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ASSESSING THE PASS-THROUGH OF ENERGY PRICES TO INFLATION IN THE EURO AREA

by Francesco Corsello* and Alex Tagliabracci*

Abstract

This paper focuses on the developments of energy prices since mid-2021 and assesses their impact on euro-area headline inflation, also considering the indirect transmission through the core and food components. We find that, while the contribution of energy inflation to core and food inflation is generally low in normal times, it has been significant in the recent period, as a consequence of the exceptional increase in energy prices. In the first nine months of 2022, energy inflation accounted for more than 60 per cent, on average, of headline inflation in the euro area, either directly or indirectly. The same result holds qualitatively true for the four largest countries in the euro area, although with some quantitative differences. These findings provide relevant indications for setting the normalization path of monetary policy in the euro area. Given the prevailing role of energy prices – an exogenous supply factor that can hardly be affected directly by policy rate increases – in driving inflation, the appropriate speed of adjustment largely depends on the assessment of the risks of second-round effects and of a de-anchoring of long-term inflation expectations.

JEL Classification: C11, E31, E32, E52.
Keywords: energy price shocks, inflation dynamics, pass-through.
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Contents

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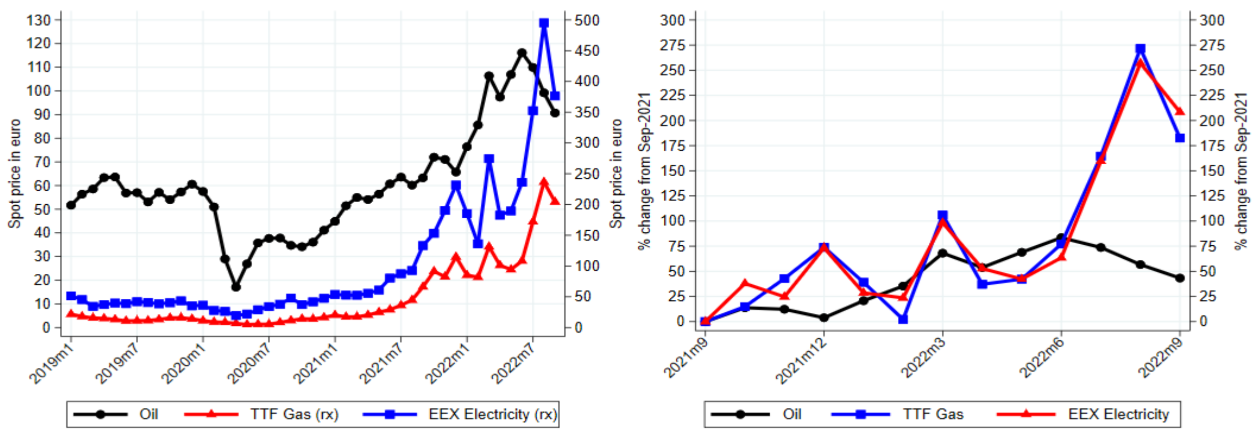
1. Introduction[1]

Starting from mid-2021, energy prices rose exponentially in the global markets reaching historically high values. While the initial jump mainly owed to the rebound of real activity across the globe after the Covid-19 shock, the economic consequences of the Russian invasion of Ukraine and the corresponding impact on the supply of the energy commodities have further fueled the dynamics of these prices since February 2022, especially in Europe.[2] This upward trend characterized all the main energy components (Figure 1a), although to a different extent: while the rise in oil price was still sizeable but not exceptional compared with previous episodes, the magnitude of those for electricity and gas prices was undoubtedly unprecedented. As shown in Figure 1b, the spot price for these two commodities rose almost by 300 per cent in less than twelve months.

Figure 1: Recent developments in energy prices



Source: authors' calculations on Refinitiv data, monthly average. Last observation: September 2022. Note: Panel a) presents the prices of the three commodities while Panel b) considers their percentage variations with respect to their value observed in September 2021. For gas the TTF market price is plotted, which is the one relevant for Europe.

The global nature of the rise in energy prices led to a sequence of energy shocks which hit hardly also consumer prices in the euro area.[3] Headline inflation almost reached the double digit in September

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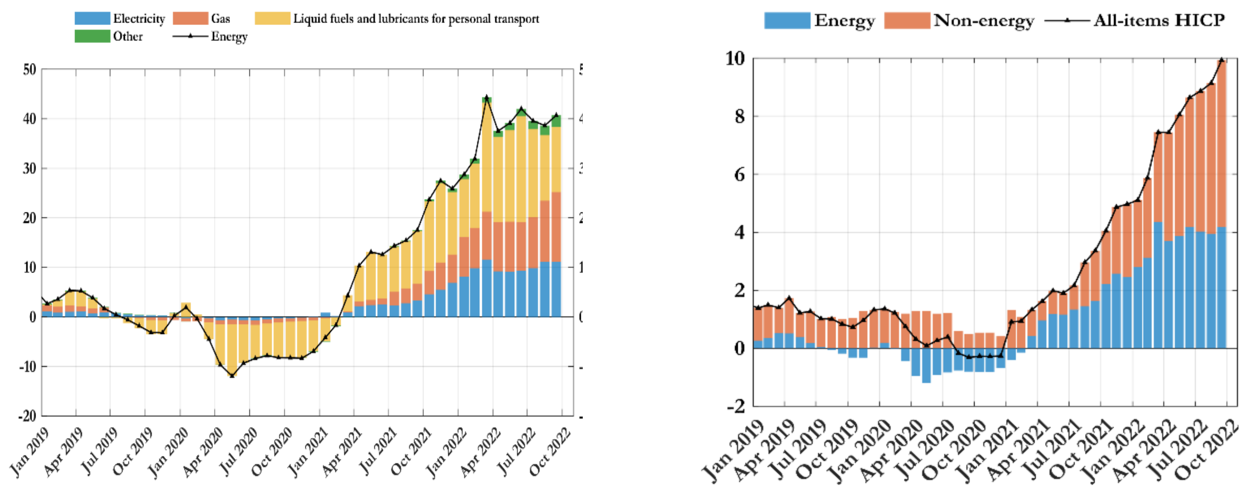
[1] Without implications, we would like to thank Fabio Busetti, Michele Caivano, Cristina Conflitti, Paolo Del Giovane, Stefano Neri, Marianna Riggi, Tiziano Ropele, Alessandro Secchi, Giordano Zevi, Roberta Zizza and Francesco Zollino for useful suggestions and comments at different stages of this work. All the remaining errors are ours alone. *The views expressed here should not be interpreted as representing the views of the Bank of Italy or of the Eurosystem.*
[2] For instance, Ropele and Tagliabracci (2022) exploit survey data on Italian firms collected in the first quarter of 2022 before and after the start of the Russian invasion to document how the outbreak of the conflict affected firms' expectations.
[3] With respect to the literature on the global nature of inflation, Ciccarelli and Mojon (2010) and Carriero et al. (2022) provide some empirical evidence for the commonality in the level and in the volatility of inflation rates, respectively.

2022 (at a historical record of 9.9 per cent), driven to a large extent by the dynamics of the energy component (which grew more than 40 per cent y-o-y, Figure 2a) which *directly* contributes for roughly 4 percentage points to the variation of the total index (see the blue bars in Figure 2b).[4]

Figure 2: Energy inflation and its contribution to headline inflation in the euro area

(a) Decomposition of energy inflation (b) Contribution to headline inflation

(*y-o-y variation; percentage points for the contributions*) (*y-o-y variation; percentage points for the contributions*)



Source: authors' calculations on Eurostat data. Last observation: September 2022.

This paper investigates to what extent the unprecedented magnitude of the increase in energy prices has exerted, in addition to the *direct* contribution, (larger-than-usual) *indirect* spillovers on headline inflation via the *non-energy* components.[5] Indeed, the price pressures originated in the energy wholesale markets may be passed-through along the production chains and, therefore, they can affect the prices of non-energy items such as food, goods and services.

To quantify this price pass-through, we rely on a standard Vector Auto Regression (VAR) model which allows us to characterize the effects of an energy shock on non-energy prices and to quantify its contribution on the dynamics of prices observed over the most recent months.

[4] In September 2022, headline inflation reached historically high values in all the euro-area countries, although with some heterogeneity. This reflects to some extent the different contribution of the energy component, which was affected by several government interventions announced to attenuate the rise in the prices of energy.

[5] In this context, some examples are Baumeister and Kilian (2014) for food items and Clark and Terry (2010) and Conflitti and Luciani (2019) for core inflation.

As to the role of energy prices on the dynamics of inflation in the euro area, our finding is that the estimated historical pass-through of energy prices to core and food inflation (i.e. the elasticity of the prices of these items to an energy price shock) is statistically significant but overall quite small. However, the unparalleled energy price shock occurred since mid-2021 has, differently from the past record, generated sizeable positive contribution on these components. Net of the impact of the estimated energy shocks, core and food inflation would have been respectively 0.7 and 2.8 percentage points lower than official figures in the average of the first 9 months of 2022 (out of 3.6 and 7.5 per cent, respectively). Second, we show that cross-country heterogeneity in the contribution of the energy component to the level dynamics of core and food inflation reflects mostly the different magnitude of the energy shocks experienced in these countries, which in turn mirrors mostly the structure of country-specific energy markets and the diverse extent of national government interventions.

Our evidence on the nature of the recent price dynamics in the euro also provides some general insights for the conduct of the optimal monetary policy. Energy prices contribute to headline inflation, via both the *direct* and the *indirect* channels, for about 60 percent in the average of the first 9 months of 2022. According to Woodford (2003) and Blanchard and Riggi (2013), the optimal response of the central bank in terms of interest rate hikes depends on two main factors: (i) the degree of anchoring of long-term inflation expectations, and (ii) the degree of wage-indexation, which provides the main channel for second-round effects to potentially trigger the so-called wage-inflation spiral. With respect to the former, in the last quarter of 2022 the median of the long-term inflation expectations from the ECB Survey of Professional Forecasters was at 2 per cent;[6] evidence provided by Neri et al. (2022) indicates, more generally, that long-germ expectations appeared broadly anchored to the ECB inflation target in the same period.[7] As for the second factor, although with some cross-country differences (see Koester and Grapow, 2021), the level of wage-indexation in the euro is relatively low in the euro area; this should mitigate the risk of the start of a wage-inflation spiral.[8] Based on this evidence, an appropriate pace of normalization of the monetary policy would see gradual adjustments to interest

[6] For complete details on the most recent results for 2022Q4, see https://www.ecb.europa.eu/stats/ecb_surveys/survey_of_professional_forecasters/html/ecb.spf2022q4~eb4b9aa2c2.en.html.

[7] Before the Covid-19 and this recent energy shock, the period between 2014 and 2019, also known as "*missing inflation*", had important effects on the degree of anchoring of (long-term) inflation expectations in the euro area, as shown by Bulligan et al. (2021), Cecchetti et al. (2021), Corsello et al. (2021) and Bottone et al. (2022).

[8] Battistini et al. (2022) study the potential second-round effects on inflation at times of energy price increases in the euro area and they show that they played a major role in the transmission of oil supply shock to inflation in the 1970s and in 1980s, but these have been negligible on average in the period since the euro was lunched.

rates as more desirable than large interest rates hikes, highly concentrated in time (see Woodford 2003).

This paper is structured as follows. Section 2 illustrates the econometric model and the identification scheme used to quantity the pass-through of energy prices to inflation. Section 3 presents the main empirical results of the structural analysis and Section 4 looks more in details at the cross-country differences. Section 5 concludes.

2. The econometric model

We rely on a standard VAR model which provides us with a flexible tool to deal with the inter-linkages between variables without imposing too much structure on the data. It can be described by the following polynomial matrix form:

$$Y_t = B(L)Y_{t-1} + \epsilon_t \qquad (1)$$

where Y_t is a $m \times 1$ vector, $B(L)$ is a polynomial containing the matrix of coefficients and ϵ_t a vector of residuals normally distributed with zero mean and variance-covariance matrix Σ. Here, Y_t is five-variable vector including monthly euro-area stationary series specified as y-o-y percentage variations. We include 13 lags of energy inflation, food inflation, core inflation, unemployment rate, and negotiated wages growth. As a caveat, this small-scale specification, aimed at quantifying the pass-through, omits fluctuations of variables related to the monetary stance, such as policy rates and inflation expectations.

The model is estimated using Bayesian techniques with standard prior settings that are able to preserve efficiency in presence of a large number of lags by providing some shrinkage. This specification allows us to study the impact of energy prices on core inflation controlling for the labour market conditions (in the spirit of a Phillips curve specification) and for the dynamics of wages.[9] The sample covers the period 2002M1-2022M9.

The model estimates time-invariant coefficients and hence it does not consider possible non-linearities (both in the shocks' volatility and in the systematic relations between variables) that may have been at play in the last years of volatile macroeconomic data, due to the pandemic outbreak and the subsequent recovery. We have also considered a specification of the VAR in equation (1) with

[9] The specification is similar to the approach proposed by Clark and Terry (2010).

time-varying coefficients and stochastic volatility to possibly capture the time evolution in the elasticities among variables and the potential changes in the pass-through of energy prices in the recent period.[10] However, the estimated coefficients appear relatively stable over the sample period, suggesting that a specification with time-invariant parameters is a reasonable choice for our analysis. Nevertheless, given the unparalleled extent and size of price increases in the energy markets occurred since 2021 our estimates may be considered a lower bound estimate of the indirect effect.

The identification of energy shocks is achieved by using a standard recursive scheme, namely a *Cholesky* decomposition of the variance-covariance matrix of the residuals. Following previous studies, in particular the seminal paper by Kilian (2008), energy price inflation is ordered first, such that structural innovations to energy prices in the VAR are exogenous with respect to all other current-period shocks. This amounts to assuming that energy prices can be simultaneously affected only by structural shocks related to its own equation innovations. The ordering of variables and the triangular identification scheme imply that core inflation can potentially react contemporaneously to energy and food shocks.

3. Estimates of pass-through in the euro area

3.1 Impulse response functions

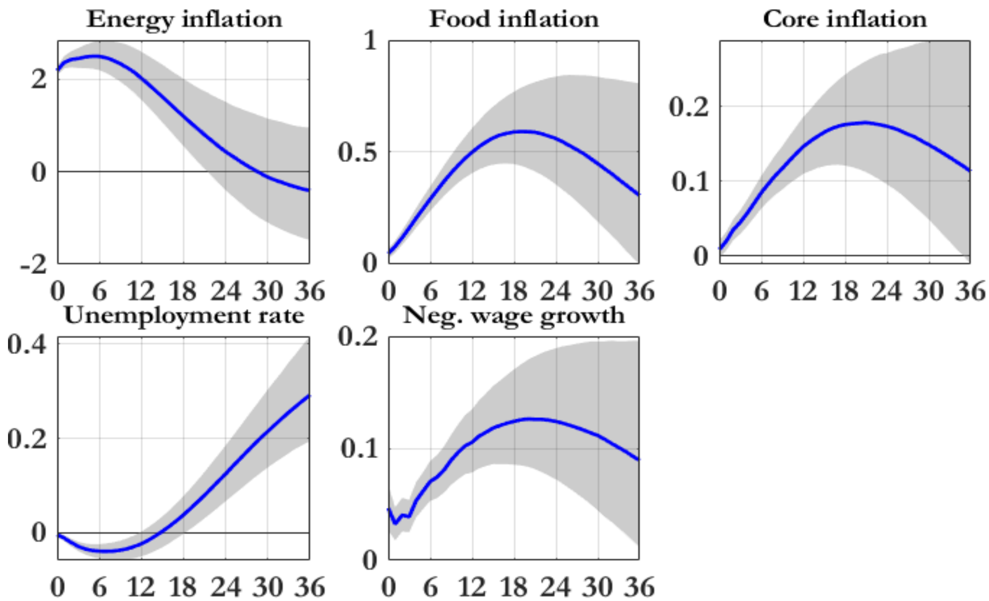
We start our analysis by looking at the effects of an energy shock on the variables included in our specification. We consider a one standard deviation shock to energy prices which, based on our sample, corresponds to an increase on impact of roughly 2 percentage points in the variation with respect to one year before (y-o-y, henceforth) of energy inflation.

Figure 3 shows some clear findings. First, the effects of an energy shock on food and core inflation are statistically significant but overall quantitatively limited, pointing towards a *largely incomplete* pass-through to non-energy components. Second, the size of the effect on food inflation is roughly three times that on core inflation, signaling a higher sensitivity of food prices to the dynamics of energy, consistently with Baumeister and Kilian (2014). Third, the response of negotiated wages mimics in size and in shape its counterpart of core inflation, suggesting that in the euro area underlying inflation is closely related to nominal wage dynamics, hence being affected by the impact of energy

[10] Some example of studies which document quantitative differences in the effects of oil price shocks over time and/or economic regimes are Clark and Terry (2010), Baumeister and Peersman (2013) and Blanchard and Riggi (2013).

prices only to a minor extent.[11] Looking at the response of unemployment, after a small decline in the first twelve periods, the energy shock causes a persistent rise in unemployment, which may reflect the persistent, although limited, increase in wage inflation and also the contraction in economic activity.

Figure 3: response to one standard deviation energy shock



Source: Authors' calculations on Eurostat data. *Note*: The blue line corresponds to the median response, while the grey areas represent 68% posterior credible intervals.

3.2 The magnitude of the recent energy shocks in historical perspective

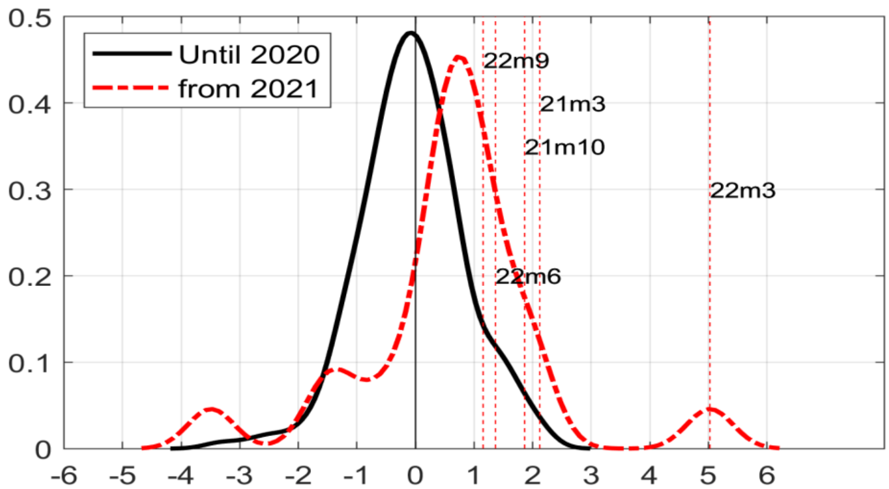
In this section, we analyse the magnitude of the estimated (structural) energy shocks in our sample from a historical perspective. To contextualize the recent episode, we look at the distribution of energy shocks observed over the last two years and we compare it with the historical distribution. Figure 4 presents two estimated distributions of shocks, based on standard kernel density techniques: the black line considers the sample until the end of 2020, while the red line uses data only from 2021 onwards.

The distribution for the last two years shows a positive mean and a marked skewness to the right, indicating the presence of a sequence of positive energy price shocks, which in several circumstances

[11] Wage indexation regimes and more in general the institutions of wage bargaining can be different across euro area countries, and the likelihood of wage-setting schemes triggering second-round effects based on inflation indexation is relatively limited, particularly when it comes to energy inflation. For instance, in Italy the reference for collective agreements is the HICP index net of imported energy. Koester and Grapow (2021) provide a comprehensive overview across euro area countries.

were exceptionally high in historical terms. The magnitude of these positive shocks is so large that combined with the responses presented in Figure 3 allows the energy shocks to play an important role in the dynamics of non-energy components of inflation in the euro area.

Figure 4: the recent structural energy shocks in historical perspective



Source: Authors' calculations on Eurostat data. *Note*: Obtained via a standard kernel estimation of the distribution of the shocks, the black curve represents the one for the sample until 2020, the red dash-dotted curve the one characterizing the shocks from 2021 onwards. The dotted vertical lines indicate the size of the shocks for the specific period.

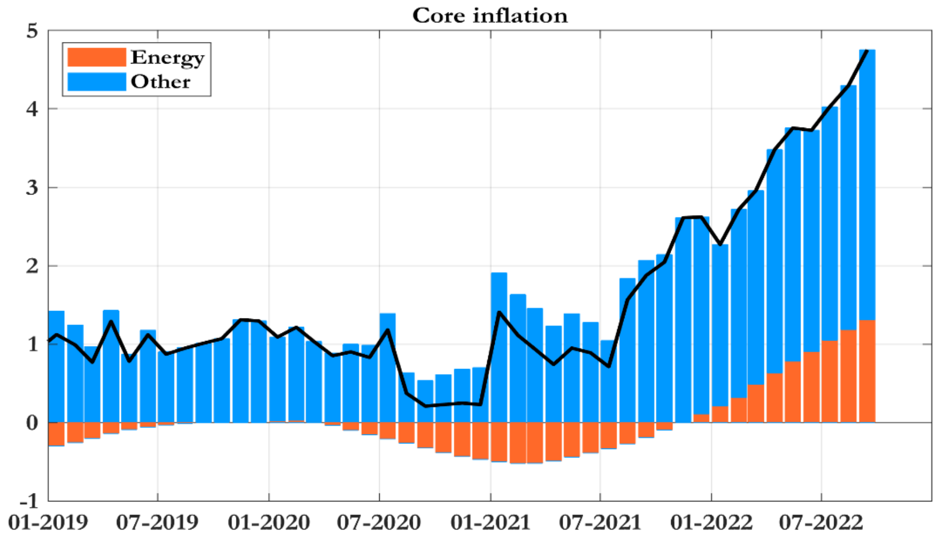
3.3 What accounts for inflation developments in recent months?

The results presented so far highlight that the pass-through of energy shocks to core and food inflation is historically modest, but also that the frequency and size of such shocks have been in the last two years of the sample exceptional. These findings motivate us in quantifying how much of the recent energy shocks has propagated to the other inflation components, and to provide *counterfactual* estimates of the dynamics of core and food inflation net of such shocks.

Figure 5 presents the historical decomposition of core inflation over the last three years, separating the contribution of energy shocks from that from the other drivers. It turns out that the negative energy shock occurred in 2020 exerted a negative pressure on core inflation until the first half of 2021. Then, the contribution turned positive starting from the end of 2021 as a consequence of the positive energy prices shock occurred in the second part of the year that exerted an upward pressure on core inflation with some delay (as described in Figure 3). In September 2022, the contribution of energy shocks accounts for about 1.3 percentage points of the 4.8 per cent value reached by core inflation; in the average of the first nine months of 2022, core inflation would have been 0.7 percentage points lower than the official figure (3.6 per cent) absent the energy shock.

Figure 5: contribution of energy shocks to core inflation dynamics

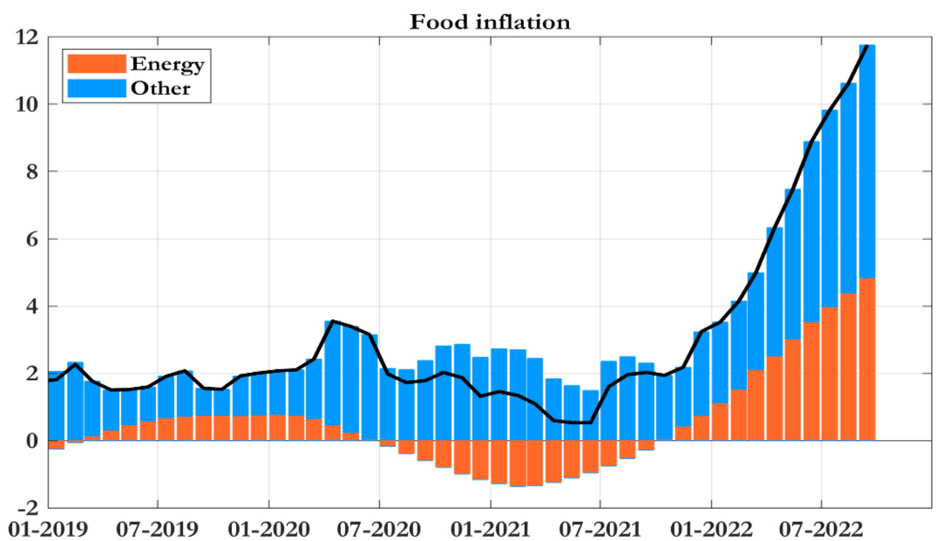
(*per cent and percentage points*)



Source: Authors' calculations on Eurostat data. *Note*: The black solid line represents the series for core inflation while the bars show the contributions of energy and of the other factors to its dynamics.

Figure 6: contribution of energy shocks to food inflation dynamics

(*per cent and percentage points*)

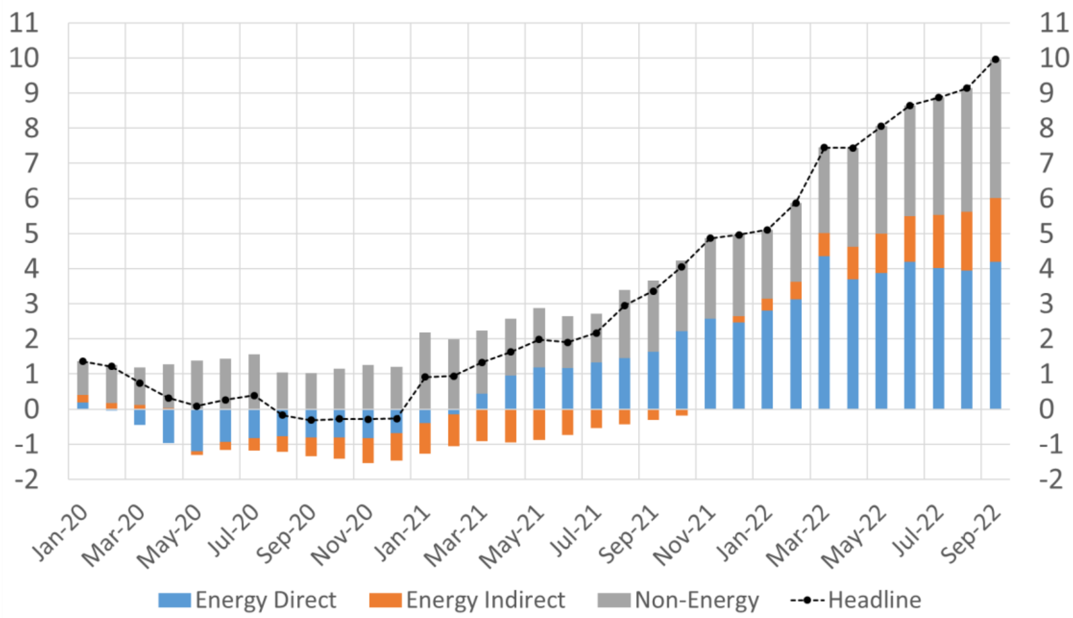


Source: Authors' calculations on Eurostat data. *Note*: The black solid line represents the series for food inflation while the bars show the contributions of the energy shocks and of the other factors to its dynamics.

The results are qualitatively similar for food inflation, although with a different order of magnitude. The counterfactual analysis in Figure 6 shows that energy shocks had a large negative contribution to the dynamics of food inflation from mid-2020 until mid-2021. Since then, food prices have been pushed upwards by energy shocks, explaining almost half of its growth in the last months.

Net of these shocks, in September 2022 food inflation would have been 4.9 percentage points lower than the official value (6.9 instead of 11.8 per cent according to the preliminary estimate). In the average of the first nine months of 2022, the contribution to the food component would have been quite sizeable, at 2.8 percentage points (out of 7.5 per cent). Figure 7 illustrates the decomposition of headline inflation: in September 2022 headline inflation has been directly affected by energy component by around 4 p.p., while indirect effects contribute to roughly 2 p.p., contributing to a total share of 60 per cent of the inflation rate.

Figure 7: total contributions of energy components to headline inflation dynamics
(*per cent and percentage points*)



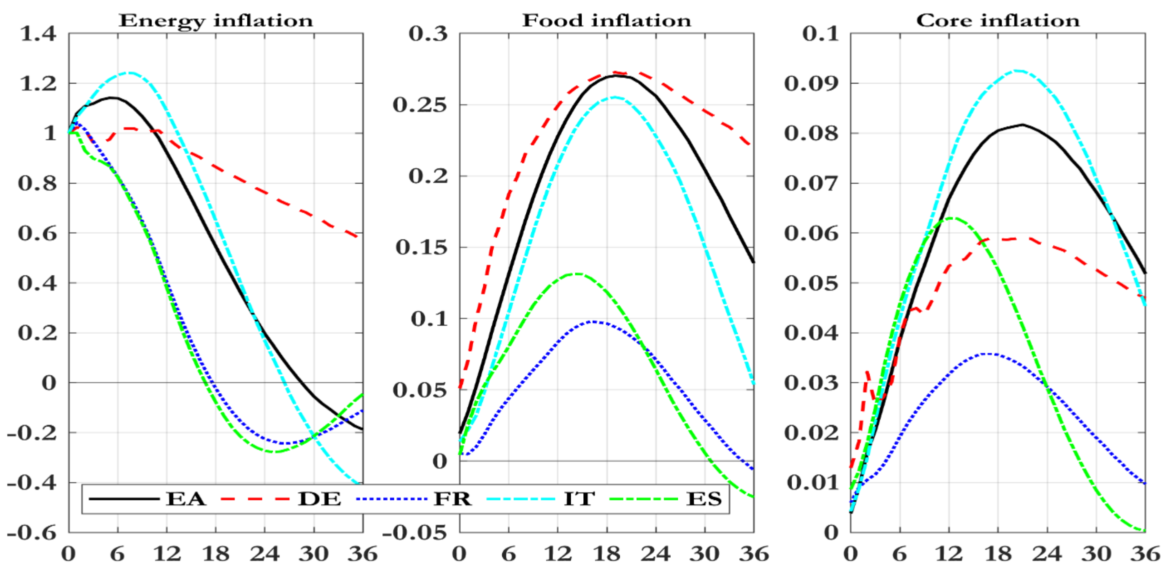
Source: Authors' calculations on Eurostat data. *Note*: The black solid line represents the series for headline inflation while the bars show the (direct and indirect) contributions of energy components.

4. A cross-country analysis

In this section, we replicate the previous analysis by considering the largest four euro-area countries, namely Germany, France, Italy and Spain, which taken together account for about 75 per cent of euro area GDP in 2022.[12] Figure 8 shows the median posterior responses for a standardized energy shock in the euro area and the main four countries.

Looking at the left panel, the estimated responses point to a larger propagation of the energy shock in the short term for Germany, coupled with a higher degree of persistence in the medium term. France and Spain show instead an impulse propagation that is generally smaller than the euro-area aggregate, while Italy display a propagation very similar to the euro area, in terms of both size and persistence. As for the responses of food inflation, Germany and Italy show a pass-through that is comparable with the euro area aggregate, while for Spain and especially France the pass-through is smaller. As for the pass-through to core inflation, in Italy there is a slightly stronger response compared with Germany, France and Spain.

Figure 8: response to one percentage point energy shock across countries



Source: Authors' calculations on Eurostat data. *Note*: The lines correspond to the median response for the corresponding country. Shocks are standardized such that the response of energy inflation on impact is equal to 1 percentage point.

The different size and propagation throughout the pricing chain of the energy shock in the main countries can be assessed by looking at the historical decomposition of core and food inflation. As noted also by some commentators (see for instance Sgaravatti, Tagliapietra and Zachmann, 2021), the dynamics of energy inflation has been heterogeneous across the main euro area countries not only

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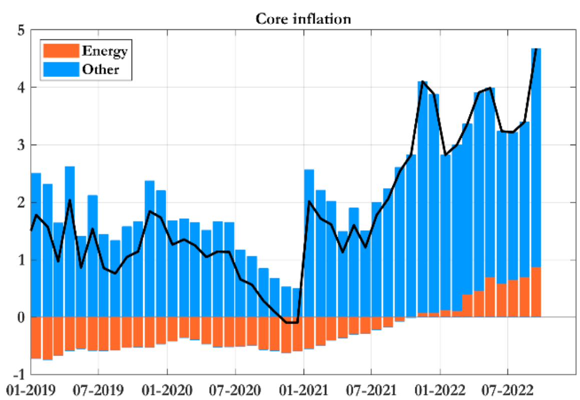
[12] Country specific priors are calibrated exactly as for the euro area estimation, except for Germany, which exhibits a more persistent VAR structure and for which we opted for an optimal tightness selection procedure.

because of structural differences related to the energy mix, but also due to a diverse set of country policies put in place to attenuate the pass through to consumers of skyrocketing wholesale prices of electricity and gas. Rising fuels inflation has been also attenuated by similar policy measures, namely tax reductions on pump prices. The resulting heterogeneity in the propagation of the energy impulse may have been reflected in the diverse transmission to core and food inflation components across countries.

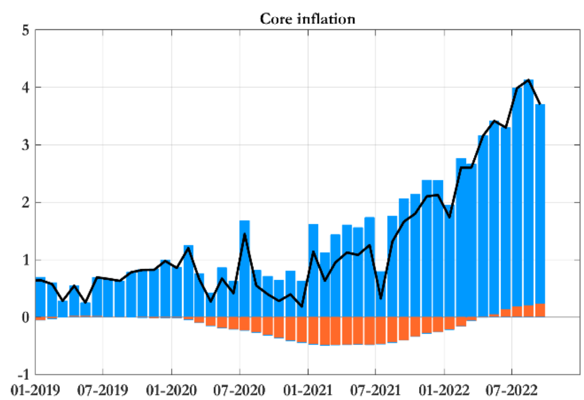
Figure 9 shows the contributions of the energy shock to core inflation in each country. Italy and especially Spain display the largest effects of the energy shock to core inflation since the end of 2021, contributing for at least one third to core inflation in the third quarter of 2022, while in Germany the contribution looks more modest (around one fifth in the same period), and in France very limited (less than 10 per cent) and even lagging (becoming positive only in the latest months).

Figure 9: contribution of energy shocks to core inflation dynamics
(*per cent and percentage points*)

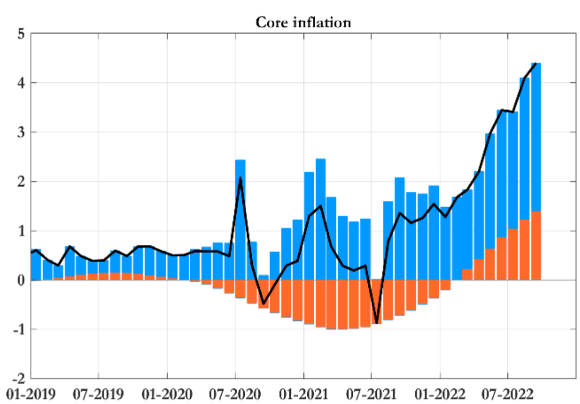
Panel A: Germany



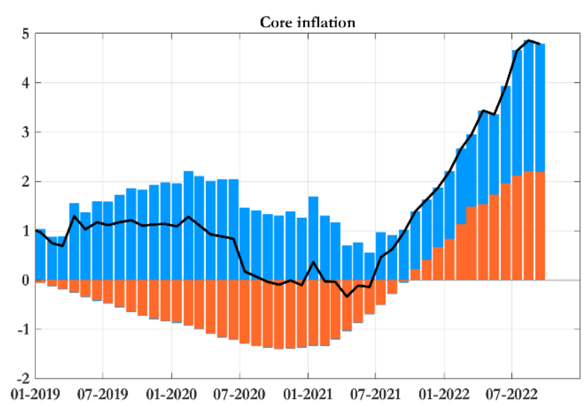
Panel B: France



Panel C: Italy



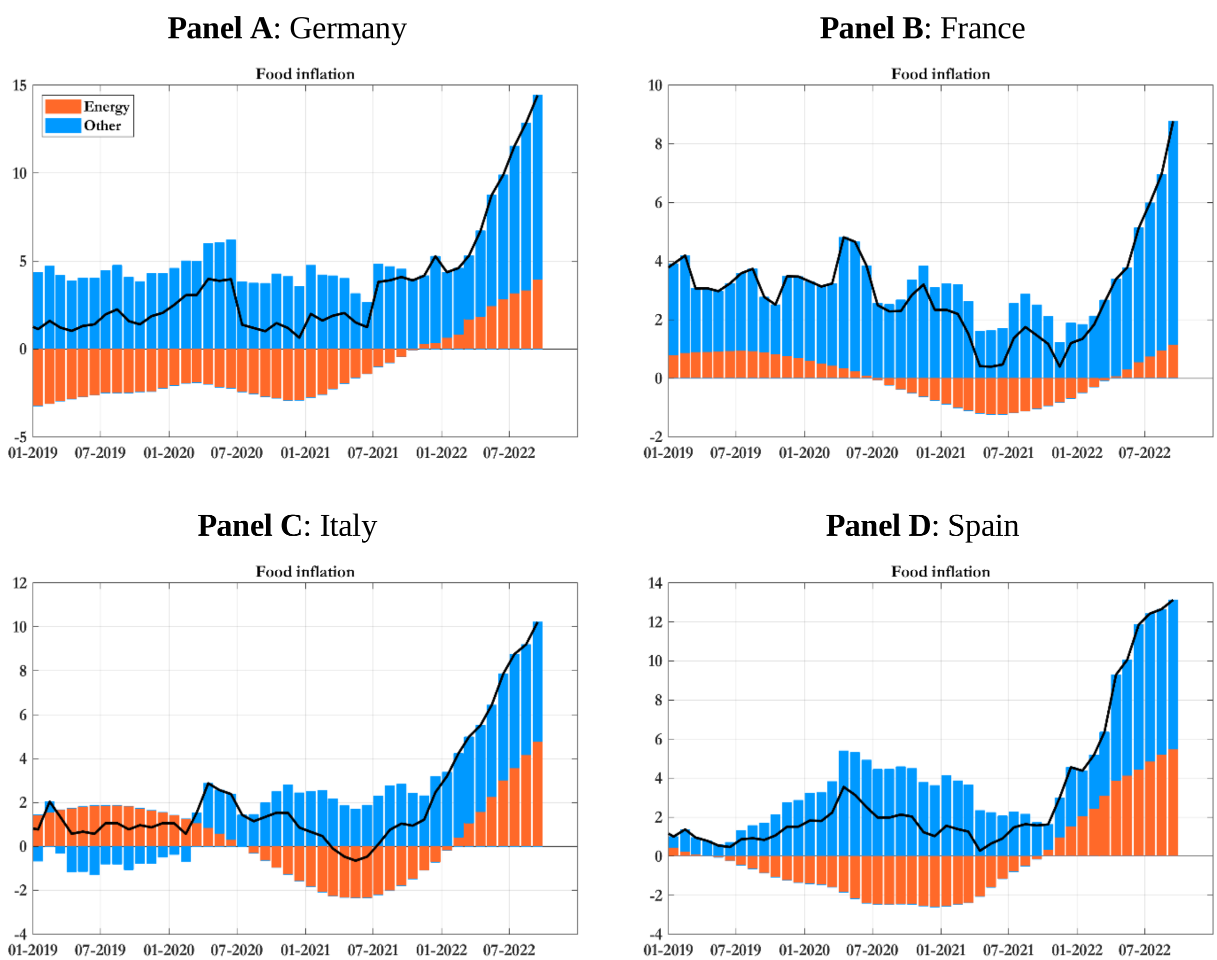
Panel D: Spain



Source: Authors' calculations on Eurostat data. *Note*: The black solid line represents the series for core inflation while the bars show the contributions of the energy shocks and of the other factors to its dynamics.

Figure 10 shows instead the contribution to food inflation. The evidence is relatively similar to what observed for core inflation. Italy shows the largest relative contribution of the energy shock to food inflation, slightly larger than in Spain. In Italy and in Germany the contribution to food inflation is relatively larger than for core inflation, while in Spain it is relatively similar in size. The limited extent of the energy shock in France is also evident for food inflation, and is most likely associated to the milder magnitude of such shock, and to the lagging dynamics of upward effects.

Figure 10: contribution of energy shocks to food inflation dynamics
(*per cent and percentage points*)



Source: Authors' calculations on Eurostat data. *Note*: The black solid line represents the series for food inflation while the bars show the contributions of the energy shocks and of the other factors to its dynamics.

Table 1 summarizes the indirect effects of the energy shock to headline inflation via core and food in the euro area and the main countries on average in 2022. While the direct effect of soaring energy prices amounts on its own to around one half of the total headline inflation in almost all the countries of interest and in the euro area as a whole, indirect effects look more heterogeneous. While Spain registers the largest contribution of energy, with the indirect effects weighting around 20 per cent of total inflation, in Italy and Germany such effects represent a 10 per cent share of total inflation. In France, the indirect effects in 2022 are negligible.

Table 1: direct and indirect contributions of energy to headline inflation in the average of 2022

	Direct effect	**Indirect effect**		**Total effect on headline (%)**
	Share of energy from *direct* effect	Share of energy via *core* (%)	Share of energy via *food* (%)	Share of energy on *headline* (%)
EA	0.52	0.06	0.07	0.65
DE	0.51	0.04	0.05	0.60
FR	0.47	0.00	0.01	0.48
IT	0.57	0.05	0.06	0.68
ES	0.49	0.12	0.11	0.72

Source: Authors' calculations on Eurostat data. Note: the contributions are computed as average over the first nine months of 2022.

5. Conclusion

The sequence of sharp increases in energy prices in 2021 and 2022 was unprecedented. The historically-high levels of inflation in the euro area in 2022 call for a deep understanding of inflation developments. In this paper, we use a standard VAR to quantify the direct and the indirect effects of shocks to energy prices on headline inflation in the euro area. Although the estimated pass-through of energy prices to non-energy items is quite small, the unprecedented sequence of large shocks since mid-2021 has generated sizeable effects on consumer prices. The *sign* and the *magnitude* of energy shocks in the course of 2022, combined with the sluggishness of the response of core and food inflation suggest that energy prices could continue exerting an upward pressure on consumer prices beyond the period considered in this paper.

These results provide relevant indications with respect to the setting of the normalization path of monetary policy, given the limited impact of policy rate increases on energy prices, which are largely driven by exogenous factors. The normalization of monetary policy in the current *non-normal* times (Panetta, 2022) should indeed consider two important factors: the anchoring of long-term inflation expectations (Neri et al., 2022) and second-round effects through wages (Blanchard and Riggi, 2013). The evidence in this paper calls for a carefully considered pace, coupled with a continuous monitoring of inflation expectations and nominal wages developments (Visco, 2022).

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