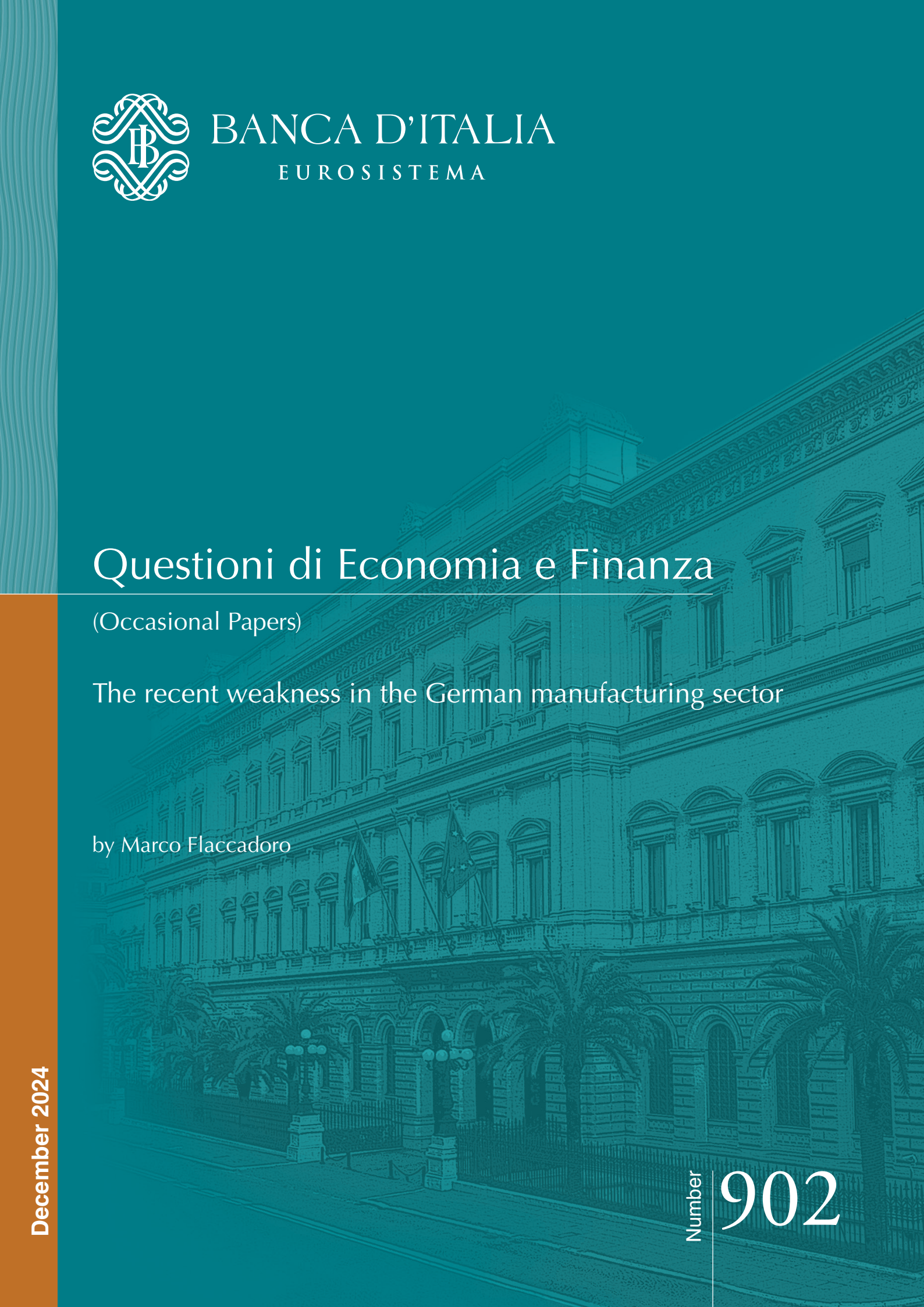

BANCA D'ITALIA
EUROSISTEMA

# Questioni di Economia e Finanza

(Occasional Papers)

## The recent weakness in the German manufacturing sector

by Marco Flaccadoro

December 2024

Number 902

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# THE RECENT WEAKNESS IN THE GERMAN MANUFACTURING SECTOR

by Marco Flaccadoro*

**Abstract**

This paper studies the weaknesses of the German manufacturing sector in recent years. Three factors weigh more heavily there than in the rest of the euro area. First, higher gas prices penalized German energy-intensive manufacturing firms more than those of other countries, owing to the German chemical sector's greater reliance on gas and strong interconnections with other energy-demanding industries. Second, the impact of weak global demand was stronger in Germany due to its higher trade openness. Third, the automotive sector – which has suffered a lacklustre demand since 2018, also as a result of the uncertainties surrounding the transition to electric vehicles and of the increasing competition from Chinese car manufacturers – is twice as relevant for manufacturing in Germany than for the euro area as a whole. An econometric analysis shows large spillovers from the German industry to the manufacturing sectors of other euro-area economies. All three of these root causes of German manufacturing weakness could have long-lasting effects if they remain unaddressed.

**JEL Classification**: E23, E31, E32, F10.

**Keywords**: German economy, energy prices, foreign demand, industrial sector.

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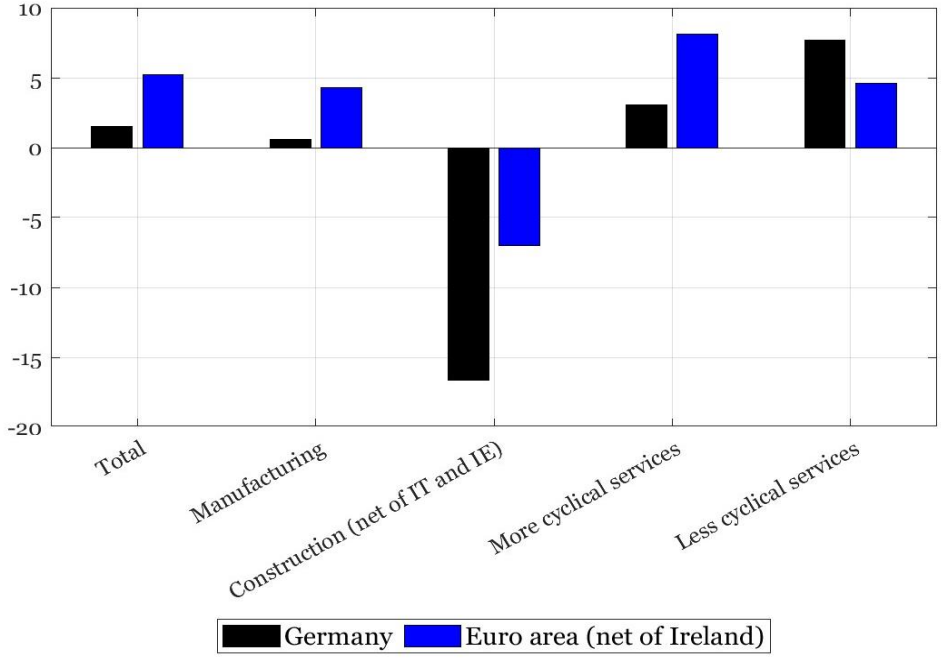
## 1. Introduction[1]

In the aftermath of the pandemic crisis, the German economy significantly underperformed the rest of the euro area (Fig. 1). During the period 2019Q4 – 2024Q2, the weakness involved all major sectors of activity but for different reasons. Construction suffered from a particularly sharp downturn in the real estate cycle that originated both in the higher funding costs due to higher interest rates, which likely affected demand for construction work (Dieckelmann et al., 2023), and in the sudden reversal of house prices.[2]

**Figure 1. Value added growth**

(*2024Q2 vs 2019Q4; per cent*)




*Source*: Eurostat and author's calculations.
*Note*: seasonally and calendar adjusted; chain-linked volume. More cyclical services are: trade, transport, accommodation and food services, financial and insurance activities, information and communication, professional, scientific and technical activities and arts, entertainment and recreation. Less cyclical services are: real estate activities and public administration, defence, education and health services. Without netting for the idiosyncratic dynamics in Italy (+42.0%), due to exceptional fiscal incentives, euro area (net of IE) construction value added increased by 2.2% in the considered period.

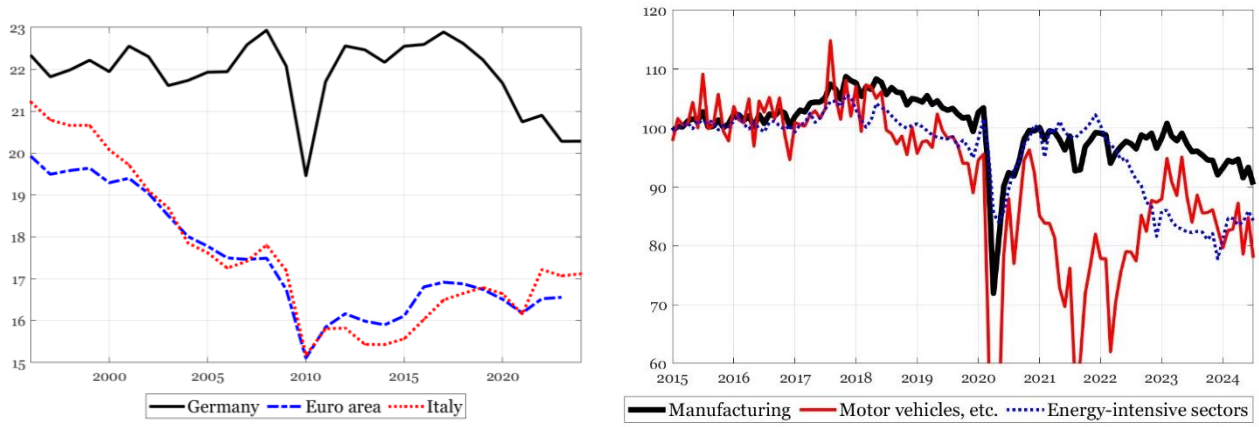
[1] I thank Andreas Worms and the Bundesbank colleagues for insightful comments. I am also grateful to Matteo Alpino, Valentina Aprigliano, Lorenzo Bencivelli, Donato Ceci, Luca Citino, Emidio Cocozza, Francesco Corsello, Andrea Foschi, Marco Fruzzetti, Andrea Orame, Stefano Neri, Marianna Riggi, Tiziano Ropele, Alessandro Secchi, Luigi Federico Signorini, Fabrizio Venditti, Stefania Villa, Achim Wambach, Giordano Zevi and Roberta Zizza for useful suggestions. The opinions expressed in this paper are those of the author and do not necessarily reflect the views of the Bank of Italy.

[2] House prices fell by 12% in Germany from their peak in 2022Q2 up to 2024Q2; in the euro area, they declined by -1.2%, in France (from 2022Q2) by -6.5%; in Italy and Spain prices kept increasing. Conversely, prices had risen by 70% in Germany since early 2013, against 50% in the euro area as a whole.

Growth in more cyclical services[3] was positive but feeble, as Germany did not benefit greatly from the recovery in the travel and accommodation sector which pushed up value added in the other large euro area countries also due to the brisk recovery in tourism.[4] Finally, manufacturing value added was stagnant when measured over the whole period, but it has contracted almost uninterruptedly in the last quarters. The weakness of the industrial sector in Germany is a reason for concern for the whole euro area: given the tight integration of manufacturing activity across euro area economies and the centrality of German companies in European value chains[5], developments in the German manufacturing sector may generate significant externalities to other euro area countries.[6,7]

**Figure 2. a) Share of manufacturing on total value added and b) German manufacturing production indices**

(*per cent and 2015Q1=100*)




*Source*: Eurostat and author's calculations. *Note*: panel a): last observations: 2022 for the euro area, and 2023 for Germany and Italy. Panel b): the industrial production index relating to the energy-intensive industries is computed using the following sectors (NACE 2-digit classification): C17, manufacture of paper and paper products; C20, manufacture of chemical and chemical products; C23, manufacture of other non-metallic mineral products; and C24, manufacture of basic metals. All data are seasonally adjusted. Last observation: July 2024.

[3] Based on the volatility of q-o-q growth rates, more cyclical services are: trade, transport, accommodation and food services, financial and insurance activities, information and communication, professional, scientific and technical activities and arts, entertainment and recreation. Less cyclical services are: real estate activities and public administration, defence, education and health services.

[4] Value added in wholesale trade, transport, accommodation and food services rose by 6.2% and 4.6% in Spain and Italy, respectively, while it decreased by -0.6% in France and -3.4% in Germany.

[5] See e.g. Amador, et al. (2015).

[6] A thorough spillover analysis is conducted in Section 5, according to the procedure of Diebold and Yilmaz (2009).

[7] The German manufacturing share of value added remained relatively stable from the late 90s up to the Covid-19 crisis; on the contrary, it declined in the euro area over the same time span (it stood at 22.1% and 17.6% for Germany and for the area, respectively, on average for the period 1995-2019). However, differently from other large euro area economies (e.g. Italy), the strong drop relating to the pandemic has not yet been fully recovered, leading to a substantial reduction in the manufacturing share in the post-pandemic period (20.3% for Germany in 2023, and 16.6% for the area in 2022).

The focus of this paper is to cast light on the causes of the recent weakness in the German manufacturing sector in the past few years and to study the spillover effects on the other euro area economies.[8]

The paper highlights three main causes (Fig. 2, panel b). First, the energy price surge in Europe, mostly due to the Russian invasion of Ukraine. This affected manufacturers more severely in Germany than in other large area economies, owing to the higher dependence on gas of German energy-intensive industries. This reflects in particular the high energy intensity of the chemical sector due to its technological characteristics and its strong interconnection with other energy-intensive sectors. Second, the subdued global demand for industrial goods hit manufacturing firms in Germany more severely than elsewhere, due to their greater exposure to foreign demand with respect to their euro area peers. Third, a very specific weakness concerns the motor vehicle sector, which accounts for a larger share of manufacturing activity in Germany than in the euro area as a whole (16% vs 9%). The industry has been subject to idiosyncratic lacklustre demand, uncertainties connected to the transition to electric vehicles production also due to regulatory uncertainty, and increasing competition from Chinese carmakers.

The paper analyses the linkages across euro area manufacturing sectors using the approach developed by Diebold and Yilmaz (2009). In particular, spillovers are quantified through a variance decomposition based on a vector autoregressive model (VAR) estimated using monthly data on manufacturing production for a sample of nine large euro area economies. The spillover from country *i* to country *j* is measured as the fraction of the forecast error variance at a six-month horizon in country *j* due to shocks originated in country *i*. The results show that the spillovers from the German industry to the manufacturing sector of other euro area economies are large. In particular, the shocks originated in the German industrial sector explain roughly 30, 15 and 10 per cent of the forecast error variance of the Italian, French and Spanish manufacturing activity, respectively, six months after the shock. Conversely, shocks originated in the industrial sector of these countries explain up to 11 per cent of the forecast error variance of German manufacturing activity in the same horizon.

Looking forward, the causes of the manufacturing weakness indicated above could be long-lasting: EU gas prices are set to remain above 2021 levels until at least early 2026, according to recent Endex TTF future contracts (Fig. A.4); foreign demand is subdued, consistent with order PMI showing a contraction in total and foreign orders (Fig. A.5), and geopolitical developments are not promising;

[8] Popular press and policy debates often point out how the Germany's "business model" revolved around a strong manufacturing-based economy supported by cheap Russian gas and foreign demand for its industrial goods, which are now both in a possibly structural crisis. However, doubts over the German business model were also raised in the early 2000s, before the Hartz labour market reforms which proved highly successful.

the automotive sector will likely keep suffering from regulatory uncertainty and the incomplete transition to Electric Vehicle (EV) production for an extended period of time.[9]

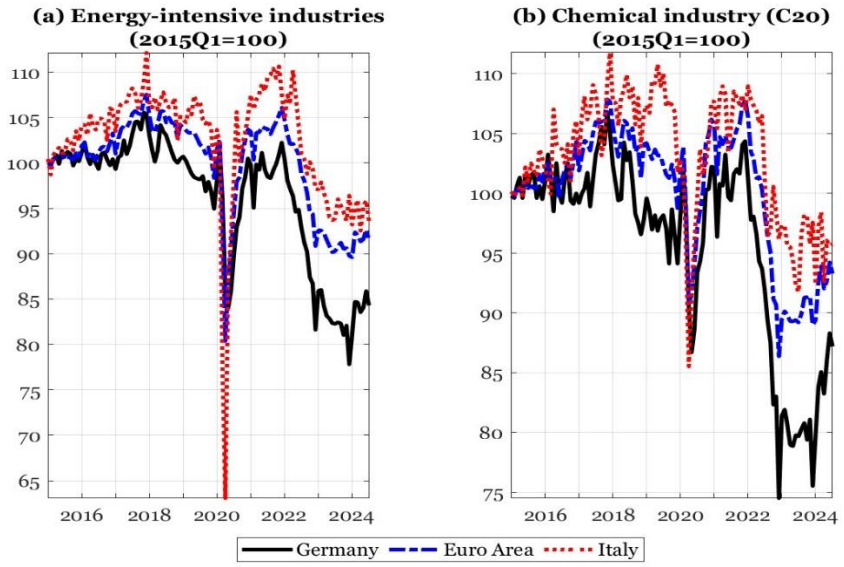
The remainder of the paper is organized as follows. Section 2 looks at the impact of the recent energy crisis on German manufacturers. Section 3 delves into the effects of lacklustre demand conditions. Section 4 focuses on the persistent weakness in the automotive sector. Section 5 shows the results of the spillover analysis, measuring the impact of German manufacturing weakness on euro area economies. Section 6 briefly concludes.

## 2. The energy crisis

The gas and electricity price surge hit manufacturers more severely in Germany than in the other large euro area economies. Looking at non-household heavy energy users, gas and energy prices started to increase in 2021 and jumped in 2022 with the outbreak of the conflict in Ukraine. Since then, amidst repeated tensions and fears of shortages, they have gradually declined in Germany and across the euro area overall, but they have remained well above their pre-crisis levels, also in the first part of the current year.

**Figure 3. Production in energy-intensive sectors**

(*2015:Q1=100*)



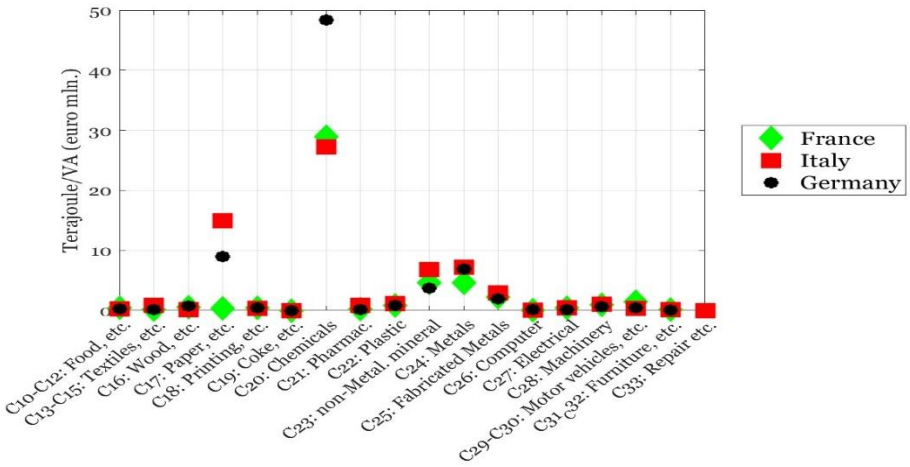

*Source*: Eurostat and author's calculations.
*Note*: the industrial production index relating to the energy-intensive industries is computed using the following sectors (NACE 2-digit classification): C17, manufacture of paper and paper products; C20, manufacture of chemical and chemical products; C23, manufacture of other non-metallic mineral products; and C24, manufacture of basic metals. All data are seasonally adjusted. Last observation: July 2024.

[9] For an analysis of the euro area car industry, see also De Santis et al. (2024).

There were no significant differences in firms' energy costs between Germany and the euro area (Fig. A.1). Instead, it is plausibly the higher intensity of gas consumption in Germany's gas-intensive industries that disrupted production there more than in other euro area countries (Fig. 3, panel a), particularly so in the chemical sector (Fig. 3, panel b). Indeed energy-intensive industries – i.e. those displaying a relatively high natural gas content in their production process[10] – account for a similar share of manufacturing in Germany and in the euro area overall (Tab. A.1). However, the German chemical sector is more reliant on natural gas as an intermediate input than in other euro area countries because of its technological characteristics (Fig. 4).[11] Furthermore, an analysis of sectorial interdependencies shows that the chemical sector exerts large spillovers on the other energy-intensive sectors.[12] As a result, the German energy intensive sector as a whole have been hit harder by increases in energy prices through their impact on the chemical industry. Thus, it is not surprising that the overall output of the energy-intensive industries has fallen more sharply in Germany than in other major euro-area economies.

**Figure 4. Natural gas consumption in manufacturing**

(*2021 data*)




*Source*: Eurostat and author's elaboration.
*Note*: the intensity in natural gas usage in manufacturing subsectors (NACE 2-digit level) is measured based on the ratio between the sectoral gas consumption (Terajoule) and value added (millions of euro).

[10] The energy content of the production process for each industry is based on the ratio between the sectorial gas consumption and value added (Fig. 4). According to this approach, paper and paper products (C17 in the NACE classification), chemicals and chemical products (C20), other non-metallic mineral products (C23) and basic metals (C24) show a relatively higher gas consumption share than the other industries and, thus, are classified as energy-intensive.

[11] Fig. 4 posits that energy intensity is largely a technological characteristic, which applies to countries with a similar level of development; a more thorough discussion on the short and medium run substitutability of the productive factors, including energy, is in Bachmann et al. (2022) and in the ensuing debate following such paper, well summarized in Lan et al. (2022). For a thorough analysis of the impact of bottlenecks and energy crisis on the Italian industrial sector, see Corsello et al. (2022).

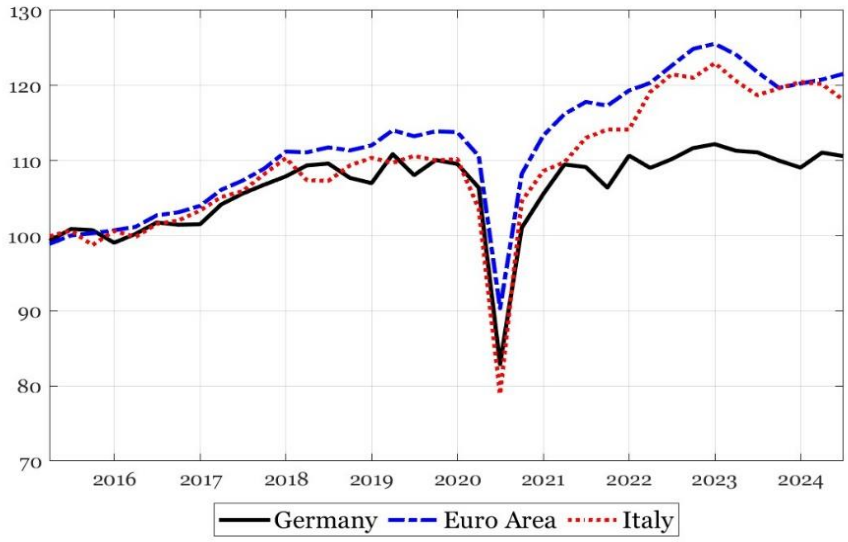
[12] The spillover analysis builds on Diebold and Yilmaz (2009) and is presented in section 5. The large impact of the chemical sector on other energy intensive sectors holds true both for Germany and the euro area as a whole.

## 3. Demand conditions

German manufacturing firms have suffered more than those in the rest of euro area from weak global demand, due to their greater trade openness.[13] The effect was compounded by the deterioration of their competitiveness. In 2023 goods exports accounted for 34% of GDP in Germany, against 27% in Italy and 23% in France;[14] furthermore Germany's goods exports were more tilted towards China (6.1% of total goods exports, compared to 4.2% in France and 3.1% in Italy). Due to greater openness, Germany was more exposed to the post-pandemic increase in trade fragmentation. Furthermore, over the period 2019Q4-2024Q2, the unit labour cost in the industrial sector increased more in Germany than in other large euro-area economies (19.9% in Germany, 17.3% in Italy, and 17.1% in France). Accordingly, price competitiveness indicators computed by the Bank of Italy show a deterioration for German manufacturers since mid-2022 with respect to other euro area countries, associated with the increase in energy costs and, later, the faster wage dynamics.

**Figure 5. German export of goods**

(*2015=100*)




*Source*: Eurostat (National Accounts), and author's elaborations.
*Note*: chain-linked values; last observations: 2024Q2.

Consistently, German exports of goods have lost momentum: after increasing in the aftermath of the pandemic crisis, they started to flatten in the second half of 2022, stabilizing to pre-pandemic values

[13] In the post-pandemic period Germany was additionally affected by weak domestic demand for industrial goods, resulting also from the decline in overall economic investments, which was more pronounced in Germany than in the euro area as a whole (-7.1% in Germany in 2024Q2 with respect to the 2019 average; compared with -2.3% in the euro area). Moreover, the recent weakness in the construction sector in Germany has presumably led to a significant drop in demand for industrial intermediate goods and construction-specific capital goods.

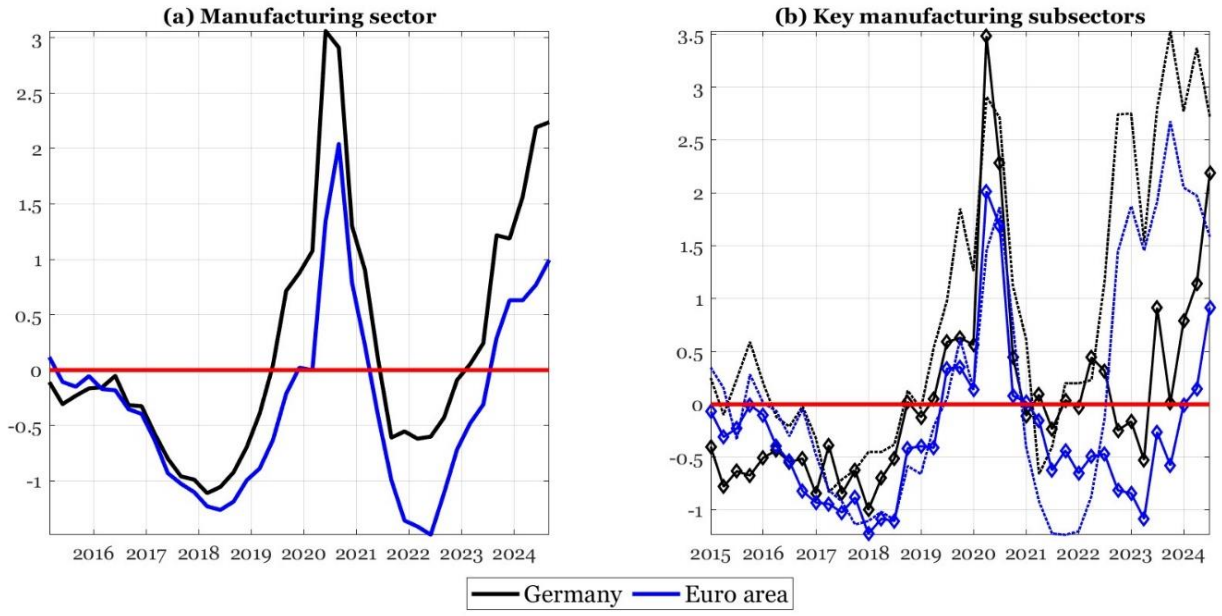
[14] In the EU the main trade partners of Germany are France and Italy, which in 2023 accounted for 7.6% and 5.5% of its total goods export. The share of Italian goods export to Germany amounted to 12.0% and goods imports from Germany to 15.5% of total Italian imports.

at the beginning of 2024 (Fig. 5). On the contrary, in the same period, euro area exports increased roughly 7% above their pre-pandemic level. According to recent analyses (e.g. Schumacher, 2024), the outlook for German exports remains weak due to an expected increase in competition from Chinese companies and the impacts from an increasingly fragmented world, with a dis-entanglement from China.

Qualitative data for manufacturing firms help assess the impact on the sector felt through trade. European Commission (EC) surveys show that the negative difference in assessment of export order-book levels between Germany and the average of the euro area is the highest since the early 2000's and the gap has been rapidly enlarging since the end of 2022. The EC surveys also report a progressive deterioration in the competitiveness of manufacturing firms, both inside and outside the EU, which is greater for firms in Germany than in the euro area as a whole (Fig. A.2). This trend has accelerated in the aftermath of the pandemic crisis and is particularly marked in the chemical and motor vehicle sectors.

**Figure 6. Factor limiting production: insufficient demand**

(*percentage balances; standardized, with 2000-2019 avg. and std.*)




*Source*: Eurostat and author's elaborations.
*Note*: (a) Firms reporting insufficient demand as factor limiting production in the manufacturing sector overall. (b) Firms reporting insufficient demand as factor limiting production in the following subsectors: (i) chemical (C20, dashed line); (ii) motor vehicles (C29, diamond line). Seasonally adjusted balances standardized considering the historical average and the standard deviation computed for the period 2000Q1-2019Q4; last observation: 2024Q3.

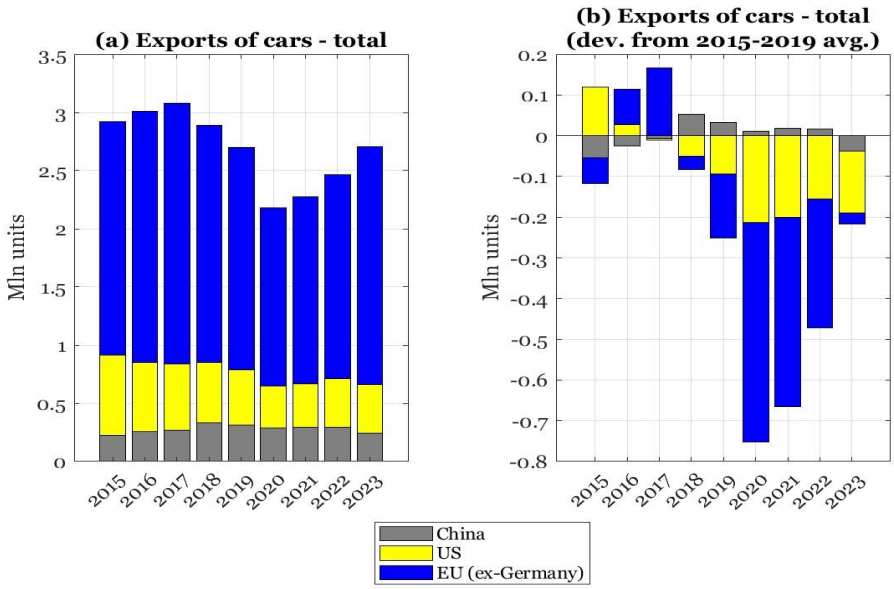
Finally, according to the EC surveys, in the past two years the share of euro area firms reporting insufficient demand as a factor limiting production has risen well above its historical average, and more strongly so for manufacturing firms operating in Germany (Fig. 6, panel a). This increase has

been more pronounced for German firms across a broad set of industries; including the chemical and auto sectors (Fig. 6, panel b).[15]

## 4. Automotive sector

The third factor is the downturn in the automotive industry, whose weight is especially relevant in Germany.[16] This sector is affected by low demand and increasing competition from Chinese carmakers.[17] Accordingly, quantitative demand-side indicators for the motor vehicle sector are consistent with a lacklustre domestic demand for cars, and show a downward trend in car registrations in all the euro area countries (Fig. A.3).[18] In addition, German exports of vehicles remained weak in the aftermath of the pandemic crisis, reaching in 2023 a level still below the 2015-19 average (Fig. 7, panel a),[19] with a negative contribution of the exports to China, US and the European Union (ex-Germany; Fig. 7, panel b).

**Figure 7. German exports of cars - units**



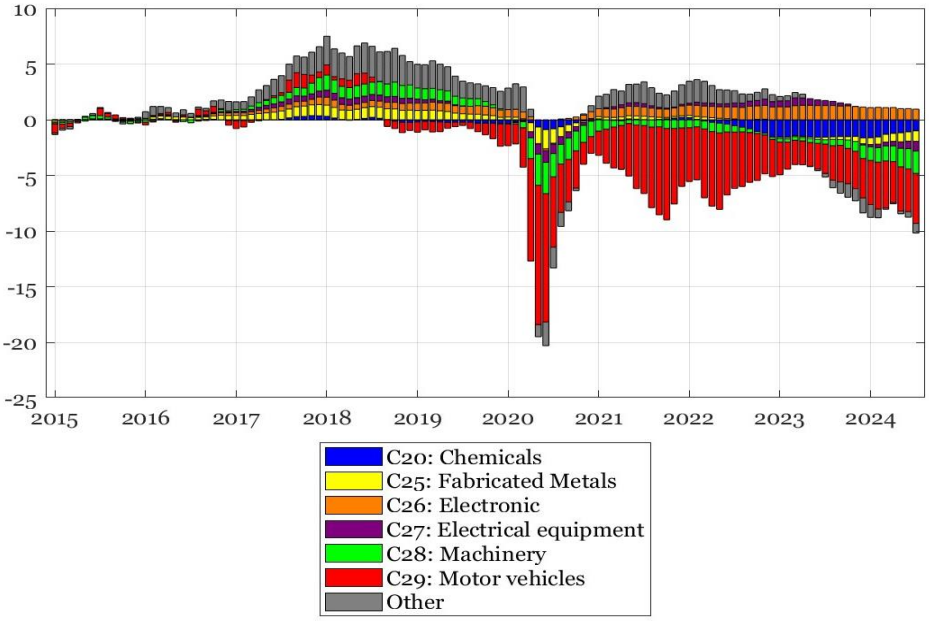

*Source*: CEIC, and author's elaborations.
*Note*: data includes vehicles with: spark-ignition internal combustion piston engine, compression-ignition internal combustion piston engine (i.e. diesel), electric motor propulsion, and others. Unit of measure: millions of car units.

[15] These subsectors account for 50% of total German manufacturing production (38% in the euro area; Table A.1).
[16] For a thorough analysis of the recent developments in Germany's automotive industry, see Deutsche Bundesbank (2024).
[17] As of 2023, Germany is the major car producer in the European Union (4.1 million cars) – well above the levels of other large euro area countries, such as Spain (1.9), France (1.0) and Italy (0.5) –, according to the International Organization of Motor Vehicle Manufacturers (OICA).
[18] Orame et al. (2024) provide a detailed assessment of the structural dynamics in the Italian automotive sector.
[19] In the average of January 2014 - June 2024, car exports represented roughly the 78% of total domestic car production in Germany, according to national producer association (VDA). This figure does not account for inventories, which may affect the relationship between production and exports.

Al-Haschimi et al. (2024) show that between 2019 and 2023, the euro area car industry faced adverse developments in its relative producer prices and a reduction in market shares with respect to Chinese manufacturers.[20] In particular, China is a fierce competitor for European car manufactures,[21] as its low-cost electric vehicles (EV) are exported to Europe in large numbers.[22] Given that the EU represents the most important market for the exports of German EVs (85% of exports, almost USD 20 billion), China represent a critical source of competitions for German carmakers.

**Figure 8. Contributions to the change vs 2015 of the manufacturing index**

(*per cent and percentage points*)




*Source*: Eurostat and authors' calculations.
*Note*: three-month moving averages. For each reference month, each bar represents the contribution (in percentage points) of the subsector to the deviation of the manufacturing index with respect to its level in 2015. For example, in July 2024 the manufacturing index is roughly 10 percent lower than its 2015 average, with a negative contribution of the car sector (C29) of almost 5 percentage points. All data are seasonally adjusted. Last observation: July 2024.

Finally, recent developments in the regulatory framework have sparked further uncertainty for car producers, both in Germany and in the EU. First, duties on the imports of electric vehicles from China, imposed by the European Commission in October 2024, could possibly induce some retaliation, dampening European car exports. Second, the potential re-opening of the 2035 zero-

[20] Since 2017, Germany has experienced a reduction in its market shares for motor vehicle products in several countries, owing to also the rising competitive pressure from China (Deutsche Bundesbank, 2024).
[21] Increased Chinese competition to German and Italian firms has been pointed out recently by Schnabel (2024).
[22] According to Inagaki et al. (2024), Chinese manufacturers are building advanced electric vehicles with costs 30 per cent lower than those of European carmakers. This is also due to its strategic control of the global supply chains relating to the critical inputs for EV technologies. For instance, China is the world largest producer of lithium-ion batteries, with an over-capacity with respect to the global demand for batteries.

emission target for new cars and vans, which was adopted by the European Commission in March 2023 within the "Fit for 55" deal,[23] may induce EU households to postpone spending.

As a consequence, the sectorial production index has exhibited a downward trend in Germany since 2018. Given its relevant weight in the overall index (16.2% in Germany; compared to 8.8% in the euro area), the decline in motor vehicle production has strongly affected the development of manufacturing activity in Germany (Fig. 8), especially during the bottleneck crisis in 2021.

## 5. Spillover analysis

We now present the results of a spillover analysis that allows us to quantify the interdependence of manufacturing activity across the main euro area economies. In particular, we follow the approach of Diebold and Yilmaz (2009) and measure spillovers via the variance decomposition associated with a vector autoregressive (VAR) model. We estimate our VAR model on monthly data relating to total and sectorial manufacturing production indices for the main euro area economies, which are previously detrended with the filter proposed by Hodrick and Prescott (1997) to ensure stationarity.[24,25] We use one lag of the endogenous variables, according to standard information criteria.

**Table 1. Manufacturing sector spillovers**
(January 2010 - December 2019; 6-months horizon)

| to\from | DE | IT | FR | ES | NL | BE | AT | FI | PT |
|---|---|---|---|---|---|---|---|---|---|
| DE | 74.1 | 11.1 | 1.6 | 6.6 | 0.1 | 0.8 | 5.1 | 0.6 | 0.1 |
| IT | 30.9 | 51.3 | 4.2 | 9.3 | 1.4 | 0.3 | 1.5 | 0.9 | 0.0 |
| FR | 16.1 | 10.1 | 51.5 | 11.6 | 3.9 | 0.2 | 4.5 | 1.1 | 1.0 |
| ES | 10.5 | 17.7 | 14.3 | 50.5 | 1.3 | 0.1 | 0.1 | 5.2 | 0.3 |
| NL | 24.3 | 6.5 | 1.7 | 1.1 | 63.0 | 1.1 | 2.3 | 0.0 | 0.1 |
| BE | 10.9 | 2.3 | 2.2 | 1.5 | 3.4 | 78.6 | 0.7 | 0.2 | 0.2 |
| AT | 31.9 | 9.7 | 1.8 | 1.3 | 0.3 | 0.4 | 54.2 | 0.1 | 0.3 |
| FI | 18.9 | 3.0 | 0.9 | 2.0 | 0.3 | 0.4 | 2.5 | 68.5 | 3.5 |
| PT | 14.3 | 10.3 | 3.1 | 5.4 | 3.8 | 1.7 | 2.9 | 3.4 | 55.2 |

*Source*: Eurostat and author's elaborations. *Note*: the underlying forecast error variance decomposition is based upon a monthly VAR with 1 lag, identified using a Cholesky procedure with the ordering as displayed in the column heading. The (i, j)-th value is the estimated contribution to the forecast error variance of the cyclical component of the manufacturing production index of country i coming from innovations to the manufacturing production index of country j. The mnemonics are defined as follows: DE (Germany); IT (Italy); FR (France); ES (Spain); NL (Netherlands); BE (Belgium); AT (Austria), FI (Finland), and PT (Portugal). The cyclical component of the manufacturing production index is obtained by applying the HP filter.

[23] Regulation (EU) 2019/631 strengthens the CO2 emission performance standard for new cars and light commercial vehicle, prohibiting to sell internal combustion engine by 2035.

[24] The Hodrick and Prescott (1997) filter is applied on the full sample, January 2000 – July 2024, to ensure that its parameters are estimated on the whole set of available information. The stationarity of the detrended series is verified with the standard test of Dickey and Fuller (1979).

[25] Our results are qualitatively similar to an alternative approach to ensure stationarity, based on first-differencing the log of the manufacturing production series.

Our baseline VAR focuses on the period January 2010-December 2019, to avoid our results being affected by the global financial crisis and the pandemic-related disruption to economic activity, and uses data referring to the manufacturing production index of nine economies (Germany, Italy, France, Spain, Netherlands, Belgium, Austria, Finland, and Portugal). We estimate a first-order, covariance-stationary VAR model:

$$x_t = \Phi x_{t-1} + \varepsilon_t,$$

where $\varepsilon_t$ is the reduced form error; structural innovations, $u_t = Q\varepsilon_t$, are identified by applying a lower-triangular Cholesky factor of the covariance matrix of the reduced form errors, Q. Obviously, our identification strategy crucially relies on the ordering of the variables in the VAR, which follows the country share in the euro area manufacturing production. This simple and intuitive rule is consistent with considering the German manufacturing activity as more exogenous compared to that of other euro area countries. In simpler terms, according to this approach, (exogenous) changes in German manufacturing activity may exert an impact within the same month on manufacturers in other euro area economies, while the opposite it is not true.[26] Then, we use our econometric setup to measure the forecast error variance decomposition associated with the identified shocks, referring to the exogenous innovations in the manufacturing sector of each country. Finally, we estimate the spillovers from country *i* to country *j* as the fraction of the forecast error variance decomposition at a six-month horizon in country *j* due to shocks originated in country *i*.[27]

As shown in Table 1, the spillovers from the German industry to the manufacturing sector of other euro area economies (see values in the first column) are large.[28] In fact, the shocks originated in the German industrial sector explain almost 31 per cent of the forecast error variance of the Italian manufacturing activity six months later; while, shocks originated in the Italian manufacturing sector explain roughly 11 per cent of the variability in German industrial activity.[29] Large spillover effects from Germany are also sizable for France and Spain; while the innovations originating in these two countries determine more attenuated spillovers in the German manufacturing sector.

We investigate the robustness of our results across several dimensions. First, we extend the period of analysis up to July 2024, the latest available data. Including the Covid-19 period into the estimation

[26] Our internal-instrument identification approach, although widely used in the literature and intuitive, is rather strong. As for future works, it would be interesting to analyse the robustness of our baseline results to alternative identification strategies. We thank Andreas Worms and the Bundesbank colleagues for highlighting this relevant issue.

[27] The results are robust upon considering different horizons (e.g. 3, 9, 12 months) for the spillover analysis.

[28] Cross-country spillovers are shown in the matrix elements off the main diagonal. For each country, the row-wise sum of the contributions adds up to 100. The numbers on the main diagonal indicate the contribution of the shock in country *i* to the same country *i*.

[29] Similar results are obtained by Istat (2024) with indicators calculated on intermediate good production data in 2020, showing that Italy's dependence on Germany is 2.5 times greater than Germany's dependence on Italy.

is challenging, as it requires controlling for the "spurious" correlation across variables, due to the wide-spread economic disruption. We resort to a simple and intuitive approach, by inserting an (exogenous) dummy for each month in the period March 2020 – December 2020.[30] Our baseline findings are largely confirmed for the period January 2010 – July 2024 (Table A.2), though somewhat smaller in magnitude. This was expected, as the large shocks occurring in the most recent years (e.g. bottlenecks, energy crisis), and the heterogeneous government responses, may have induced a profound change in firms' strategies in the euro area economies, thus attenuating cross-country sectorial linkages. Second, we extend the period of estimation backward up to January 2000. We control for the spurious correlation across variables, owing to the Global Financial Crisis, by inserting an (exogenous) dummy for each month in the period December 2007 – June 2009. The results are broadly in line with the baseline (Table A.3). Third, we control for developments outside the euro area, adding either the US or Chinese production index in our VAR model. This exercise allows us to discriminate between common shocks, affecting all euro area economies (e.g. spillovers from the US), and idiosyncratic shocks, affecting only a single country. Even including the US or Chinese production index in the VAR, the results of the spillover analysis from Germany to the rest of euro area countries remain robust.[31]

We apply the same approach to the main industrial groupings (MIGs), showing that spillovers are large for capital, intermediate and durable-consumption goods, while are more attenuated for non-durables (Tables A.4 - A.7). This is not surprising, as it confirms the significant role of investment and durable consumer goods in the transmission of shocks originating in the German industrial sector to manufacturers across the euro area.

Finally, the Diebold-Yilmaz method strengthens the results illustrated in Sections 2 and 3. By focusing on the energy-intensive industries (Table A.8), it is found that the spillovers from the chemical sector (C20) to the other industries that use energy intensively as an intermediate input – namely, paper and paper products (C17), non-metallic minerals (C23) and basic metals (C24) – are large both in Germany and in the euro area as a whole. By focusing on the automotive industry (Table A.9), it is clear that the sector is strongly integrated across Europe, with a leading role for Germany.[32]

[30] Alternative strategies to mitigate the impact of extreme observations related to the Covid-19 crisis are based on: treating them as outliers (Schorfheide and Song, 2020); modelling a break in the shock volatility during the pandemic (Lenza and Primiceri, 2020); taking directly into account the epidemic propagation channels and evaluate its impact on macroeconomic variables (e.g. Aprigliano et al., 2021; and Ng, 2021); among others.

[31] The results of this analysis are available upon request.

[32] For the purpose of this analysis, the sample period is limited to the mid-2018 when the decreasing trend in the German automotive industry started materializing, probably also due to the negative effects of the introduction of EU regulation on CO2 emissions (Worldwide Harmonized Light Vehicle Test Procedure, WLTP). The introduction of the WLTP procedure occurred gradually, initially concerning only new models (from 1 September 2017); while from 1 September 2018 it was extended to all cars.

## 6. Conclusions

The objective of the analysis is to study the main factors contributing to the prolonged challenges facing the German manufacturing sector: the permanent rise in firms' energy costs; the deterioration in competitiveness leading to a reduction in German exports; and the structural headwinds in the car industry. By employing a spillover analysis, the paper shows that shocks to German industry exert considerable influence over the manufacturing sectors of other euro area economies.

Looking ahead, the challenges presented above are not likely to dissipate soon. First, EU gas prices are set to remain above pre-energy crisis levels in the years to come. The impact on the activity of manufacturing firms, especially the energy-intensive ones, will depend on the extent to which German firms will invest to improve energy efficiency.[33] Second, the outlook for demand remains subdued and geopolitical factors pose a downward risk for economic activity. Third, demand is particularly weak for firms in the automotive sector; in addition, the competition from Chinese manufacturers is set to intensify in coming years, especially in the green energy technology segment. Moreover, the outcome of trade clashes and the regulatory framework decisions remains highly uncertain.

[33] According to the Bundesbank Online Panel – Firms (BOP-F) survey in 2023Q1, 40% of firms reported to have already implemented investments to improve energy efficiency, as of 2022, while almost 20% were planning them (Deutsche Bundesbank, 2023).

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# Appendix

**Table A.1. Manufacturing sector weights**

| Nace Code | Description | German weights | EA weights |
|---|---|---|---|
| *Energy intensive* | | *15.7%* | *17.3%* |
| C17 | Manufacture of paper and paper products | 1.7% | 2.0% |
| C20 | Manufacture of chemicals and chemical products | 7.5% | 8.1% |
| C23 | Manufacture of other non-metallic mineral products | 3.0% | 3.4% |
| C24 | Manufacture of basic metals | 3.5% | 3.9% |
| *Non-energy intensive* | | *84.3%* | *82.6%* |
| C10 | Manufacture of food products | 6.4% | 9.2% |
| C11 | Manufacture of beverages | 1.0% | 1.8% |
| C12 | Manufacture of tobacco products | 0.3% | 0.2% |
| C13 | Manufacture of textiles | 0.7% | 1.1% |
| C14 | Manufacture of wearing apparel | 0.3% | 0.9% |
| C15 | Manufacture of leather and related products | 0.1% | 0.8% |
| C16 | Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials | 1.7% | 2.0% |
| C18 | Printing and reproduction of recorded media | 1.0% | 1.1% |
| C19 | Manufacture of coke and refined petroleum products | 1.2% | 1.5% |
| C21 | Manufacture of basic pharmaceutical products and pharmaceutical preparations | 3.4% | 6.9% |
| C22 | Manufacture of rubber and plastic products | 5.0% | 4.5% |
| C25 | Manufacture of fabricated metal products, except machinery and equipment | 9.4% | 9.2% |
| C26 | Manufacture of computer, electronic and optical products | 5.8% | 8.1% |
| C27 | Manufacture of electrical equipment | 7.0% | 4.7% |
| C28 | Manufacture of machinery and equipment n.e.c. | 15.7% | 11.5% |
| C29 | Manufacture of motor vehicles, trailers and semi-trailers | 16.2% | 8.8% |
| C30 | Manufacture of other transport equipment | 2.1% | 2.5% |
| C31 | Manufacture of furniture | 1.3% | 1.5% |
| C32 | Other manufacturing | 2.9% | 2.7% |
| C33 | Repair and installation of machinery and equipment | 2.7% | 3.7% |

*Source*: Eurostat and Destatis, and authors' calculation. *Note*: Base year 2021.

**Table A.2. Manufacturing sector spillovers**
(January 2010 - July 2024 sample, 6-months horizon)

| to\from | DE | IT | FR | ES | NL | BE | AT | FI | PT |
|---|---|---|---|---|---|---|---|---|---|
| DE | 73.4 | 11.7 | 1.7 | 9.3 | 0.3 | 0.3 | 2.6 | 0.7 | 0.1 |
| IT | 14.9 | 65.5 | 4.9 | 9.8 | 0.2 | 3.2 | 0.5 | 0.8 | 0.2 |
| FR | 17.0 | 11.4 | 52.5 | 13.2 | 1.2 | 0.7 | 2.6 | 1.1 | 0.3 |
| ES | 8.6 | 22.0 | 13.4 | 50.0 | 1.0 | 0.1 | 0.0 | 4.7 | 0.1 |
| NL | 8.4 | 13.8 | 1.1 | 3.7 | 63.8 | 0.9 | 6.3 | 1.8 | 0.1 |
| BE | 1.0 | 4.6 | 1.2 | 0.5 | 1.9 | 90.0 | 0.1 | 0.2 | 0.4 |
| AT | 20.2 | 16.8 | 1.8 | 5.0 | 3.1 | 3.2 | 49.6 | 0.3 | 0.1 |
| FI | 5.8 | 6.3 | 0.5 | 4.3 | 3.2 | 3.7 | 3.5 | 71.9 | 0.8 |
| PT | 11.1 | 10.3 | 4.1 | 13.3 | 3.6 | 0.3 | 3.9 | 1.2 | 52.2 |

*Source*: Eurostat and author's elaborations. *Note*: the underlying variance decomposition is based upon a monthly VAR with 1 lag, identified using a Cholesky procedure with the ordering as displayed in the column heading. The (i, j)-th value is the estimated contribution to the variance of the cyclical component of the manufacturing production index of country i coming from innovations to the manufacturing production index of country j. T The mnemonics are defined as follows: DE (Germany); IT (Italy); FR (France); ES (Spain); NL (Netherlands); BE (Belgium); AT (Austria), FI (Finland), and PT (Portugal). The cyclical component of the manufacturing production index is obtained by applying the HP filter. To account for the most acute phase of the pandemic period a series of monthly dummy variables have been included from 2020:M3 through 2020:M12.

**Table A.3. Manufacturing sector spillovers**
(January 2000 - December 2019; 6-months horizon)

| to\from | DE | IT | FR | ES | NL | BE | AT | FI | PT |
|---|---|---|---|---|---|---|---|---|---|
| DE | 67.0 | 10.6 | 0.1 | 15.3 | 1.6 | 0.5 | 4.3 | 0.5 | 0.1 |
| IT | 28.0 | 47.2 | 0.2 | 19.3 | 2.0 | 0.6 | 1.8 | 0.8 | 0.0 |
| FR | 23.1 | 8.2 | 47.8 | 13.5 | 0.8 | 0.2 | 5.4 | 0.6 | 0.4 |
| ES | 13.2 | 17.5 | 3.0 | 60.0 | 0.2 | 2.3 | 0.4 | 3.3 | 0.1 |
| NL | 21.7 | 5.0 | 3.3 | 7.1 | 59.6 | 0.5 | 2.4 | 0.3 | 0.0 |
| BE | 15.4 | 4.2 | 0.5 | 4.5 | 3.5 | 68.7 | 1.5 | 1.0 | 0.8 |
| AT | 33.0 | 9.2 | 1.2 | 6.2 | 1.8 | 0.1 | 48.0 | 0.3 | 0.2 |
| FI | 17.1 | 4.6 | 0.2 | 7.4 | 2.4 | 1.2 | 3.2 | 60.5 | 3.5 |
| PT | 10.6 | 0.3 | 4.4 | 0.4 | 2.1 | 0.5 | 0.2 | 0.7 | 80.7 |

*Source*: Eurostat and author's elaborations. *Note*: the underlying forecast error variance decomposition is based upon a monthly VAR with 1 lag, identified using a Cholesky procedure with the ordering as displayed in the column heading. The (i, j)-th value is the estimated contribution to the forecast error variance of the cyclical component of the manufacturing production index of country i coming from innovations to the manufacturing production index of country j. The mnemonics are defined as follows: US (United States); DE (Germany); IT (Italy); FR (France); ES (Spain); NL (Netherlands); BE (Belgium); AT (Austria), FI (Finland), and PT (Portugal). The cyclical component of the manufacturing production index is obtained by applying the HP filter.

**Table A.4. Capital good spillovers**
(January 2010 - December 2019 sample, 6-months horizon)

| to\from | DE | IT | FR | ES | NL | BE | AT | FI | PT |
|---|---|---|---|---|---|---|---|---|---|
| DE | 73.2 | 5.3 | 3.9 | 5.1 | 2.8 | 1.0 | 6.7 | 1.2 | 0.7 |
| IT | 33.8 | 45.0 | 1.9 | 2.2 | 13.5 | 1.7 | 0.2 | 0.6 | 1.1 |
| FR | 19.1 | 4.4 | 51.7 | 9.2 | 0.3 | 2.6 | 12.0 | 0.2 | 0.5 |
| ES | 18.9 | 8.8 | 8.5 | 58.7 | 0.3 | 0.7 | 2.0 | 1.3 | 0.9 |
| NL | 18.7 | 1.5 | 2.9 | 0.2 | 72.8 | 0.4 | 1.0 | 0.5 | 1.9 |
| BE | 18.3 | 3.9 | 3.9 | 4.0 | 0.9 | 64.3 | 2.8 | 0.8 | 1.0 |
| AT | 11.2 | 4.9 | 2.8 | 1.3 | 1.8 | 6.7 | 70.8 | 0.1 | 0.2 |
| FI | 4.3 | 1.8 | 3.3 | 0.4 | 2.6 | 0.7 | 3.4 | 82.7 | 0.7 |
| PT | 22.2 | 2.7 | 6.2 | 5.6 | 2.2 | 6.6 | 6.3 | 2.5 | 45.8 |

*Source*: Eurostat and author's elaborations. *Note*: the underlying variance decomposition is based upon a monthly VAR with 1 lag, identified using a Cholesky procedure with the ordering as displayed in the column heading. The (i, j)-th value is the estimated contribution to the variance of the cyclical component of the capital good production index of country i coming from innovations to the capital good production index of country j. The mnemonics are defined as follows: DE (Germany); IT (Italy); FR (France); ES (Spain); NL (Netherlands); BE (Belgium); AT (Austria), FI (Finland), and PT (Portugal). The cyclical component of the production index of capital goods is obtained by applying with the HP filter.

**Table A.5. Intermediate good spillovers**
(January 2010 - December 2019 sample, 6-months horizon)

| to\from | DE | IT | FR | ES | NL | BE | AT | FI | PT |
|---|---|---|---|---|---|---|---|---|---|
| DE | 76.7 | 9.0 | 0.0 | 4.6 | 0.5 | 0.8 | 5.6 | 0.2 | 2.6 |
| IT | 29.2 | 52.8 | 0.8 | 10.5 | 0.3 | 1.2 | 2.8 | 1.6 | 0.7 |
| FR | 17.1 | 23.0 | 40.7 | 9.8 | 3.8 | 0.6 | 3.4 | 1.2 | 0.3 |
| ES | 21.5 | 13.7 | 1.9 | 57.8 | 0.3 | 0.7 | 3.2 | 0.6 | 0.3 |
| NL | 12.0 | 2.6 | 6.4 | 0.2 | 73.3 | 0.1 | 3.8 | 0.1 | 1.4 |
| BE | 30.5 | 3.7 | 1.2 | 3.7 | 4.0 | 50.3 | 4.3 | 1.5 | 0.7 |
| AT | 33.3 | 5.4 | 4.3 | 4.4 | 0.9 | 0.1 | 50.3 | 0.2 | 1.0 |
| FI | 24.8 | 3.3 | 1.4 | 6.4 | 2.6 | 0.0 | 10.2 | 50.6 | 0.7 |
| PT | 6.7 | 5.1 | 0.7 | 18.7 | 4.1 | 2.8 | 1.7 | 0.2 | 60.0 |

*Source*: Eurostat and author's elaborations. *Note*: the underlying variance decomposition is based upon a monthly VAR with 1 lag, identified using a Cholesky procedure with the ordering as displayed in the column heading. The (i, j)-th value is the estimated contribution to the variance of the cyclical component of the intermediate good production index of country i coming from innovations to the intermediate good production index of country j. The mnemonics are defined as follows: DE (Germany); IT (Italy); FR (France); ES (Spain); NL (Netherlands); BE (Belgium); AT (Austria), FI (Finland), and PT (Portugal). The cyclical component of the production index of intermediate goods is obtained by applying the HP filter.

**Table A.6. Durable consumption spillovers**

(January 2010 - December 2019 sample, 6-months horizon)

| to\from | DE | IT | FR | ES | NL | BE | AT | FI | PT |
|---|---|---|---|---|---|---|---|---|---|
| DE | 85.9 | 3.1 | 0.3 | 5.0 | 0.1 | 0.1 | 0.7 | 1.1 | 3.8 |
| IT | 6.2 | 87.7 | 0.5 | 2.1 | 0.1 | 0.5 | 1.0 | 0.1 | 2.0 |
| FR | 6.7 | 2.4 | 79.7 | 1.1 | 6.5 | 0.2 | 0.9 | 2.5 | 0.2 |
| ES | 23.5 | 8.3 | 0.7 | 56.0 | 1.2 | 1.1 | 2.5 | 4.7 | 2.0 |
| NL | 1.2 | 2.3 | 1.0 | 4.5 | 82.2 | 0.1 | 2.9 | 5.7 | 0.0 |
| BE | 6.5 | 4.7 | 2.6 | 3.4 | 3.3 | 73.2 | 0.8 | 4.7 | 0.8 |
| AT | 2.2 | 1.4 | 3.3 | 0.8 | 3.0 | 0.7 | 87.5 | 0.2 | 0.9 |
| FI | 9.5 | 4.6 | 1.6 | 8.4 | 1.7 | 2.2 | 0.7 | 70.7 | 0.6 |
| PT | 4.3 | 0.8 | 2.0 | 0.5 | 2.8 | 0.4 | 1.5 | 2.4 | 85.3 |

*Source*: Eurostat and author's elaborations. *Note*: the underlying variance decomposition is based upon a monthly VAR with 1 lag, identified using a Cholesky procedure with the ordering as displayed in the column heading. The (i, j)-th value is the estimated contribution to the variance of the cyclical component of the durable consumption production index of country i coming from innovations to the durable consumption production index of country j. The mnemonics are defined as follows: DE (Germany); IT (Italy); FR (France); ES (Spain); NL (Netherlands); BE (Belgium); AT (Austria), FI (Finland), and PT (Portugal). The cyclical component of the production index of durable consumption goods is obtained by applying the HP filter.

**Table A.7. Non-durable consumption spillovers**

(January 2010 - December 2019 sample, 6-months horizon)

| to\from | DE | IT | FR | ES | NL | BE | AT | FI | PT |
|---|---|---|---|---|---|---|---|---|---|
| DE | 71.1 | 0.1 | 1.0 | 1.3 | 23.4 | 0.3 | 1.5 | 0.9 | 0.5 |
| IT | 2.3 | 80.3 | 7.1 | 0.5 | 6.7 | 0.8 | 1.1 | 0.9 | 0.5 |
| FR | 3.2 | 4.4 | 86.0 | 0.8 | 3.7 | 0.3 | 0.5 | 0.2 | 0.7 |
| ES | 0.4 | 11.5 | 4.5 | 81.1 | 0.0 | 0.2 | 0.1 | 0.9 | 1.2 |
| NL | 8.9 | 1.1 | 2.6 | 3.0 | 80.5 | 0.9 | 2.6 | 0.3 | 0.0 |
| BE | 0.6 | 0.8 | 5.0 | 1.4 | 0.9 | 89.1 | 0.2 | 0.1 | 1.9 |
| AT | 4.1 | 9.6 | 2.6 | 0.0 | 6.7 | 1.3 | 74.4 | 1.1 | 0.1 |
| FI | 0.9 | 4.3 | 0.6 | 0.9 | 2.4 | 0.2 | 0.1 | 90.7 | 0.0 |
| PT | 6.8 | 21.4 | 0.5 | 0.7 | 1.5 | 1.5 | 0.6 | 0.5 | 66.6 |

*Source*: Eurostat and author's elaborations. *Note*: the underlying variance decomposition is based upon a monthly VAR with 1 lag, identified using a Cholesky procedure with the ordering as displayed in the column heading. The (i, j)-th value is the estimated contribution to the variance of the cyclical component of the non-durable consumption production index of country i coming from innovations to the non-durable consumption production index of country j. The mnemonics are defined as follows: DE (Germany); IT (Italy); FR (France); ES (Spain); NL (Netherlands); BE (Belgium); AT (Austria), FI (Finland), and PT (Portugal). The cyclical component of the production index of non-durable consumption goods is obtained by applying the HP filter.

**Table A.8 Energy-intensive industry spillovers**
(January 2010 - December 2019 sample, 6-months horizon)

**(a) Germany**

| to\from | Paper and paper product (C17) | Chemicals (C20) | Non-metallic minerals (C23) | Basic metals (C24) |
|---|---|---|---|---|
| Paper and paper product (C17) | 70.9 | 21.2 | 0.3 | 7.6 |
| Chemicals (C20) | 15.8 | 82.9 | 0.2 | 1.0 |
| Non-metallic minerals (C23) | 3.6 | 15.6 | 71.8 | 9.0 |
| Basic metals (C24) | 7.0 | 24.6 | 1.6 | 66.8 |

**(b) Euro area**

| to\from | Paper and paper product (C17) | Chemicals (C20) | Non-metallic minerals (C23) | Basic metals (C24) |
|---|---|---|---|---|
| Paper and paper product (C17) | 68.1 | 22.6 | 3.7 | 5.6 |
| Chemicals (C20) | 26.7 | 67.0 | 4.1 | 2.2 |
| Non-metallic minerals (C23) | 9.2 | 21.1 | 54.5 | 15.3 |
| Basic metals (C24) | 17.8 | 33.3 | 2.5 | 46.5 |

*Source*: Eurostat and author's elaborations. *Note*: the underlying variance decomposition is based upon a monthly VAR with 1 lags, identified using a Cholesky procedure with the ordering as displayed in the column heading. The (i, j)-th value is the estimated contribution to the variance of the cyclical component of the manufacturing production index of sector i coming from innovations to the manufacturing production index of sector j. The cyclical component of the sectorial manufacturing production index is obtained by applying with the HP filter.

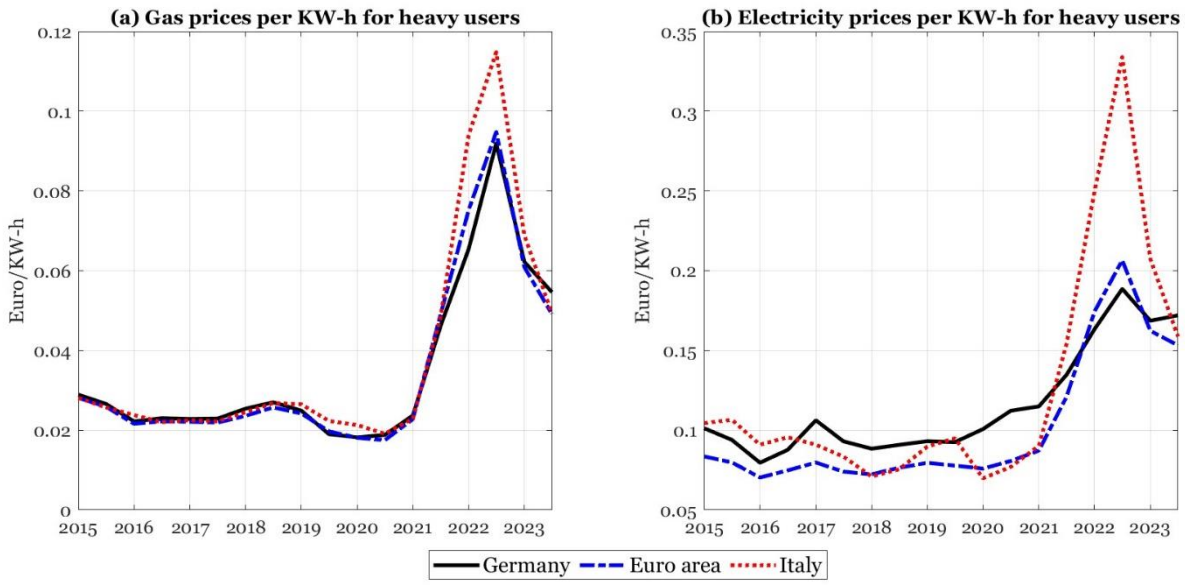
**Table A.9 Automotive industry spillovers**
(sample January 2010 - June 2018; 6-months horizon)

| to\from | DE | ES | FR | IT |
|---|---|---|---|---|
| DE | 87.1 | 1.1 | 6.8 | 5.0 |
| ES | 9.3 | 82.3 | 2.6 | 5.8 |
| FR | 24.8 | 9.2 | 59.1 | 7.0 |
| IT | 11.0 | 10.2 | 16.5 | 62.3 |

*Source*: Eurostat and author's elaborations. *Note*: the underlying variance decomposition is based upon a monthly VAR with 1 lag, identified using a Cholesky procedure with the ordering as displayed in the column heading. The (i, j)-th value is the estimated contribution to the variance of the cyclical component of the motor vehicle production index of country i coming from innovations to the motor vehicle production index of country j. The mnemonics are defined as follows: DE (Germany); ES (Spain); FR (France); IT (Italy). The ordering follows the relevance of each country, measured by the number of cars produced in 2023, within the euro-area automotive industry. The cyclical component of the motor vehicle production index is obtained by applying the HP filter.

## Figure A.1. Gas and electricity prices

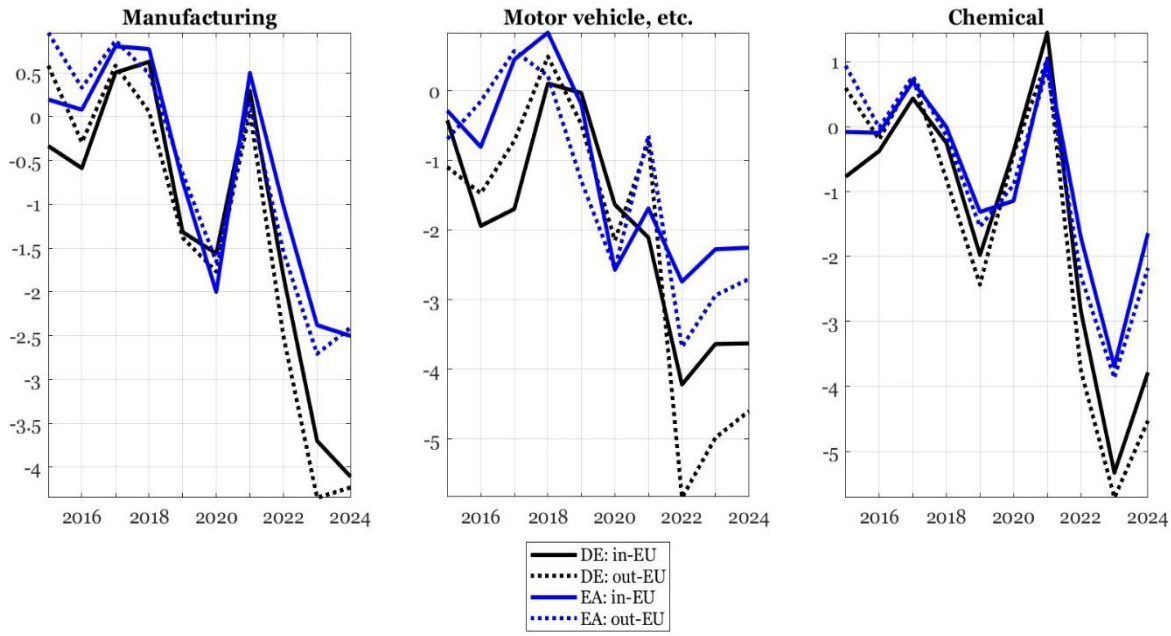
(Non-household users; Excluding VAT and other recoverable taxes and levies)




*Source*: Eurostat.

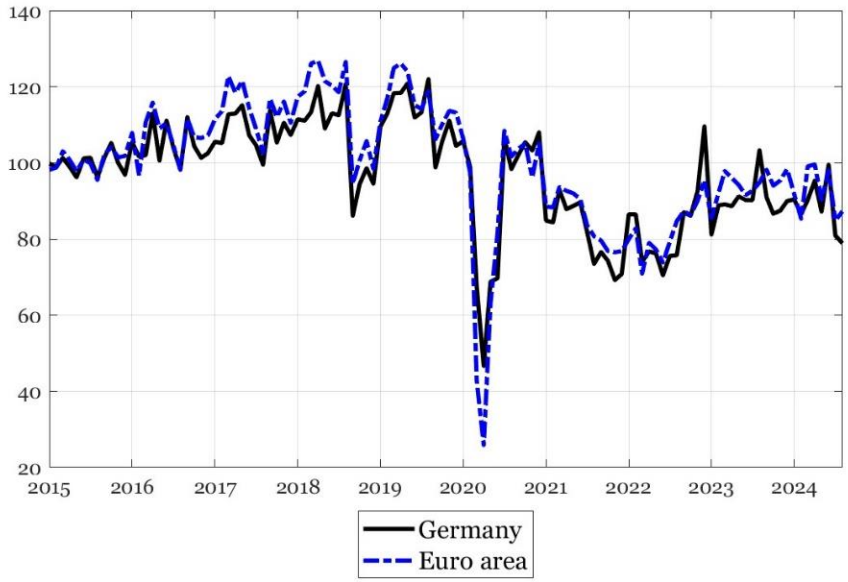
*Note*: the gas prices refer to non-household's users, consuming from 1 000 000 GJ (gigajoule) to 3 999 999 GJ. This band represents the second-highest category of gas consumption (band I5), potentially referring to heavy industrial users, with data available for a sufficiently long time-span. Last observations: 2023H2.

**Figure A.2. Competitive positions**
(balances; standardized, with 2000-2019 avg. and std.)



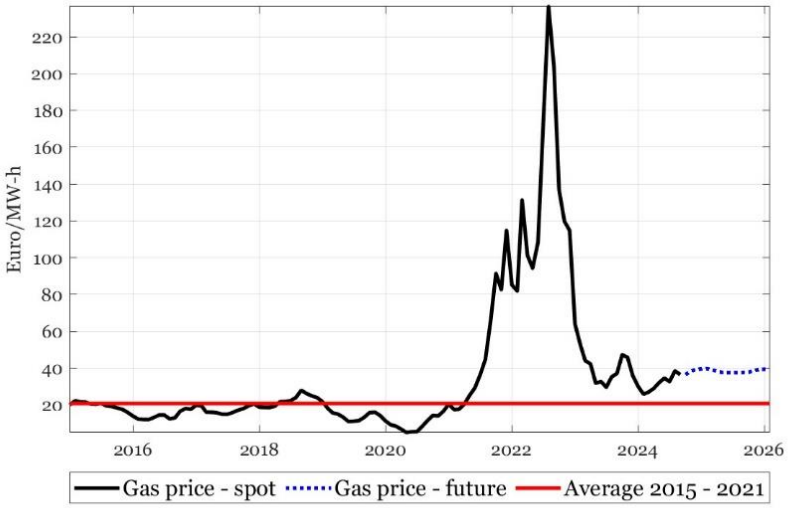

*Source*: Eurostat and author's elaborations.
*Note*: Balances of firms reporting an improvement in their competitiveness minus those reporting a worsening in it, both outside the EU (dotted lines) and inside the EU (straight line). Balances standardized considering the historical average and the standard deviation computed for the period 2000Q1-2019Q4; last observation: 2024Q3; the yearly average for 2024 is based on the observations for 2024Q1-2024Q3. Unit of measure: percentage points.

**Figure A.3. Car registrations**
(2015Q1 = 100)



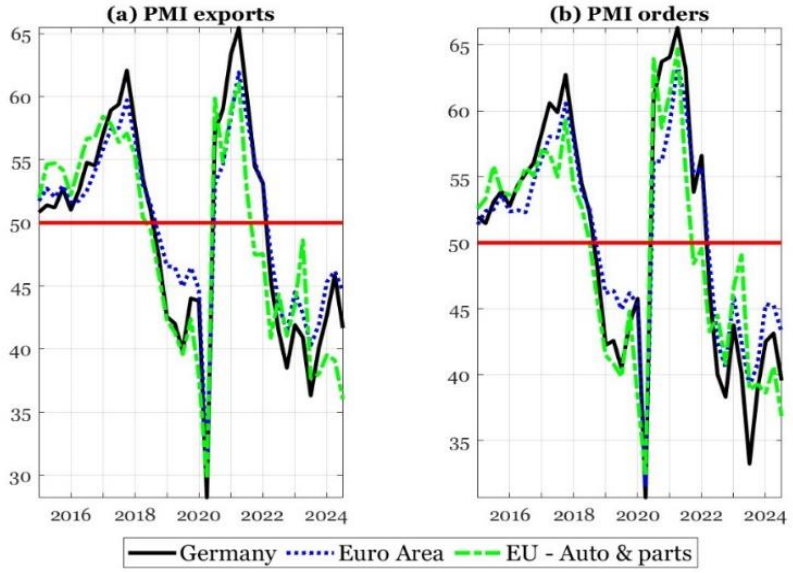

*Source*: Eurostat and author's elaborations.
*Note*: Car registrations; seasonally adjusted data. Last observation: August 2024.

**Figure A.4. Gas prices in Europe (Endex TTF)**




*Source*: Refinitiv Datastream and author's elaborations.
*Note*: monthly averages. Last observations: September 2024 for spot gas prices; February 2026 for future gas prices.

**Figure A.5. PMI**
(diffusion indices)




*Source*: Refinitiv Datastream and author's elaborations.
*Note*: last observations: September 2024 for Germany and the Euro Area PMI; August 2024 for EU sectoral PMI (the estimate for 2024Q3 is obtained as an average for the observations for July and August).