The impact of demand and supply shocks on inflation. Evidence for the US and the Euro area

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Abstract. After a long period of price stability, inflation returned to record levels in many parts of the world economy. This paper investigates the role of demand and supply shocks behind this process. Structural VAR models are specified for the US and the euro area. Shocks are identified by sign restrictions and external instruments. Demand shocks dominate in the US and can explain roughly 75 percent of the inflation experience. Supply side shocks like bottlenecks in global value chains account for the remaining 25 percent of the variance of inflation forecast errors. In the euro area, the shocks are balanced. Depending on the specification, supply shocks may even play a larger role over longer periods. Higher interest rates can tame inflation due to their adverse effects on demand. However, supply factors are beyond the control of central banks. Thus, monetary policy might become overly restrictive if the impact of the non-demand drivers is neutralized. Due to the larger weight of supply shocks in the euro area, the risk of stagflation, i.e. a longer period of high inflation and low output growth is especially high in that region. To return to the inflation target of around 2 percent, a resolution of supply side pressures is required in any case.

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1 Introduction

After a long period of price stability, inflation accelerated to record peaks in many regions of the world economy. While consumer prices increased by 2.5 percent per annum in the US and 1.7 in the euro area on average over the last decade, the rates arrived at 10 percent in the mid of 2022 (Figure 1). Even sticky prices as a proxy for long term inflation raised substantially, although at a slower pace, see the ongoing reports of the Fed Atlanta and Bryan and Meyer (2010). Hence, higher inflation rates may become persistent. The soar of producer prices was much more pronounced, suggesting significant inflation potential in the future, especially for goods close to final consumption. The rapid and strong acceleration of prices surprised many analysts. Initially, rising inflation was often interpreted as a transitory and short lived phenomenon, primarily driven by base effects due to the Corona pandemic. In line with the dominant view, the Fed and the ECB started to increase interest rates only with a delay. Despite the decline of inflation in the most recent months, it is still an open question whether a more restrictive monetary policy can be successful to reduce inflation in due time. The transmission lags of monetary policy are usually long, i.e. more than two years, notably in countries with advanced financial markets (Havranek and Rusnak, 2013).

-Figures 1 and 2 about here-

It is important the explain the factors behind the recent inflation experience. The recovery of demand after Corona is at the base of the development. After the easing of mobility restrictions, the recovery has been rather fast in the US (Figure 2). Output reached its pre-pandemic level already in Spring 2021, one year after the initial outbreak of the virus[2]. Financial assistance to households and firms, and extremely loose monetary conditions contributed to restore confidence and stimulated the development. See Bhutta, Blair, Dettling and Moore (2020) for the fiscal packages and Clarida, Duygan-Bump and Scotti (2021) for the monetary policy response. After the relaxation of the restrictions, the massive fall in unemployment to historically lows and a huge decline of savings rates from involuntary heights has boosted private consumer demand (Carroll, Crawley, Slacalek and White, 2021).

[2] Containment policies to reduce the spread of the pandemic are monitored by the Oxford index, see Hale, Kira, Cameron-Blake, Tatlow, Hallas, Phillips and Zhang (2021).

The composition of expenditures changed during the recovery. Households have spent a higher income share on goods to relief their limited mobility, such as products related to the work from home, communication, entertainment and fitness equipment. In contrast, the demand for services suffered, especially if they rely on face-to-face contacts. According to the pattern in the recent months, consumers gradually return to previous habits. The moderation of excessive demand for home-based appliances and facilities can help to lower inflation over the next future. Despite the deeper recession and weaker recovery in the euro area, the initial rise in unemployment has been rather minor in most member states. Fiscal expenditures to support the economy focused heavily on contingent measures such as loans and guarantees, instead of direct spending in the US (IMF Fiscal Monitor).

Besides the demand effects, supply disruptions have become widespread and might be behind the inflation experience. Since the onset of the globalization of markets, production is increasingly organized in global value chains. To exploit efficiency gains, production has been dismantled into several stages carried out by firms located in different countries. The value of traded intermediate goods doubled and accounts for more than 50 percent of world trade (Baldwin, 2006). Companies restructure their operations internationally through the outsourcing and offshoring of tasks. The integration of firms from emerging markets has boosted competition, especially in lower wage industries (Auer and Fischer, 2010). By reducing mark-ups of firms this behaviour contributed to keep inflation at modest levels over the recent decades (Guerrieri, Gust and Lopez-Salido, 2010).

On the other hand, the international fragmentation of production is particularly vulnerable, as shocks occurring in specific locations can undermine the stability of the whole chain. Firms may be forced to close if political authorities implement mobility restrictions to limit the spread of virus variants. For example, the Omicron virus led to a harsh lockdown in Shanghai and other Chinese cities lasting several weeks. As trade linkages are tighter for countries in the regional neighborhood, the associated fall in Chinese demand led to immediate losses especially for the trading partners along the Asian production networks, with subsequent spillovers to other countries. In any case, the decline in output is not limited to firms directly affected by the restrictions. The partners will suffer as shortages in the delivery of intermediates cannot be easily compensated. The extent of supply bottlenecks is not homogeneous across regions, industries and time. The shocks are largest in countries where the manufacturers operate at later stages of the production process and are reliant on highly differentiated inputs such as the automotive industry (Celasun, Hansen, Mineshima, Spector and Zhou, 2022). Delivery times increased more for firms in advanced economies, compared to emerging markets, as the latter often operate at upstream stages of the chains. While the re-structuring of production to include more firms from a closer regional distance can reduce the impact of idiosyncratic shocks, efficiency losses can be implied. The reversal of the globalization process can decrease competition and increase the inflation potential in the medium and long run[3].

The disruptions in global value chains and the subsequent strong recovery led to accelerating transportation costs that amplified supply constraints. By looking at the Baltic Dry index, Carriere-Swallow, Deb, Furceri, Jimenez and Ostry (2022) argued that global shipping costs add substantially to the inflation pressure. The strength of the impact is heterogeneous across countries and raises with the import shares of domestic consumption and the degree of integration into global value chains. While transport companies reduced their capacities in the Corona crisis, they cannot be easily reconstructed. Many workers found jobs in other industries and will not return to their previous occupations. At the same time, the participation in the labor force decreased and has not fully recovered so far. Labor market tightness may contribute to the inflationary pressure in the US, because workers can realize higher wages (Domash and Summers, 2022).

In the recent months, the Russian invasion of the Ukraine have put further strains on inflation. Both Russia and the Ukraine are major exporters of commodities. Higher prices and an increase in price volatility have been striking especially in energy markets. For example, gas prices increased by more than 80 percent at the peak of the development (Figure 3). In recent month, energy prices fell, but are still 20 percent above the long run average. The euro area is especially vulnerable to soaring prices, as the region is a main importer of energy. In contrast, the US is the largest producer of oil and gas in the international economy. The production of energy exceeded its consumption over the last years.

-Figure 3 about here-

There is still no consensus whether the rise of inflation is transitory or persistent. Various risks such as the emergence of wage-price spirals and the de-anchoring of inflation expectations can

[3] In addition, the sustained increase of CO_2 prices due to the climate change can lead to higher inflation pressure in the long run.

materialize in the future. Households may demand higher wages to compensate for the losses in purchasing power, and firms may raise prices to protect profit margins. In fact, wage growth has picked up significantly in some advanced countries, including the US. A de-anchoring of inflation expectations due to losses in the credibility of central banks might reinforce the inflation trend. Monetary policy seems to be still credible, as long term inflation expectations are in line with the targets of central banks (Coibion, Gorodnichenko and Kamdar, 2018). According to the Federal Reserve Bank of Cleveland, the long run inflation expectations rates in the US have been relatively stable so far, more or less. Expectations for the short term increased, probably due to the rise of inflation in sticky prices.

To gain insights into the drivers of the inflation process, this paper provides a quantitative assessment into the role of demand and supply shocks. Their relevance is investigated by structural VAR (SVAR) models. For robustness, the shocks are identified by different methods, such as sign restrictions and external instruments. Due to their orthogonality, the relative contribution of the shocks can be inferred from the variance decomposition of forecast errors. Demand shocks dominate especially in the US but can explain the inflation experience only partially. Supply side shocks like disruptions in global value chains account for the remaining 25 percent of the variance of inflation forecast errors. In the euro area, the drivers of inflation are balanced. Depending on the specification, supply shocks may even play a larger role over longer periods. A more restrictive monetary policy affects the demand side of inflation. Higher interest rates can reduce inflation, as they have adverse effects on private consumption and investment, probably after some delay in the policy transmission. However, supply factors are usually beyond the control of central banks. Thus, monetary policy might become overly restrictive if the impact of the non-demand drivers is neutralized. Because of the larger weight of supply shocks in the monetary union, the risk of stagflation, i.e. a longer period of high inflation and low output growth is especially high in the euro area. For the US and the euro area, a resolution of supply side pressures is required as a tailwind to return to the previous inflation targets of around 2-3 percent. Otherwise, slightly higher long run inflation rates should be accepted to avoid real economic losses.

The rest of the paper is organized as follows. In the next section (Section 2) SVAR models and the identifying assumptions are presented. Section 3 discusses the data and results based on impulse responses and variance decompositions. Finally, Section 4 concludes with some policy recommendations.

2 SVAR models including demand and supply shocks

To investigate the impact of demand and supply shocks on inflation, the SVAR technology provides the convenient framework. If the relevant variables are embedded, the SVAR includes all dynamic effects

$$(1) \qquad B_0 y_t = B_1 y_{t-1} + \ldots + B_q y_{t-q} + \varepsilon_t$$

between inflation and the determinants closely connected to the price development. The vector of *n* stationary variables *y* (including inflation) depends on its own history up to la maximum delay of *q* periods. The B_i are *n*x*n* matrices of unknown parameters. Deterministic terms (constants, trends) and exogeneous variables can be easily added. The contemporaneous linkages (impact multipliers) between the series are specified by the parameters in the non-singular B_0 matrix, with diagonal elements normalized to unity. The *n* shocks in ϵ are orthogonal and fulfill the white noise properties, i.e. they have a mean of zero, no autocorrelation, and constant, but not necessarily equal variances. In particular, they are not correlated. As the shocks affect only one specific variable, they have a structural interpretation. For example, the error in the inflation equation is interpreted as the inflationary shock. If the system is pre-multiplied with B_0^{-1}, the reduced form

$$(2) \qquad y_t = A_1 y_{t-1} + \ldots + A_q y_{t-q} + u_t \quad , \quad A_i = B_0^{-1} B_i \quad , \quad i = 1, \ldots, q$$

is obtained. It can be estimated, as *y* depends only on predetermined variables. Since the errors (*u*) of the reduced form

$$(3) \qquad u_t = B_0^{-1} \varepsilon_t \quad \Leftrightarrow \quad \varepsilon_t = B_0 u_t$$

arise as combinations of different structural shocks, the impact of specific shocks on individual variables cannot be evaluated by these measures. This point is important as uncorrelated shocks are required for the impulse responses. With the lag operator *L* equation (2) can be rewritten in a more compact form:

$$(4) \qquad A(L) y_t = u_t \quad , \quad A(L) = (I - A_1 L - \ldots A_q L^q)$$

By pre-multiplying with the inverse of the lag polynomial the Wold (MA) representation can be obtained:

$$(5) \qquad y_t = \sum_{i=0}^{\infty} \Phi_i u_{t-i} = \sum_{i=0}^{\infty} \Phi_i B_0^{-1} \varepsilon_{t-i}$$

Based on equation (5) the dynamic effects of certain shocks (impulses) on the variables are investigated. However, the structural parameters collected in the B_0 matrix are unknown without theoretical or statistical assumptions. In the absence of such restrictions, the structural MA coefficients cannot be determined, as they require knowledge of B_0. Therefore, the identification of the matrix of impact multipliers is of utmost importance. In earlier studies, researchers often employed the Cholesky decomposition to transform the covariance matrix of the reduced form residuals into a lower triangular matrix with orthogonal disturbances. However, the approach requires a particular ordering of the variables, according to their degree of exogeneity. The ordering implies a recursive structure that might be inconsistent with reality. For example, demand and supply shocks could affect inflation simultaneously, but not sequentially. Therefore, alternative strategies are preferred.

In a first approach, the identification of structural shocks is based on agnostic sign restrictions. This type of restrictions has been proposed, inter alia, by Uhlig (2005) and Mountford and Uhlig (2009) to overcome some puzzling results often found in empirical analysis, such as the positive response of prices to a more contractive monetary policy. Prior beliefs about the sign that certain shocks should have on certain endogenous variable are applied. The ordering of variables does not play any role. Evidence on the importance of demand (*D*) and supply (*S*) shocks can be taken from a bivariate model comprising inflation and output growth (Kilian, Nomikos and Zhou, 2021). While an acceleration of demand triggers a rise of inflation and output, a supply shock implies reactions of prices and output in opposite directions. A positive supply shock increases output, causing prices to fall, while a negative supply shock decreases output, causing prices to rise. The latter interpretation dominates in the current debate, as the bottlenecks in global value chains might raise inflation and reduce output growth. Thus, the specification of the matrix of sign restrictions

$$(6) \qquad \begin{pmatrix} u_{1,t} \\ u_{2,t} \end{pmatrix} = \begin{pmatrix} + & + \\ + & - \end{pmatrix} \times \begin{pmatrix} \varepsilon_{D,t} \\ \varepsilon_{S,t} \end{pmatrix}$$

Is straightforward. Although the direction of the contemporaneous impacts is consistent with economic theory, the results might not be unique. By selecting appropriate weights of the reduced form residuals in (3) linear independent shocks can be calculated. As the weights might vary many such combinations are possible. Some can lead to impulse responses that have the correct signs, but others will not. By looking at the entire space of orthogonal decompositions of the reduced form residual covariance matrix, it is investigated whether the corresponding impulse responses are in line with the predictions[4]. If they are, the responses are kept, if not, they are discarded. The process is repeated until a sufficient number of draws has been successful.

In many applications, only single shocks have been identified by sign restrictions, often related to monetary policy. In large SVAR models, the approach is less feasible, as multiple shocks can generate the same sign pattern. In a similar vein, the responses of different variables can be identical across all shocks. Without additional information, neither shocks nor responses can be distinguished. While sign restrictions can solve the identification problem by providing information to identify the structural parameters, they do not make progress with respect to the model identification. Impulse responses arising from different models can fulfill the restrictions (Fry and Pagan, 2011). As the concrete drivers behind the shocks are unknown the results cannot be interpreted in terms of observed variables. This limits the usefulness for policy purposes. Furthermore, the results might easily mix up with the prior beliefs. A low ratio of successful to total replications can cast doubts on the validity of the theoretical assumptions.

Therefore, sign restrictions are extended by more data-driven approaches. External instruments might serve as observable proxies to identify structural shocks, see, inter alia, Mertens and Ravn (2013), Caldara and Herbst (2019) and Herwartz, Rohloff and Wang (2022). To be a valid instrument for a certain shock, two criteria are met. The instrument is correlated with one particular shock (relevance) but uncorrelated to all other shocks (exogeneity). As the reduced form residuals are linear combinations of different structural shocks, the impact of a single shock might be isolated by a two stage regression approach. Specifically, the residual from the demand equation arises as a mixture of demand and supply shocks:

[4] The space of orthogonal decompositions is constructed by the product of a random orthonormal matrix Q and the Cholesky lower triangular P of the reduced form residual covariance matrix, $\Sigma_u=PP'=PQQ'P'=PQ(PQ)'$. Thus, the PQ matrix is a suitable candidate for B_0 to solve the identification problem. In contrast to P, the PQ matrix is no longer triangular.

$$u_t^D = b_{11}\varepsilon_t^D + b_{12}\varepsilon_t^S$$

To identify the demand shock, the reduced form residual is regressed upon an appropriate instrument (z):

(7) $$u_t^D = \beta z_t + \upsilon_t$$

The OLS estimate of β is the covariance between the endogenous and the exogeneous variable, divided by the variance of the latter. Since the instrument is uncorrelated with the supply shock, the covariance term simplifies to

$$Cov\left(u_t^D, z_t\right) = Cov\left(b_{11}\varepsilon_t^D + b_{12}\varepsilon_t^S, z_t\right) = b_{11}Cov\left(\varepsilon_t^D, z_t\right) = b_{11}c$$

Thus, the impact of the demand shock is identified up to a term equal to the covariance between the demand shock and the instrument:

$$\beta = \frac{b_{11}c}{Var\left(\varepsilon_t^D\right)} \quad \Rightarrow \quad \beta Var\left(\varepsilon_t^D\right) = b_{11}c$$

In the second stage, the remaining residuals are projected onto the fitted values of the first stage regression. Hence, the impact of the demand shock to all variables can be derived. In the equation

(8) $$u_t^S = \gamma \hat{u}_t^D + w_t = \gamma\left(\frac{b_{11}c}{Var\left(z_t\right)}\right)z_t + \omega_t$$

the OLS estimate of γ is the ratio between a covariance and a variance term. The former can be rewritten as

$$Cov\left(u_t^S, \hat{u}_t^D\right) = Cov\left(b_{21}\varepsilon_t^D + b_{22}\varepsilon_t^S, \frac{b_{11}c}{Var\left(z_t\right)}z_t\right) = \frac{b_{21}b_{11}c^2}{Var\left(z_t\right)}$$

The variance of the second stage regressor is

$$Var\left(\hat{u}_t^D\right) = Var\left(\frac{b_{11}c}{Var\left(z_t\right)} z_t\right) = \frac{b_{11}^2 c^2}{Var\left(z_t\right)}$$

Thus, the OLS estimate of γ is b_{21}/b_{11}. If the demand shock is normalized to unity, the matrix of the contemporaneous impacts

(9) $$B_0 = \begin{pmatrix} 1 & b_{12} \\ \hat{\gamma} & b_{22} \end{pmatrix}$$

is partially identified up to the supply shock in the second column. To test for weak instruments, Lunsford (2015) proposed a *F*-type test of the null hypothesis of zero coefficients of instruments on the VAR residuals. External instruments have been used, inter alia, by Gertler and Karadi (2015), who identify the unexpected change in policy interest rate by choosing as instrument movements of futures prices around the policy announcements. Note that a full identification of all structural shocks is not achieved by the approach. Therefore, external instruments are combined with sign restrictions, following the suggestion of Cesa-Bianchi and Sokol (2022). In particular, the B_0 matrix is partitioned accordingly. Instruments are selected to identify a pre-defined group of shocks. Conditional on the results, sign restrictions are applied to identify the remaining shocks.

Overall, the impact of demand and supply shocks on inflation can be investigated under three specifications. In the first setting, identification is purely achieved through sign restrictions. The other approaches are based on the combination of instruments and sign restrictions. While one shock is proxied by an instrument, the other one is identified by the signs of the responses, respectively. Bivariate SVAR models serve as the workhorse for the analysis, comprising inflation and output growth. Energy prices might exert an additional impact and are treated as exogeneous. They are mainly driven by the Russian war in the Ukraine and affect both the demand and supply side. While inflation will increase, output growth tends to decrease, because of the fall in demand (lower purchasing power) and the fact that the former allocation of input factors is no longer optimal.

3 Data and empirical results

Given its relevance in the policy debate, inflation refers to the development of consumer prices (CPI). Producer prices (PPI) are internally used to cross-check the results. The manufacturing part of industrial production (IP) is used for output growth. It is often seen as a timely indicator for the business cycle. The series is regularly monitored by numerous institutions to construct nowcast estimates of GDP.

New orders received by the manufacturing sector are used as the proxy for the demand side. The series is often interpreted as a measure of economic activity with forecasting properties (Stock and Watson, 1999). New orders enter the various leading indicators, for example those of the Conference board and the OECD. For the supply conditions, the Global Supply Chain Pressure Index (GSCPI) proposed by Benigno, Di Giovanni, Groen and Noble (2022) is selected[5]. It measures tensions in global value chains and is built on information from other indices, such as the Baltic Dry and the Harpex index for the costs for shipping goods and the prices on the charter market for container ships. The GSCPI includes the costs of international transportation for different vehicles and raw materials, and chain-related components of the Purchasing Manager Index, such as delivery times, backlogs, i.e. orders that have been received but not completed so far and the inventories of firms. Although inventories are costly, they can insure against the risk of sudden disruptions at earlier stages of the chain. Firms at upstream stages of production may be unexpectedly forced to cut their deliveries.

-Figure 4 about here-

The GSPCI is not correlated with demand. To isolate the supply side, the respective components of the Purchasing Manager Index are regressed on new orders, and the further analysis is done with the residuals from that regressions. The GSCPI is based on information of firms located in the US, euro area, UK, China, Japan, South Korea and Taiwan. The country series are combined through principal components.

The GSCPI reached record heights at the end of 2021 (Figure 4). Supply side pressures have fallen since then, but they are still stronger than in the pre-pandemic period. Given the transmission lags of monetary policy, the decline of inflation in the most recent months might reflect primarily the relaxation of tensions in international markets, as well as lower energy prices.

[5] Kilian, Nomikos and Zhou (2021) proposed an indicator based on container trade, but it is limited to the US.

The variables are measured at the monthly frequency. Due to data availability the sample ranges from 1997.01 to 2022.12. Seasonal patterns are removed by the Census X-12 method. The GSCPI is taken from the New York Fed. The manufacturing part of industrial production, prices (consumer, producer and energy prices) and new orders are taken from the Fred database, Fed St Louis. Series for the euro area are from the Euroindicators database provided by Eurostat. Due to missing data even for some large member states, new orders are not available for the entire monetary union. Therefore, the German series reported by the German Statistical Office is used instead[6]. To remove unit roots, the variables refer to year-on-year differences, compared to the same period in the previous year. While the noise inherent in monthly differences is avoided the annual differences exhibit autocorrelation of higher order. Therefore, a lag length of 15 periods is selected, in line with the Akaike information criterion. Due to the huge number of parameters, the models are estimated via Bayesian methods, using the BEAR toolbox of the ECB (Dieppe, Legrand and van Roye, 2016). The Normal-Wishart prior is chosen, see Giannone, Lenza and Primiceri (2015) for the details. The specification of the prior is incidental, as other options show similar results.

Impulse responses of the SVAR identified by the sign restrictions in equation (6) are exhibited in Figure 5. Inflation increases in response to both demand and supply shocks. Output growth rises in response to demand but falls after supply shocks. Note that these reactions are heavily shaped by the assumptions, as the direction of the contemporaneous impacts is restricted on a priori grounds. About one third of the total draws are compatible to the restrictions. Compared to the US, the inflation response to demand and supply shocks is more persistent in the euro area. The initial rise in industrial production after a demand shock and its fall after a supply shock appear to be more pronounced in absolute value.

Figure 5 and 6 about here-

Figure 6 holds the impulse responses, if the theoretical measures are replaced by empirical variables. While one shock is identified by external instruments, the other one is identified by sign restrictions, respectively. In the upper part, new orders in the manufacturing sector are used as an instrument for tbe demand shock. The lower part has the results if the supply shock is proxied

[6] Germany heavily shapes the business cycle of the entire euro area. For instance, the correlation between growth in terms of GDP and industrial production is 0.9, respectively.

on the grounds of the GSPCI. The shocks are displayed in Annex 1. The correlation between the shocks from alternative models is about 0.8, both for the demand and supply side. Within each model, demand and supply shocks are linearly independent, with correlation coefficients of 0.01. Thus, the shocks can be fairly interpreted as structural.

The principal reactions of CPI inflation and manufacturing output growth are resembled if external instruments are used. Hence, both specifications deliver results in line with the theoretical assumptions. While the broad tendency is confirmed in all cases, some differences arise. As often reported, the impulse responses show a more erratic pattern if the shocks are identified by empirical methods. Despite that, US inflation responds more to the business cycle environment, compared to the GSCPI approach. In contrast, supply conditions play a stronger role for the inflation experience in the euro area. With respect to the changes in manufacturing output the reversed ordering is detected. For instance, the responses are stronger in absolute value for the euro area in the new orders specification, compared to the GSCPI variant. However, note that the differences are often insignificant, due to the wide range of confidence bands around the median value.

-Table 1 about here-

Due to their orthogonality, the contribution of demand and supply shocks on inflation can be revealed from a variance decomposition analysis (Table 1)[7]. In the US, the inflation experience is mainly driven by the demand side. In fact, the respective shock amounts to roughly 75 percent after 20 months have passed. Supply shocks account for the remaining 25 percent of the inflation forecast errors. The role of shocks is almost balanced in the euro area. In the longer run, supply shocks might dominate the evolution, depending on the model specification. For example, demand shocks have a weight of 40 percent, if the shocks are identified by sign restrictions. Given the wide confidence intervals of ±0.4 percentage points at the 0.68 level, the differences are not significant. Nonetheless, the pattern has implications for the chances of success of the course of monetary policy.

[7] A similar analysis can be done for manufacturing output growth. It is skipped here but can be obtained from the author upon request.

In particular, a more restrictive monetary policy can reduce inflation, especially if price hikes are demand driven. Higher interest rates can tame inflation, as they have adverse effects on private consumption and investment, probably after a delay in the policy transmission. Besides that, the policy needs to compensate for the supply drivers of inflation. The latter are usually beyond the control of central banks. Seen from that perspective, monetary policy might become overly restrictive. The risk of stagflation, i.e. a longer time period of rather high inflation and low economic growth is stronger in the euro area, due to the larger weight of supply shocks. Once again, the results underpin the necessity to implement structural reforms on the labor and product markets to improve the resilience of the monetary union against adverse shocks. This issue has a long standing tradition in policy consulting, see for example Artis, Dreger, Moreno, Ramos and Surinach (2007) and Gomes (2018). In any case, a more contractive monetary policy will benefit from the relaxation of lower tensions in international production networks. Without sufficient tailwind from the supply side, a return to the pre-Corona inflation targets of about 2 percent might be difficult.

4 Conclusion

After a long period of price stability, inflation returned to record levels in many parts of the world economy. This paper investigates the role of demand and supply shocks behind this process. Structural VAR models are specified for the US and the euro area. Shocks are identified by sign restrictions and external instruments. Demand shocks dominate in the US and can explain roughly 75 percent of the inflation experience. Supply side shocks like bottlenecks in global value chains account for the remaining 25 percent of the variance of inflation forecast errors. In the euro area, the shocks are almost balanced. Depending on the model specification, supply shocks may even play a larger role over longer periods. Higher interest rates can tame inflation due to their adverse effects on private consumption and investment. However, supply factors are usually beyond the control of central banks. Thus, monetary policy might become overly restrictive if the impact of the non-demand drivers is neutralized. Due to the larger weight of supply shocks in the monetary union, the risk of stagflation, i.e. a longer period of high inflation and low output growth is especially high in that region. The results underpin the need of structural reforms for the euro area to improve the resilience against adverse shocks. Hence, monetary policy could be easily overburdened if it is used as the only instrument to combat inflation. For the US and the euro area, a resolution of supply side pressures is required as a tailwind to return to the previous inflation targets of around 2-3 percent. Otherwise, slightly higher long run inflation rates should be accepted to avoid real economic losses.

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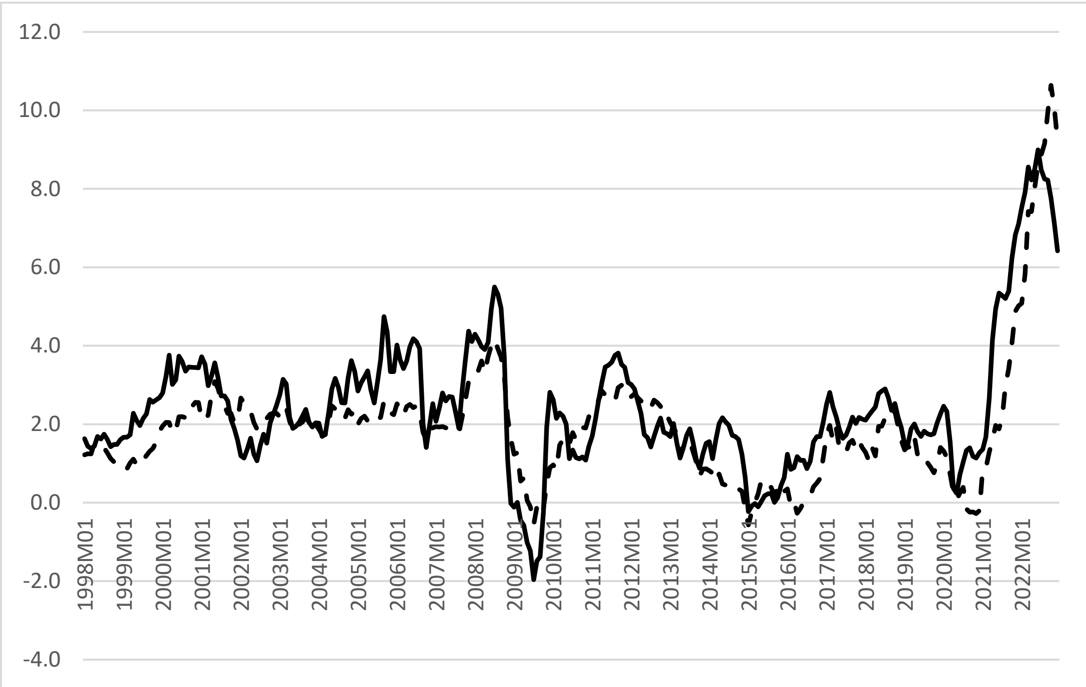
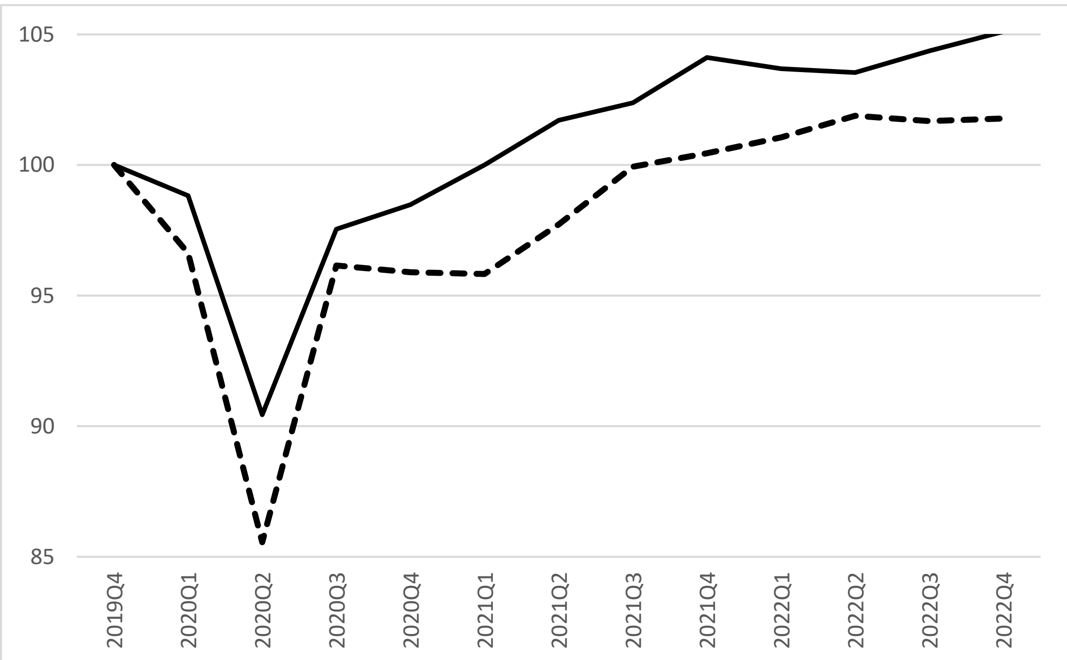
Figure 1: CPI inflation in the US and euro area



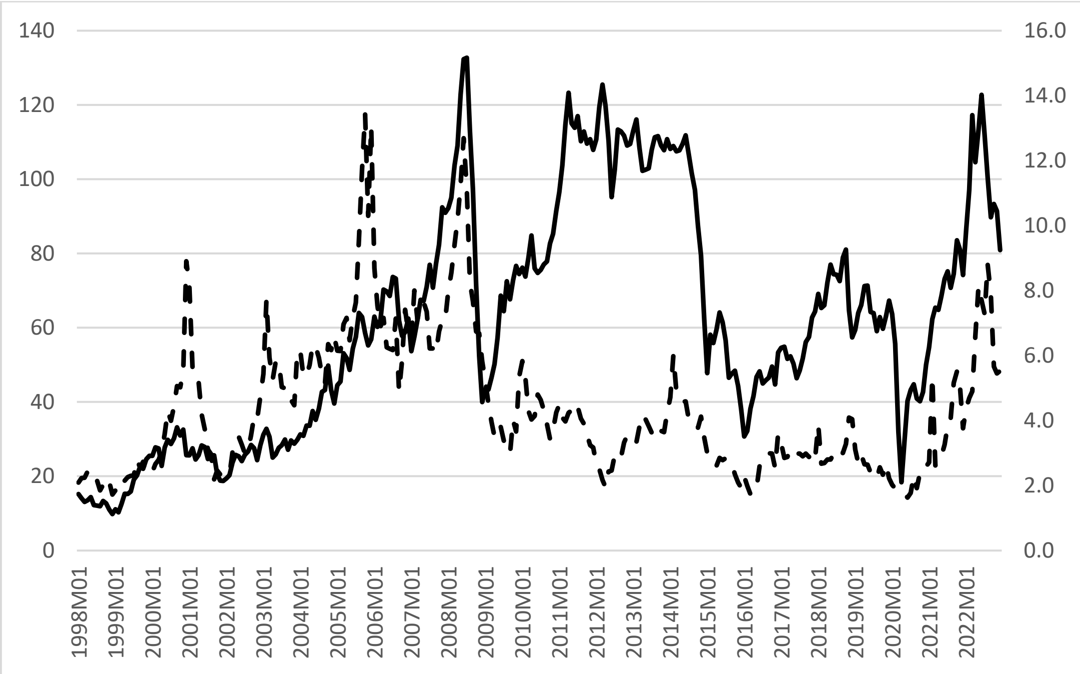
Note: OECD Main Economic Indicators. CPI growth relative to same period in previous year. US solid line, euro area dashed line.

Figure 2: Real GDP in the US and euro area



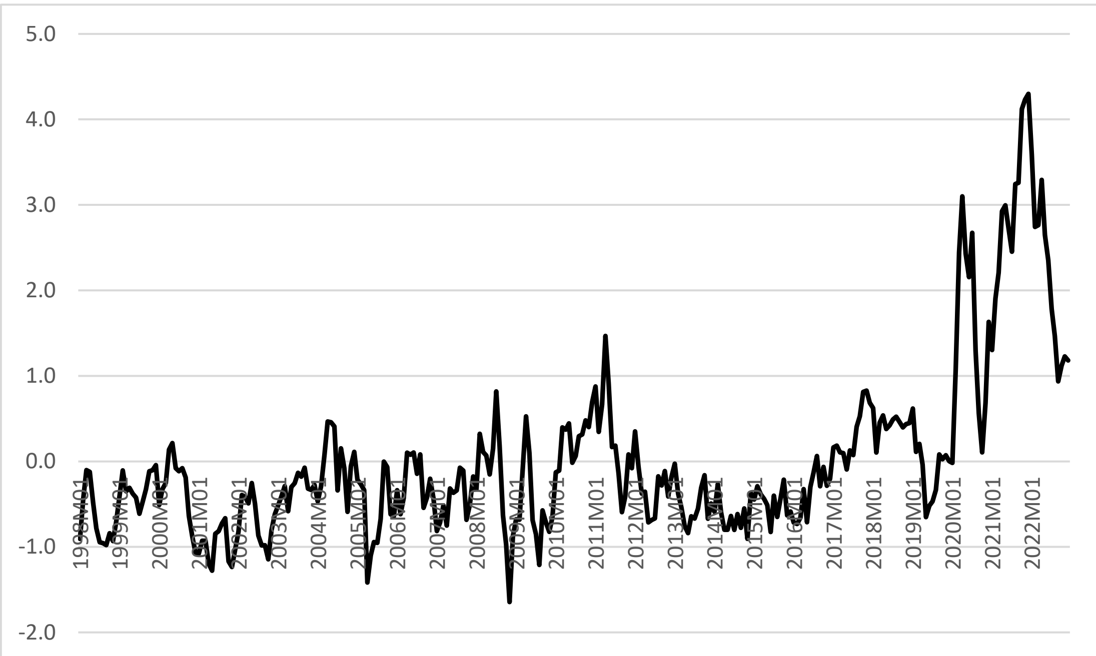
Note: OECD Main Economic Indicators. 2019.4=100. US solid line, euro area dashed line.

Figure 3: Energy prices



Note: Brent oil prices in USD, left scale (solid), natural gas spot prices per million BTU in USD, right scale (dashed line).

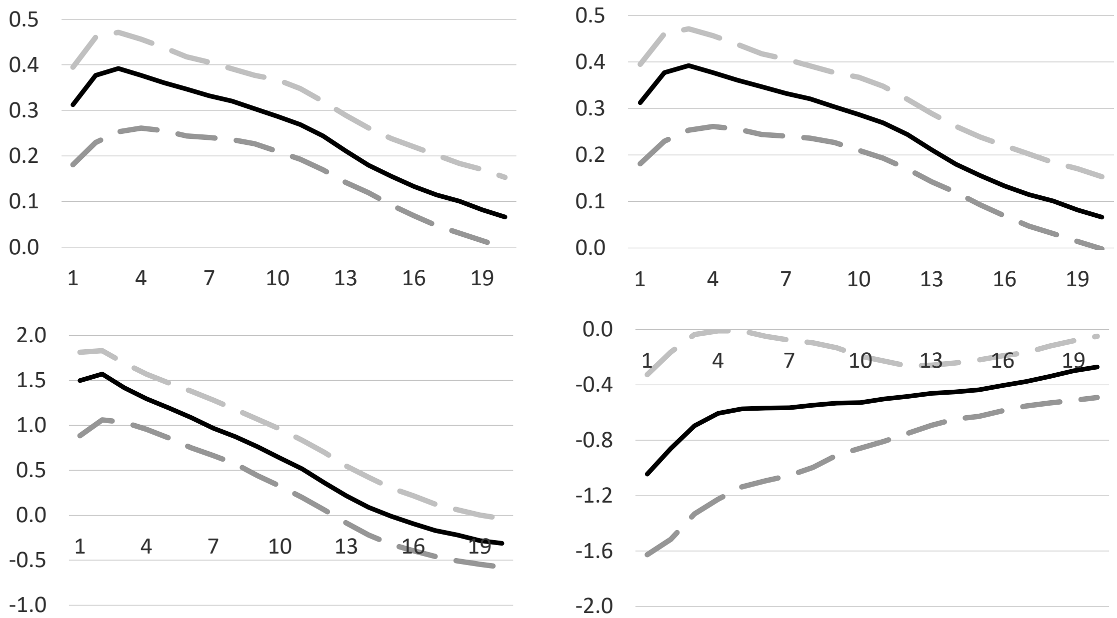
Figure 4: Global supply side chain pressures



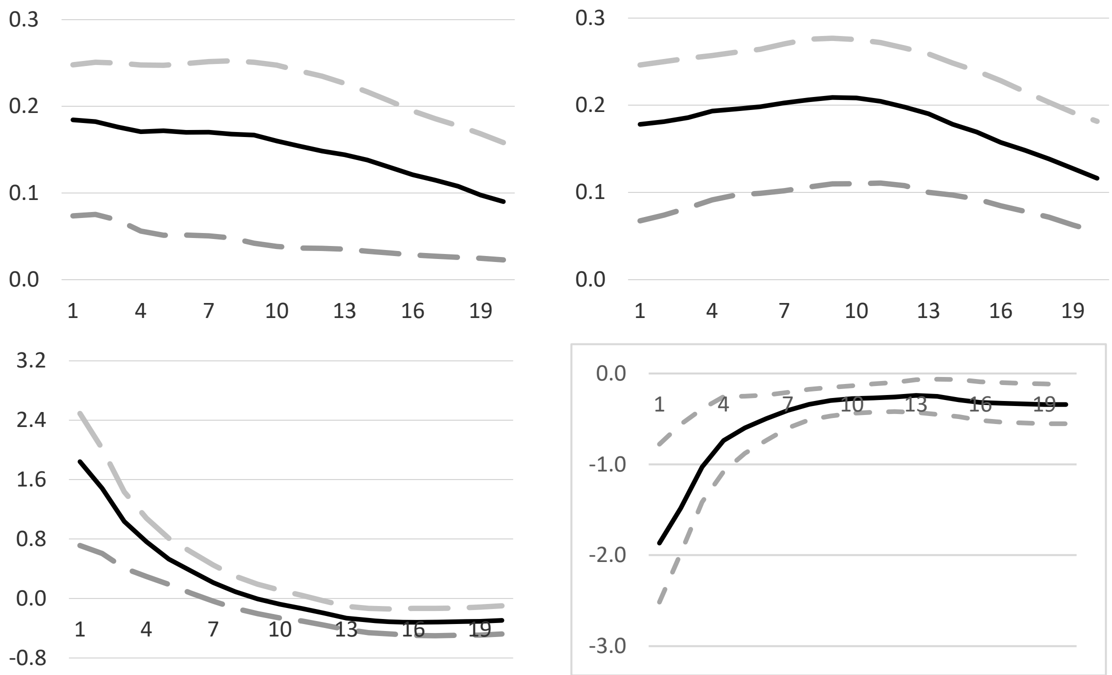
Note: Index is normalized to 0, i.e. positive (negative) values indicate a tighter (weaker) restrictions. See Benigno, Di Giovanni, Groen and Noble (2022).

Figure 5: Impulse responses: Identification by sign restrictions

United States



Euro area

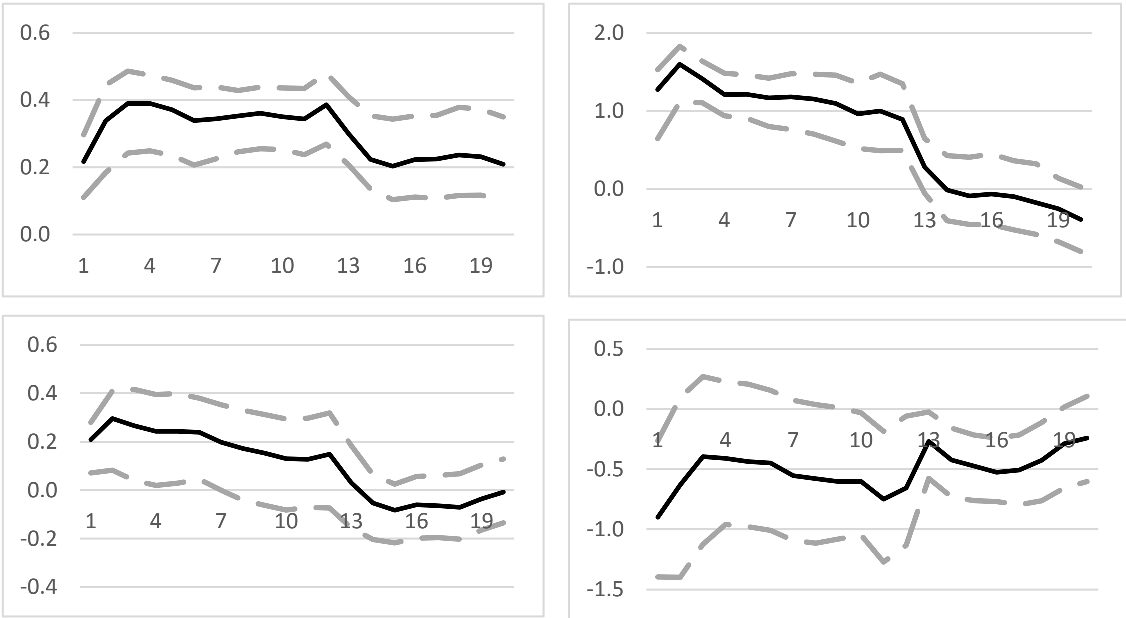


Note: Bayesian SVAR, Normal Wishart prior, 15 lags (Akaike). Sign restrictions equation (6). Shocks in columns on the demand (left) and supply side (right). Responses in rows: CPI inflation (above) and output growth (below). Responses refer to median, 68 percent confidence bands.

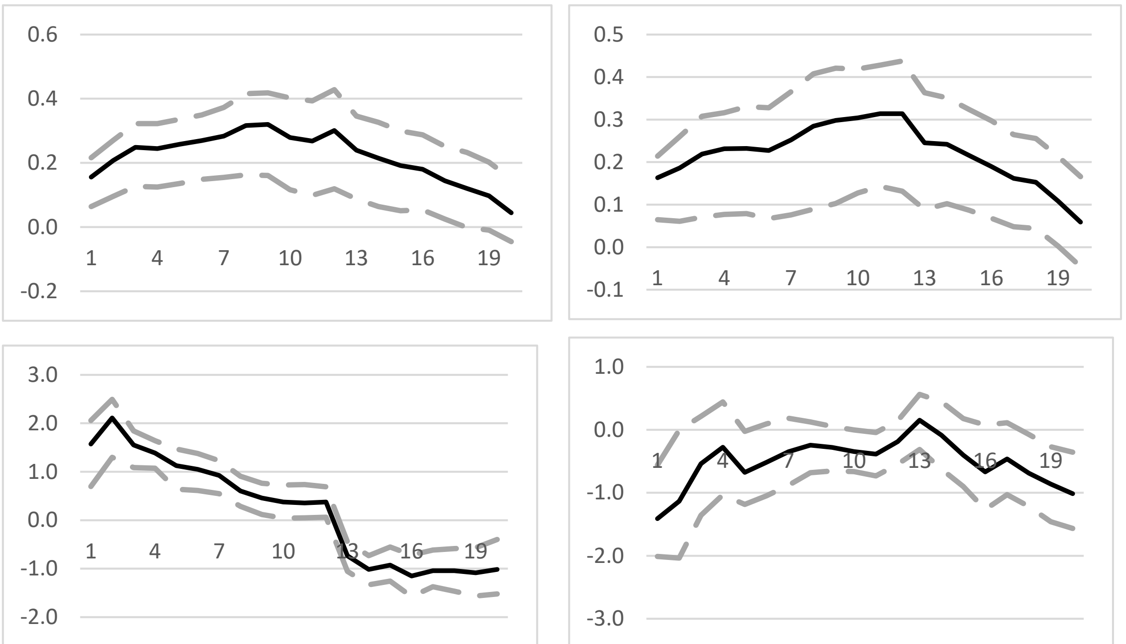
Figure 6: Impulse responses: Identification by external instruments

A Demand shock proxied by new orders, manufacturing sector

United States



Euro area

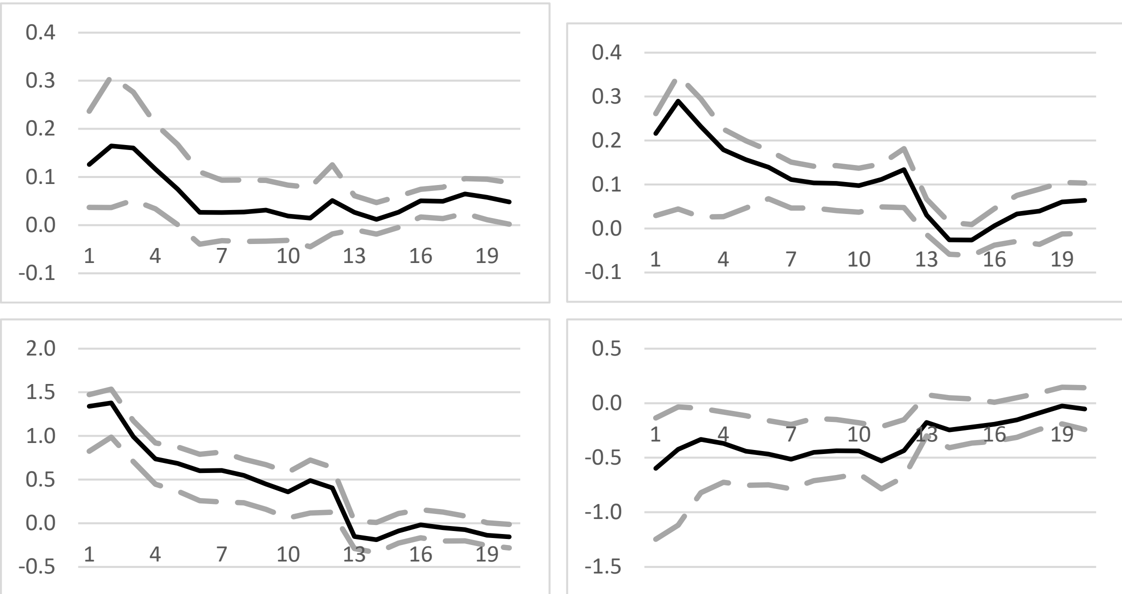


Note: Bayesian SVAR, Normal Wishart prior, 15 lags (Akaike). Demand shock identified by new orders, supply shock by sign restriction. Shocks in columns on the demand (left) and supply side (right). Responses in rows: CPI inflation (above) and output growth (below). Responses refer to median, 68 percent confidence bands.

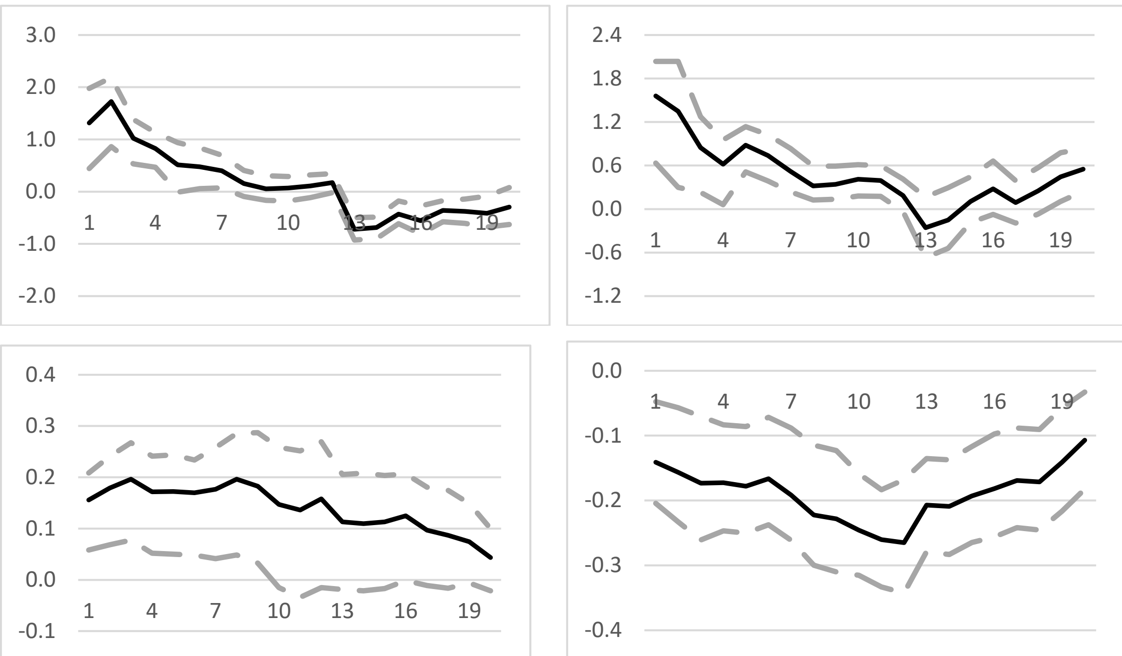
Figure 6: Impulse responses: Identification by external instruments

B Supply shock proxied by bottlenecks in global value chains (GSCPI)

United States



Euro area



Note: Bayesian SVAR, Normal Wishart prior, 15 lags (Akaike). Supply shock identified by GSCPI, demand shock by sign restriction. Shocks in columns on demand (left) and supply side (right). Responses in rows: CPI inflation (above) and output growth (below). Responses refer to median, 68 percent confidence bands.

Table 1: Variance decomposition of inflation forecast errors

United States

	Sign		Instrument New Orders		Instrument GSPCI	
Shock →	Demand	Supply	Demand	Supply	Demand	Supply
1	0.59	0.41	0.55	0.45	0.79	0.21
5	0.68	0.32	0.65	0.35	0.78	0.22
10	0.76	0.24	0.72	0.28	0.81	0.19
15	0.77	0.23	0.77	0.23	0.82	0.18
20	0.77	0.23	0.76	0.24	0.79	0.21

Euro area

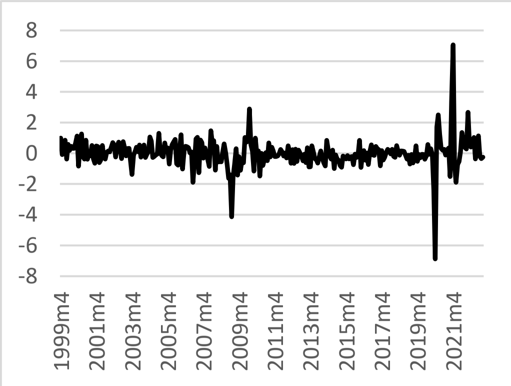
	Sign		Instrument New Orders		Instrument GSPCI	
Shock →	Demand	Supply	Demand	Supply	Demand	Supply
1	0.52	0.48	0.47	0.53	0.54	0.46
5	0.47	0.53	0.53	0.47	0.51	0.49
10	0.43	0.57	0.51	0.49	0.45	0.55
15	0.43	0.57	0.49	0.51	0.37	0.63
20	0.42	0.58	0.48	0.52	0.35	0.65

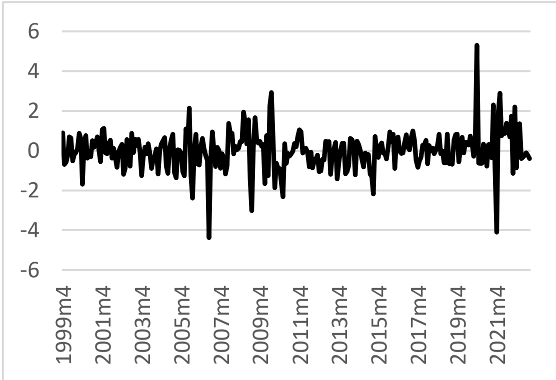
Shares in the decomposition of the variance of the inflation forecast errors attributed to shocks identified by sign restrictions or external instruments, combined with sign restrictions.

Annex 1: Structural shocks in the different models

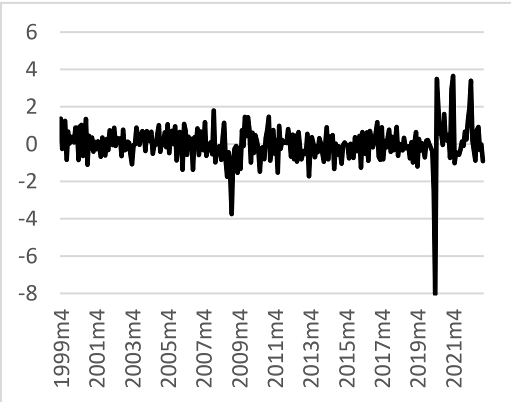
United States

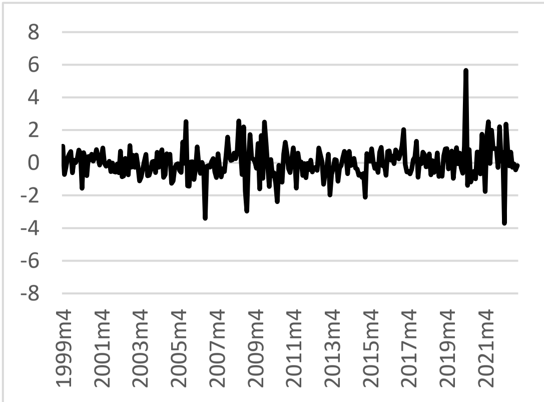
Identification by sign restrictions



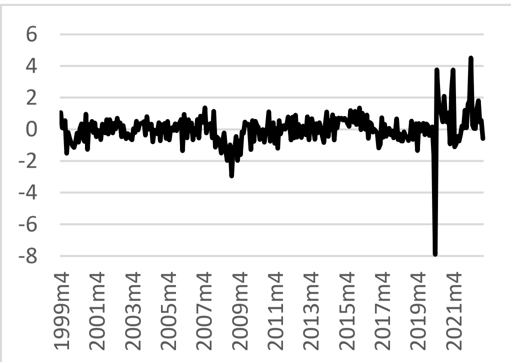


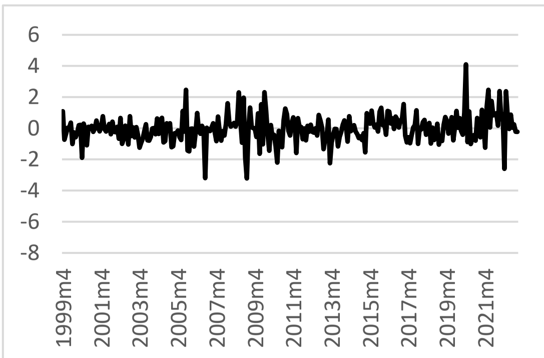
Identification by external instruments: New orders (proxy for demand)





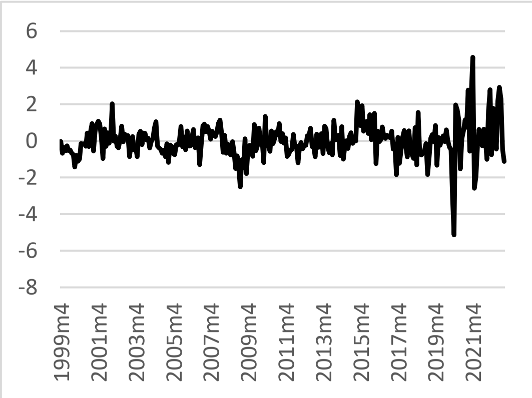
Identification by external instruments: GSCPI (proxy for supply)

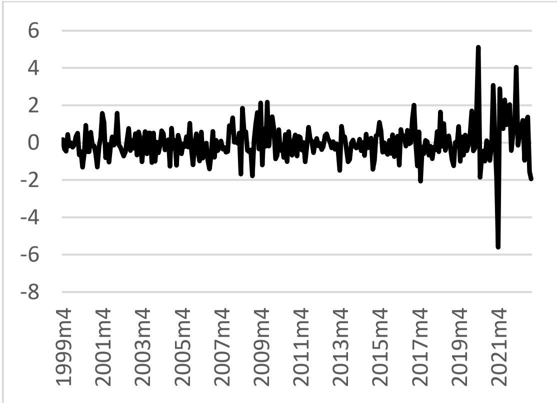




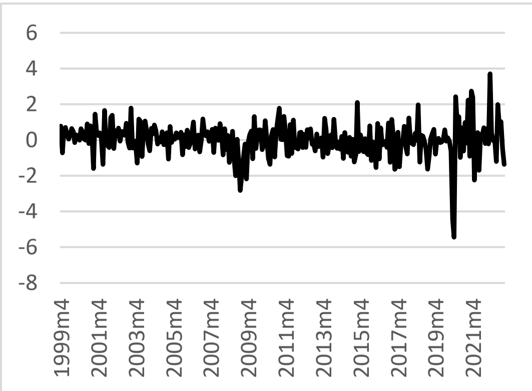
Euro area

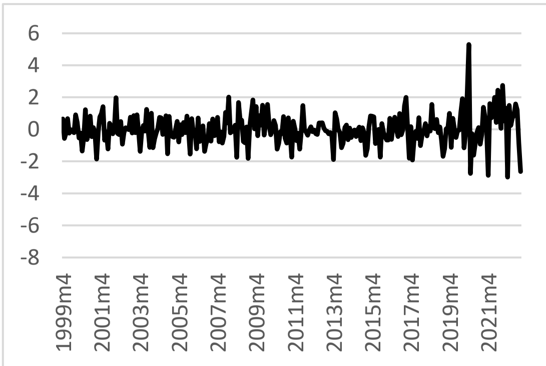
Identification by sign restrictions



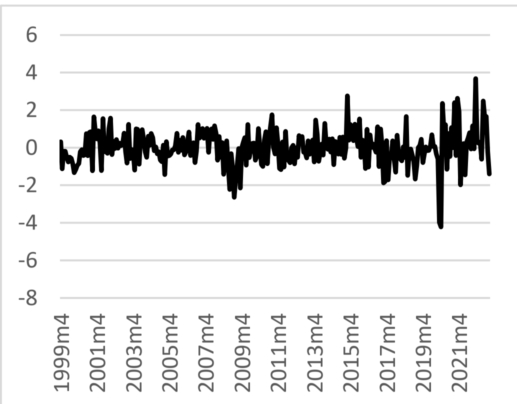


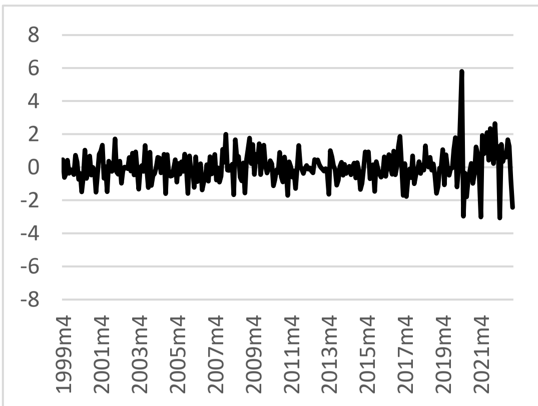
Identification by external instruments: New orders (proxy for demand)





Identification by external instruments: New orders (proxy for supply)





Note: Left column show the demand shocks, right column the supply shocks from the different models.