs is the energy sector, accounting for more than 50 percent of the overall effect, while among the sub-sectors the largest contribution may be ascribed to producer prices in manufacturing, but, in contrast to the effects on activity, also the electricity, gas and water supply sector contributes significantly. Among the manufacturing sub-sectors, the "fuel" and "food" sectors provide the largest contribution to the overall producer price effects. Early signs of emerging price pressures arising from an exchange rate shock may be gained from producer prices in the MIG energy and intermediate goods sectors.

Finally, the sector results suggest that shifts in the sector structure have, over the relatively short time horizon considered, led to only rather small changes in the impact of exchange rate shocks on both aggregate euro area prices and output. Nevertheless, it cannot be ruled out that these effects might have been more pronounced over longer time horizons. This highlights, that despite progress in this paper towards a better understanding of the effects of exchange rate shocks across the euro area economy, interesting and important aspects of this topic remain open for future research.

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A Appendix

Table 1: Sector breakdown of the euro area economy, model lag length selection and sectoral export and import shares

Sector	Weight* (in %)	Lags in the model	Export share in prod.** (in %)	Import share** (in %)	Share of imported inputs in prod.** (in %)
Total economy/baseline model	100	3	16	15	10
Total services	71.4	-	6	4	4
Trade/transportation services	21.2	2	12	5	7
Financial/business services	27.6	3	4	5	3
Government related services	22.6	2	1	1	4
Agriculture	1.9	2	13	21	7
Industry (excl. construction)	20.5	2	35	35	20
Construction	6.2	2	0.4	1	8

*Weights in terms of real gross value added. Weights refer to the year 2006. Source: Eurostat.

**Source: Input output table approx. for the euro area based on country data for Germany, France, Italy, the Netherlands, Austria, Finland and Belgium for the year 2000. The import share is defined as the share of imports, that are not re-exported, to the sum of imports and domestic production minus exports.

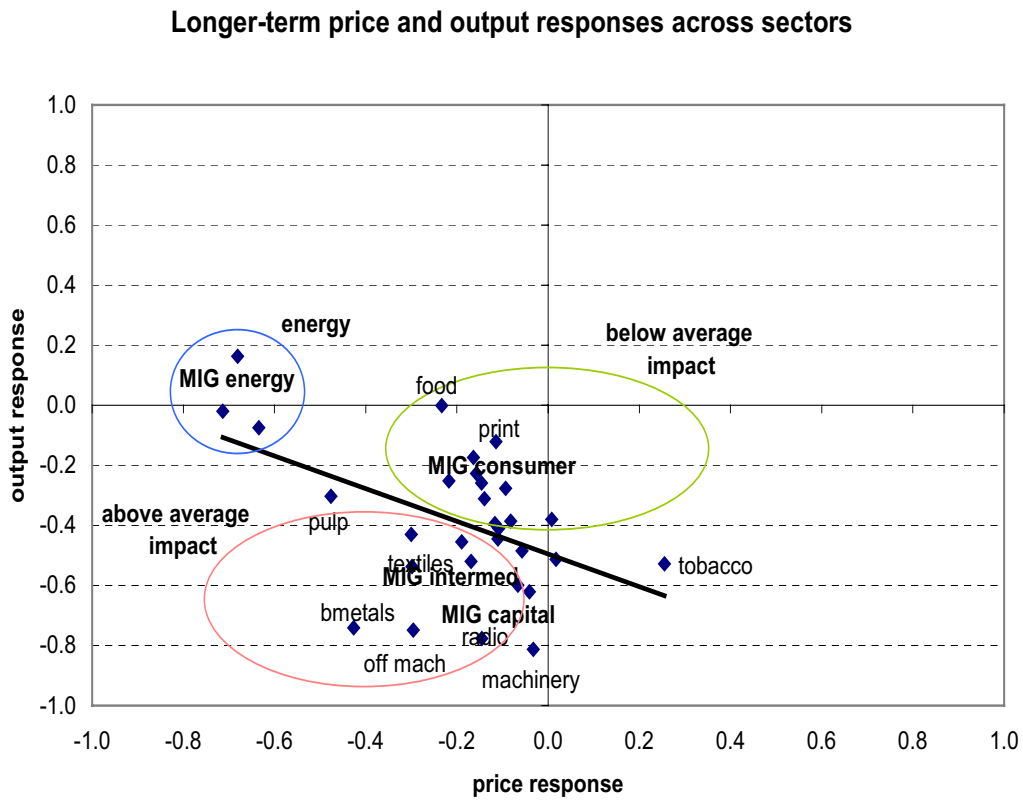

Figure 1: Impact of a one percent appreciation of the exchange rate

Table 2: Sector breakdown of euro area industrial production (excluding construction) and producer prices, model lag length selection and sectoral export and import shares

Sector	Weight* (in %) prod.	ppi	Lag length activ.	prices	Exp.** share	Imp.** share	Imp.** input share
Total industry (excluding construction)	100	100	2	4	35	35	20
Mining and quarrying	-	-	-	-	-	-	-
Manufacturing	90.5	89.5	3	4	37	35	21
Manufacture of food products and beverages	9.0	14.3	3	1	21	20	13
Manufacture of tobacco products	0.4	1.2	3	3	39	35	19
Manufacture of textiles	2.4	2.0	2	2	43	39	21
Manufacture of wearing apparel; dressing etc.	1.5	1.7	2	2	30	47	18
Tanning and dressing of leather etc.	-	-	2	3	54	55	19
Manufacture of wood, products of wood, cork	-	-	2	2	19	22	14
Manufacture of pulp, paper and paper products	-	-	3	3	39	37	21
Publishing, printing, reprod. of recorded media	-	-	2	4	11	10	10
Manufacture of coke, refined petroleum products and nuclear fuel	-	-	3	4	24	27	64
Manufacture of chemicals and chemical products	9.8	8.2	2	2	53	50	26
Manufacture of rubber and plastic products	4.1	3.4	3	3	35	31	22
Manufacture of other non-metallic mineral prod.	-	-	3	3	21	17	10
Manufacture of basic metals	-	-	2	2	44	48	30
Manufacture of fabricated metal products	-	-	3	3	18	14	13
Manufacture of machinery and equipment n.e.c.	10.1	6.6	3	3	51	38	17
Manufacture of office machinery and computers	-	-	2	3	47	76	41
Manufacture of electrical machinery etc.	-	-	3	3	38	35	16
Manufacture of radio, television, etc.	-	-	2	2	51	53	25
Manufacture of medical, precision etc.	-	-	3	4	43	45	14
Manufacture of motor vehicles, trailers etc.	-	-	3	3	48	41	20
Manufacture of other transport equipment	-	-	3	4	55	51	26
Manufacture of furniture; manufacturing n.e.c.	-	-	2	4	34	33	17
Recycling	0.2	0.3	-	-	-	-	-
Electricity, gas and water supply	-	-	3	3	2	3	12
MIG intermediate goods industry	36.2	31.6	2	4	34	32	19
MIG capital goods industry	27.1	21.3	3	2	43	39	19
Consumer goods industry	26.0	29.5	4	2	35	34	18
MIG durable consumer goods industry	4.3	4.0	2	3	43	43	19
MIG non-durable consumer goods industry	21.6	25.5	3	2	33	32	18
MIG energy	10.8	17.5	2	2	11	13	33

*Weights refer to the year 2000. Value added weights for production and domestic turnover weights for producer prices. Source: ECB computations based on Eurostat.

**Export and import shares and share of imported inputs in production in %. Source: Input output table approx. for the euro area based on data for Germany, France, Italy, the Netherlands, Austria, Finland and Belgium for the year 2000. The import share is defined as the share of imports, that are not re-exported, to the sum of imports and domestic production minus exports.

Table 3: Data sources and description (1)

Variable/sector	Data sample	Source
GDP (y_t)	1985(1) - 2004(1)	Eurostat , ECB (AWM database)
HICP ($hicp_t$)	1985(1) - 2004(1)	Eurostat , ECB (AWM database)
NEER (e_t)	1985(1) - 2004(1)	ECB
3-months-interest rate (i_t)	1985(1) - 2004(1)	ECB, before 1980 calculations based on OECD and MEI
World GDP	1985(1) - 2004(1)	ECB (AWM database)
World producer prices, approximated by OECD PPI	1985(1) - 2004(1)	OECD
Real gross value added in:		
Agriculture, hunting, forestry and fishing	1991(1) - 2004(1)	Eurostat
Industry (excluding construction)	1991(1) - 2004(1)	Eurostat
Construction	1991(1) - 2004(1)	Eurostat
Trade, repairs, hotels, restaurants, transportation	1991(1) - 2004(1)	Eurostat
Financial, real estate, renting and business activities	1991(1) - 2004(1)	Eurostat
Government related services	1991(1) - 2004(1)	Eurostat
Sectoral data (NACE Rev. 1 classification):		
Industrial production/PPI in:		
Total industry (excluding construction)	1985(1) - 2004(1)	Eurostat
MIG intermediate goods industry	1985(1)/1990(1) - 2004(1)	Eurostat
MIG capital goods industry	1985(1)/1990(1) - 2004(1)	Eurostat
Consumer goods industry	1985(1) - 2004(1)	Eurostat
MIG durable consumer goods industry	1990(1) - 2004(1)	Eurostat
MIG non-durable consumer goods industry	1985(1) - 2004(1)	Eurostat
MIG energy	1990(1) - 2004(1)	Eurostat
Electricity, gas and water supply	1985(1) - 2004(1)	ECB

Table 4: Data sources and description (2)

Variable/sector	Data sample	Source
Manufacturing	1985(1) - 2004(1)	Eurostat
Manufacture of food products and beverages	1985(1) - 2004(1)	Eurostat
Manufacture of tobacco products	1985(1) - 2004(1)	Eurostat
Manufacture of textiles	1990(1) - 2004(1)	Eurostat
Manufacture of wearing apparel; dressing and dyeing of fur	1990(1) - 2004(1)	Eurostat
Tanning and dressing of leather; manufact. of luggage etc.	1990(1) - 2004(1)	Eurostat
Manufacture of wood and products of wood and cork	1990(1) - 2004(1)	Eurostat
Manufacture of pulp, paper and paper products	1985(1) - 2004(1)	Eurostat
Publishing, printing and reproduction of recorded media	1985(1) - 2004(1)	Eurostat
Manufacture of coke, refined petroleum products and nuclear fuel	1985(1) - 2004(1)	Eurostat
Manufacture of chemicals and chemical products	1985(1) - 2004(1)	Eurostat
Manufacture of rubber and plastic products	1985(1) - 2004(1)	Eurostat
Manufacture of other non-metallic mineral products	1985(1) - 2004(1)	Eurostat
Manufacture of basic metals	1985(1) - 2004(1)	Eurostat
Manufacture of fabricated metal products	1985(1) - 2004(1)	Eurostat
Manufacture of machinery and equipment n.e.c.	1985(1) - 2004(1)	Eurostat
Manufacture of office machinery and computers	1985(1) - 2004(1)	Eurostat
Manufacture of electrical machinery and apparatus n.e.c.	1985(1) - 2004(1)	Eurostat
Manufacture of radio, television and communic. equipment	1990(1) - 2004(1)	Eurostat
Manufacture of medical, precision and optical instruments, etc.	1985(1) - 2004(1)	Eurostat
Manufacture of motor vehicles, trailers and semi-trailers	1985(1) - 2004(1)	Eurostat
Manufacture of other transport equipment	1985(1) - 2004(1)	Eurostat
Manufacture of furniture; manufacturing n.e.c.	1990(1) - 2004(1)	Eurostat

Table 5: Qualitative assessment of sector characteristics across the MIGs of industry

Sector	Openness			Degree of product differentiation	Price elasticity of demand	Other factors affecting degree of competition*
	export share	import share	share of imp. inputs			
Capital goods	high	high	medium	high	medium	-
Intermediate goods	medium	medium	medium	low	medium	-
Consumer goods	medium	medium	medium	high	low/medium	-
Energy	low	low	high	low	low	**

*E.g. degree of market segmentation or trade barriers.
**Market segmentation and oligopolistic market structures in some markets such as electricity.
Sources: Openness indicators: assessment based on input output table approx. for the euro area based on data for Germany, France, the Netherlands, Austria, Finland and Belgium for the year 2000; Degree of product differentiation: assessment based on *UNECE (2004)*; Price elasticity of demand: usually classified as medium; classified as low to medium for consumer goods based on the assumption of a low price elasticity for some consumer goods such as food and as low for energy assuming a generally low price elasticity for these goods.

Table 6: Impact and adjustment speed* of a one percent appreciation of the exchange rate of the euro on the HICP, GDP and value added in main economic sectors

Variable/sector	Size of response in			Adjustment speed share of response in			Statistical significance
	Q1	Q4	Q8	Q1	Q4	Q8	of responses
HICP	-0.03	-0.07	-0.14	20	52	100	sig.
GDP	-0.02	-0.11	-0.14	11	76	100	sig.
Real gross value added in:							
Trade/transportation services	-0.06	-0.17	-0.17	36	98	100	sig.
Financial/business services	-0.03	-0.08	-0.11	30	71	100	not sig.
Government related services	-0.01	-0.04	-0.06	25	73	100	not sig.
Agriculture	-0.01	-0.09	-0.10	-5	89	100	not sig.
Industry (excl. construction)	-0.03	-0.27	-0.18	15	151	100	sig.
Construction	0.06	-0.06	-0.06	-113	110	100	not sig.

*The adjustment speed is measured in terms of the share in the total effect that has materialised over different time horizons. The total effect is defined as the effect after two years.

Table 7: Impact and adjustment speed* of a one percent appreciation of the exchange rate on industrial production across sectors

Sector	Size of response in			Adj. speed share of resp. in			Stat. sign.
	Q1	Q4	Q8	Q1	Q4	Q8	
Total industry (excluding construction)	-0.07	-0.33	-0.40	17	83	100	sign.
Mining and quarrying	-	-	-	-	-	-	-
Manufacturing	-0.07	-0.43	-0.45	16	94	100	sign.
Manufacture of food products and beverages	-0.08	-0.01	0.00	91	6	100	not sign.
Manufacture of tobacco products	0.07	-0.42	-0.53	-13	80	100	sign. partly
Manufacture of textiles	-0.07	-0.60	-0.54	14	111	100	sign.
Manufacture of wearing apparel; dressing of fur	0.02	-0.20	-0.39	-6	53	100	not sign.
Tanning and dressing of leather; manuf. of luggage	-0.03	-0.47	-0.43	8	110	100	sign.
Manufacture of wood and products of wood and cork	-0.08	-0.45	-0.26	31	172	100	sign.
Manufacture of pulp, paper and paper products	-0.13	-0.35	-0.30	44	114	100	sign. partly
Publishing, printing and reprod. of recorded media	-0.10	-0.11	-0.12	85	90	100	not sign.
Manufacture of coke, refined petroleum products and nuclear fuel	0.32	0.03	-0.07	-422	-45	100	not sign.
Manufacture of chemicals and chemical products	-0.13	-0.34	-0.25	51	134	100	sign.
Manufacture of rubber and plastic products	-0.13	-0.44	-0.45	29	100	100	sign.
Manufacture of other non-metallic mineral products	-0.10	-0.37	-0.41	25	91	100	sign.
Manufacture of basic metals	-0.21	-0.78	-0.74	29	105	100	sign.
Manufacture of fabricated metal products	0.02	-0.29	-0.39	-6	73	100	not sign.
Manufacture of machinery and equipment n.e.c.	-0.11	-0.54	-0.81	14	67	100	sign.
Manufacture of office machinery and computers	-0.05	-0.72	-0.75	7	96	100	not sign.
Manufacture of electrical machinery and apparatus	-0.06	-0.49	-0.60	11	81	100	sign.
Manufacture of radio, television & communic. equip.	-0.15	-0.72	-0.78	19	93	100	sign.
Manufacture of medical, precision and optical instr.	-0.03	-0.31	-0.48	5	63	100	sign.
Manufacture of motor vehicles and trailers	0.13	-0.50	-0.51	-24	97	100	not sign.
Manufacture of other transport equipment	-0.06	-0.34	-0.38	15	89	100	not sign.
Manufacture of furniture; manufacturing n.e.c.	0.00	-0.26	-0.28	1	93	100	not sign.
Recycling	-	-	-	-	-	-	-
Electricity, gas and water supply	0.04	0.01	-0.02	-200	-50	100	not sign.
MIG intermediate goods industry	-0.15	-0.52	-0.52	29	99	100	sign.
MIG capital goods industry	-0.03	-0.47	-0.62	5	76	100	sign.
Consumer goods industry	-0.08	-0.16	-0.23	36	71	100	sign. partly
MIG durable consumer goods industry	-0.13	-0.39	-0.31	43	126	100	sign.
MIG non-durable consumer goods industry	-0.06	-0.13	-0.17	33	74	100	not sign.
MIG energy	0.16	0.17	0.16	97	105	100	not sign.

*The adjustment speed is measured in terms of the share in the total effect that has materialised over different time horizons. The total effect is defined as the effect after two years.

Table 8: Manufacturing sub-sectors grouped according to the size of the longer-term impact of a one percent appreciation of the exchange rate on activity

Group	Sector	Total impact*	Export share**	Import share**	MIG category
1	Manufacture of food products and beverages	0.00	21	20	nondur./interm.
1	Manufacture of coke, refined petroleum products and nuclear fuel	-0.07	24	27	energy
1	Publishing, printing, reprod. of recorded media	-0.12	11	10	nondur.
2	Manufacture of chemicals and chemical products	-0.25	53	50	interm./ nondur.
2	Manufacture of wood, products of wood, cork	-0.26	19	22	interm.
2	Manufacture of furniture; manufacturing n.e.c.	-0.28	34	33	dur./nondur.
2	Manufacture of pulp, paper and paper products	-0.30	39	37	interm.
2	Manufacture of other transport equipment	-0.38	55	51	capital/ dur.
2	Manufacture of wearing apparel, dressing, etc.	-0.39	30	47	nondur.
2	Manufacture of fabricated metal products	-0.39	18	14	interm./ capital
2	Manufacture of other non-metallic min. products	-0.41	21	17	interm.
2	Tanning and dressing of leather; manuf. of luggage	-0.43	54	55	nondur.
2	Manufacture of rubber and plastic products	-0.45	35	31	interm.
2	Manufacture of medical, precision, etc.	-0.48	43	45	capital/ dur.
3	Manufacture of motor vehicles, trailers, semi-trailers	-0.51	48	41	capital
3	Manufacture of tobacco products	-0.53	39	35	nondur.
3	Manufacture of textiles	-0.54	43	39	interm./ nondur.
3	Manufacture of electrical machinery and apparatus	-0.60	38	35	capital/ interm.
3	Manufacture of basic metals	-0.74	44	48	interm.
3	Manufacture of office machinery and computers	-0.75	47	76	capital
3	Manufacture of radio, television, communic. equip.	-0.78	51	53	capital/ interm.
3	Manufacture of machinery and equipment	-0.81	51	38	capital.

*The total impact is defined as the impact after two years.

**Export and import shares in %.

Table 9: Impact and adjustment speed* of a one percent appreciation of the exchange rate on producer prices across sectors

Sector	Size of response in			Adj. speed share of resp. in			Stat. sign.
	Q1	Q4	Q8	Q1	Q4	Q8	
Total industry (excluding construction)	-0.05	-0.23	-0.26	17	86	100	sign.
Mining and quarrying	-	-	-	-	-	-	-
Manufacturing	-0.05	-0.21	-0.19	25	110	100	sign.
Manufacture of food products and beverages	-0.03	-0.18	-0.23	14	78	100	sign.
Manufacture of tobacco products	0.05	0.13	0.26	19	52	100	not sign.
Manufacture of textiles	-0.02	-0.20	-0.30	7	66	100	sign.
Manufacture of wearing apparel; dressing of fur	-0.01	-0.04	-0.08	16	52	100	sign. partly
Tanning and dressing of leather; manuf. of luggage	-0.03	-0.12	-0.30	10	39	100	sign.
Manufacture of wood and products of wood and cork	0.00	-0.09	-0.15	1	60	100	not sign.
Manufacture of pulp, paper and paper products	0.02	-0.21	-0.48	-3	44	100	not sign.
Publishing, printing and reprod. of recorded media	0.01	-0.04	-0.11	9	38	100	not sign.
Manufacture of coke, refined petroleum products and nuclear fuel	-0.41	-1.35	-0.63	64	213	100	sign.
Manufacture of chemicals and chemical products	-0.02	-0.26	-0.22	11	121	100	sign.
Manufacture of rubber and plastic products	0.02	-0.04	-0.11	-20	37	100	not sign.
Manufacture of other non-metallic mineral products	0.01	-0.04	-0.11	-13	35	100	not sign.
Manufacture of basic metals	-0.16	-0.52	-0.43	37	123	100	sign.
Manufacture of fabricated metal products	0.00	-0.06	-0.12	1	51	100	not sign.
Manufacture of machinery and equipment n.e.c.	0.01	0.02	-0.03	-38	-56	100	not sign.
Manufacture of office machinery and computers	-0.03	-0.27	-0.30	10	91	100	not sign.
Manufacture of electrical machinery and apparatus	0.00	-0.02	-0.07	4	32	100	not sign.
Manufacture of radio, television & communic. equip.	-0.05	-0.15	-0.15	31	106	100	sign.
Manufacture of medical, precision and optical instr.	0.00	-0.03	-0.06	-5	55	100	not sign.
Manufacture of motor vehicles and trailers	0.01	0.03	0.02	48	164	100	not sign.
Manufacture of other transport equipment	-0.02	0.00	0.01	-200	48	100	not sign.
Manufacture of furniture; manufacturing n.e.c.	-0.01	-0.04	-0.09	14	40	100	sign. partly
Recycling	-	-	-	-	-	-	-
Electricity, gas and water supply	-0.05	-0.41	-0.71	7	57	100	sign.
MIG intermediate goods industry	-0.03	-0.23	-0.17	21	134	100	sign.
MIG capital goods industry	0.00	-0.01	-0.04	1	29	100	not sign.
Consumer goods industry	-0.01	-0.10	-0.16	4	66	100	sign.
MIG durable consumer goods industry	-0.01	-0.05	-0.14	10	36	100	sign.
MIG non-durable consumer goods industry	-0.01	-0.11	-0.16	4	67	100	sign.
MIG energy	-0.23	-0.61	-0.68	33	90	100	sign.

*The adjustment speed is measured in terms of the share in the total effect that has materialised over different time horizons. The total effect is defined as the effect after two years.

Table 10: Manufacturing sub-sectors grouped according to the size of the longer-term impact of a one percent appreciation of the exchange rate on producer prices

Group	Sector	Total impact*	Imp. input share**	MIG category
1	Manufacture of tobacco products	0.26	19	nondur.
1	Manufacture of motor vehicles, trailers, semi-trailers	0.02	20	capital
1	Manufacture of other transport equipment	0.01	26	capital/ dur.
1	Manufacture of machinery and equipment n.e.c.	-0.03	17	capital.
1	Manufacture of medical, precision, optical instruments	-0.06	14	capital/ dur.
1	Manufacture of electrical machinery and apparatus n.e.c.	-0.07	16	capital/ intermed.
1	Manufacture of wearing apparel, dressing, dyeing of fur	-0.08	18	nondur.
1	Manufacture of furniture; manufacturing n.e.c.	-0.09	17	dur./nondur.
1	Manufacture of other non-metallic mineral products	-0.11	10	intermed.
1	Manufacture of rubber and plastic products	-0.11	22	intermed.
1	Publishing, printing and reproduction of recorded media	-0.11	10	nondur.
1	Manufacture of fabricated metal products	-0.12	13	intermed./ capital
1	Manufacture of radio, television and communic. equipm.	-0.15	25	capital/ intermed.
1	Manufacture of wood and products of wood and cork	-0.15	14	intermed.
2	Manufacture of chemicals and chemical products	-0.22	26	intermed./ nondur.
2	Manufacture of food products and beverages	-0.23	13	nondur./intermed.
2	Manufacture of office machinery and computers	-0.30	41	capital
2	Manufacture of textiles	-0.30	21	intermed./ nondur.
2	Tanning and dressing of leather; manufact. of luggage	-0.30	19	nondur.
2	Manufacture of basic metals	-0.43	30	intermed.
2	Manufacture of pulp, paper and paper products	-0.48	21	intermed.
3	Manufacture of coke, refined petroleum products and nuclear fuel	-0.63	64	energy

*The total impact is defined as the impact after two years.

**Share of imported inputs in output in %.

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