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# The direct and indirect impacts of the war on inflation


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# The direct and indirect impact of the war on inflation

**Abstract**

The paper explores the possible direct and indirect impacts of the Russian war in Ukraine on different measures of inflation in the euro area. It notably shows that the core inflation index is sensitive to energy and food prices, and questions its reliability for policy decisions. Finally, we discuss medium-term inflation prospects and the effectiveness of monetary policy measures.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| **APP** | Asset purchase programme |
| **ECB** | European Central Bank |
| **EU** | European Union |
| **GDP** | Gross domestic product |
| **IEA** | International Energy Agency |
| **HICP** | Harmonised index of consumer prices |
| **LNG** | Liquefied natural gas |
| **HWWI** | Hamburgisches WeltWirtschafts Institute |
| **MwH** | MeggaWatt Hour |
| **US** | United States |
| **USD** | US dollar |
| **y-o-y** | Year-on-Year |

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# EXECUTIVE SUMMARY


- **The Russian invasion of Ukraine has led to a substantial increase in the prices of energy and food since the start of this war**, as Russia and Ukraine were major suppliers of energy and food for European countries.
- **However, energy and food prices were already increasing substantially before the start of the war**, perhaps for speculative reasons, but also more importantly because of the reopening of the economy following the COVID-19 pandemic. It is not easy to evaluate quantitatively how much is due to the war compared to alternative given the lack of a "clean" counterfactual. Despite the difficulty of constructing such a counterfactual, we endeavour on this exercise.
- **We show that the contributions of energy and food prices on headline and core inflation should not be overstated.** Had no rise in energy and food prices occurred, headline and core inflation would still have risen sharply.
- **Nevertheless, we show that increases in energy and food inflation lead to increases in headline inflation and core inflation.** Core inflation also depends on energy and food inflation through input-output linkages, automatic indexations of goods and services prices, and automatic indexations of wages. Core inflation is not a "clean" measure of aggregate demand, but also depends on supply shocks.
- **There are opposing forces influencing inflation dynamics, but downward pressures on inflation should eventually dominate.** In the medium-term, inflation has yet to diffuse through input-output linkages (producer prices) and automatic indexations of goods, services and wages, which tend to make inflation persistent. Similarly, price shields that have been put in place will be made less generous going forward, which could contribute to making inflation higher. At the same time, energy and food inflation is coming down quickly, as pressures on the natural gas supply, in particular, have substantially eased in the last few weeks. Overall, this force should dominate and inflation should come down.
- **Monetary policy measures are probably rather ineffective in slowing down inflation in the euro area**. Inflation is likely not mainly demand-driven, and second-round effects are so far relatively absent in the euro area. However, interest rate increases probably are effective in boosting the euro, reducing imported prices, and exporting some inflation to the euro area's main trading partners.

# 1. INTRODUCTION

The Russian invasion of Ukraine that started on 24 February 2022 and the related energy crisis have had a substantial effect on the euro area economy and inflation.

The prices of energy and food have increased substantially since the start of the invasion in all European countries due to this war, as Russia was a major supplier of energy. The sheer expectation of future shortages (especially in natural gas) has contributed to a significant increase in energy prices. The price of food has also gone up: directly, because Russia and Ukraine are major producers of agricultural products as well as indirectly because energy is an important input for the production and transportation of food. Energy and food inflation has further led to an increase in other prices, at least through the input-output structures (energy and food being input to the production of many goods and services), automatic indexations of many goods and services, and automatic indexations of wages.

Even though the positive effect on inflation of the Russian invasion of Ukraine is certain, knowing precisely how much of the inflation we currently experience is due to this invasion, and how much is due to other factors (reopening of the economy after COVID-19, supply bottlenecks, excess demand, etc.) is harder to assess. The reason is that the Russian invasion occurred at a moment when the economy was only starting to recover from the COVID-19-related economic shocks. In this paper, we attempt to shed some light on this debate. Drawing on a counterfactual exercise, we show that inflation would probably have been on a rising trend in 2022. Thus, while the war has fuelled inflation, it may not be the only cause. Prices of energy and agricultural goods had already increased in 2021, which would have still contributed to inflation in 2022 and beyond. It remains, however, uncertain whether some of these price increases were due to strategic behaviour by some actors in advance of the Russian invasion of Ukraine. Besides, inflation in the euro area has also been driven by other supply factors, as illustrated by Abbai et al. (2022). Moreover, demand factors have certainly played a role, although to a lower extent than in the United States (US) (see Ball et al., 2022). As exemplified by the recent assessment of Gonçalves and Koester (2022), both supply- and demand-driven components have impacted core inflation.

In this paper, we also spend some time examining some important drivers of fluctuations between headline and core harmonised index of consumer prices (HICP) inflation and show that the interpretation is harder than what is often being argued. For example, we show that core inflation is not a good measure of demand pressures *per se*: even core inflation tends to rise for mechanical reasons after an increase in energy and food prices, and so it is a mistake to view core inflation as a "clean" measure that central banks should attempt to target.[1]

Our analysis also allows us to anticipate the medium-term outlook for inflation. We argue that on the side of financial markets, existing monetary policy measures have overall been successful in slowing down the flow of credit and increasing its cost (particularly for homeowners and governments). Whether monetary policy has been successful in slowing down inflation is more subject to debate, although one might argue that slowing down demand might in the end exert lower pressure on energy prices.

[1] Core inflation is measured by the overall index excluding energy, food, alcohol and tobacco, as provided by Eurostat.

# 2. THE IMPACT OF THE RUSSIAN INVASION OF UKRAINE

## 2.1. Context

Even though not all restrictive measures were lifted in 2021, the world economy recovered from the deep recession of 2020. Growth has been characterised by a buoyant demand, notably for goods and therefore increasing energy demand. Energy prices started to increase and the monthly average market price for Brent crude oil went from USD 27 in April 2020 to USD 86 in January 2022. While the monthly average market price of gas was generally less volatile than the oil price, it rose in 2021 and reached a first peak at EUR 112.5 per megawatt-hour (MwH) in December 2021[2]. The rise notably stemmed from a reduction in imports from Russia.

The shock was amplified from February 2022 onwards. Within a few weeks, all energy prices went up. Oil prices reached a peak in June 2022. The price of gas exceeded EUR 300 per MwH during a few days in August 2022 and has decreased since then. The monthly average price in August settled at EUR 236, 1.8 times higher than the level observed in January.

The geopolitical situation has certainly contributed to this dynamic as Russia is an oil and natural gas producer. Uncertainty was acute for gas compared to the oil market. On the one hand, the European Union (EU) was heavily dependent on Russian gas, which accounted for 45% of EU natural gas imports in 2021 according to the International Energy Agency (IEA). On the other hand, the infrastructure needed to transport the gas or liquefied natural gas (LNG) made it very difficult to substitute between suppliers and redirect flows in the short run. The fear of shortages and the incapacity to substitute imports from Russia in the short run triggered an unprecedented shock to the price of gas on European markets. Finally, electricity prices also soared due to the alignment with the marginal cost of production of energy[3].

## 2.2. The direct effect on the energy and food sub-indices of the HICP

The war has reinforced the growing inflationary pressures that started to materialise in 2021. According to Eurostat, headline inflation in the euro area was already above the 2% inflation target at the beginning of 2022. The year-on-year (y-o-y) increase in prices reached 5.1% in January 2022. It has doubled since then reaching a peak at 10.6% in October 2022, with a significant contribution of energy prices of 4.5 percentage points (p.p) against 2.7 p.p. in January (Figure 1).

Since energy and food prices already increased in 2021, it would be misleading to consider that the rise of inflation in 2022 is entirely due to the geopolitical and economic situation resulting from the Russian invasion of Ukraine.

In order to disentangle the effect of past increases in the price of oil, gas, electricity and agricultural goods from the effect of the outbreak of the war, we simulate counterfactual scenarios where we assume that the raw prices of energy and food goods have been constant since February 2022. Thus, we explore whether the share of inflation stemming from the rise of raw prices of energy and food goods observed in 2022. To that end, we first estimate equations relating the energy and food indices of the HICP for the euro area to the prices of oil, electricity, coal, and food products measured by the Hamburgische WeltWirtschaftsInstitut (HWWI)'s overall food and wheat indices.[4] Those equations are

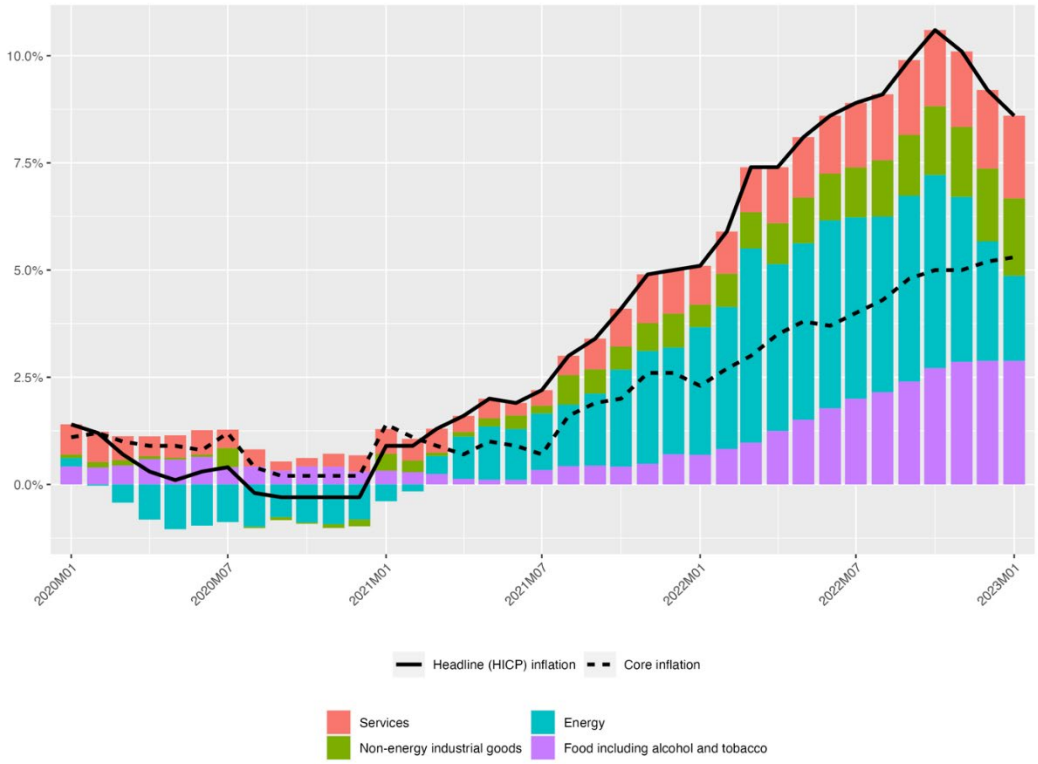
[2] From 2011 to 2019, the price of gas, measured by the Dutch TTF price of natural gas, fluctuated between EUR 11 and EUR 28.

[3] The correlation between the price of gas in the European market and the price of electricity is 0.97.

[4] As the price of gas is strongly correlated to the price of electricity, it is not considered in the equations since the data are available for a shorter time period.

estimated from May 1999 to December 2021 and are then used to compute the counterfactual scenarios for energy and food indices of the HICP from February 2022 onwards, where we set the price (in EUR) of oil, electricity, coal, wheat and the HWWI-Food index at their January 2022 level. The results of those estimations are shown in the Table 1 of the Annex.

**Figure 1:** Inflation and contributions to the inflation rate in the euro area




Source: Eurostat, authors' own elaboration.

Thus, we make the implicit assumption that all the changes in oil, electricity, coal, wheat and HWWI-food prices can be attributed to the invasion of Ukraine[5]. This is certainly an extreme hypothesis since these prices are highly volatile, so it is hard to imagine that they would have remained fixed had Russia not started the war. Given the hypothesis of constant prices of energy and food prices, the equations enable to provide a simulation of the energy and food components of the HCPI. The comparison between the observed sub-indices and the counterfactual provides some insights on the contribution of oil, gas, coal, electricity, wheat and HWWI-food prices to the inflation observed in 2022. The counterfactual scenario for the headline inflation rate is calculated from the counterfactual sub-indices for energy and food and by assuming that the core inflation (excluding energy and food products) has not been affected by the changes in the prices of oil, gas, electricity, coal and food products.[6] In this counterfactual scenario, the inflation of the energy index would have been more than 10 p.p. lower than observed inflation from May to October (Figure 8 in the Annex), respectively 1.5 p.p. lower since

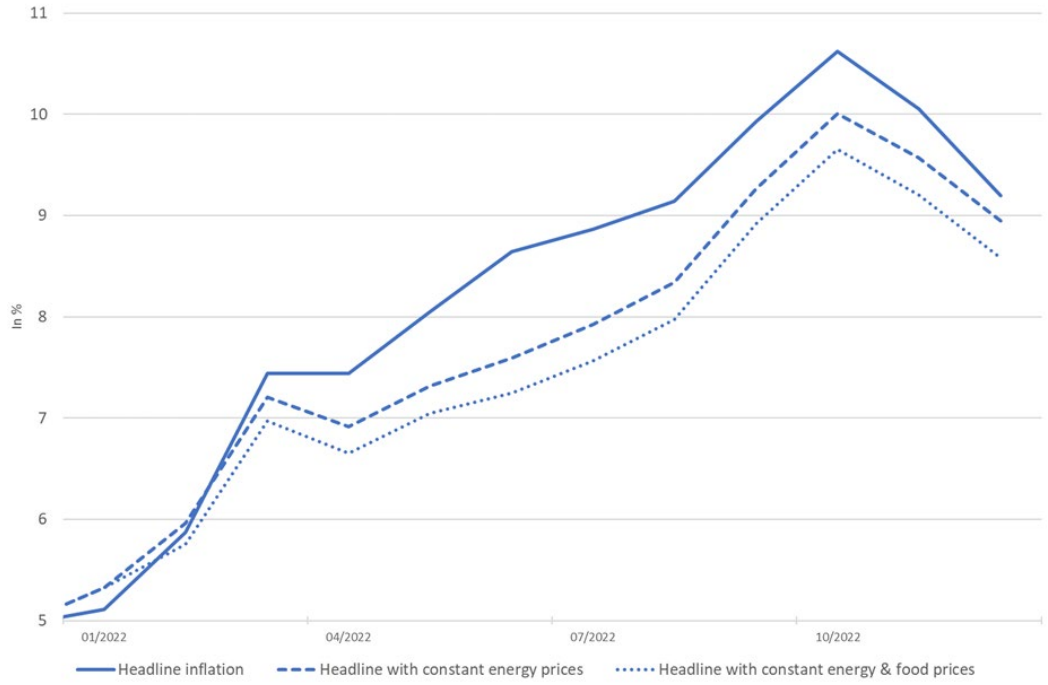
[5] Actually, the counterfactual scenario for the energy and food components of the HICP is computed in two steps. First, the models are used for out-of-sample forecasts with the observed raw prices of energy and food goods. This out-of-sample forecast for 2022 provides the baseline scenario according to our models. The counterfactual sub-indices are then given by the comparison of the out-of-sample forecast of the model estimated with constant prices and the baseline scenario.

[6] We remove this assumption later on.

June for the counterfactual food index *vis-à-vis* the observed inflation (Figure 9 in the Annex). As the prices of oil, gas, electricity and coal receded in the autumn of 2022, the difference between the observed energy index and the counterfactual index declined. This is not the case for the comparison relating to the food index. In December 2022, the food inflation in the euro area would have been 1.7 p.p. lower with constant raw energy and food product prices.

Sub-components of inflation, like those relating to energy and food, are certainly important, but headline inflation is key to assessing the impact of prices on households' purchasing power and on the real costs for firms. It is also key to anticipate future monetary policy shifts. Drawing on the monthly weights of energy and food products in the computation of headline inflation, we can provide some evidence of their overall contribution to inflation. The scenario with constant raw energy and food products would have led to lower inflation than the observed one in 2022 (Figure 2). The maximum difference (1.4 p.p.) would have been reached in June. In December, the difference was 0.6 p.p. This simulation shows that headline inflation would have increased and reached 9.7% in October even at constant prices for energy and food products.

**Figure 2:** The dynamic of headline inflation at constant oil, electricity, coal and food prices




Sources: Eurostat, HWWI, Refinitiv Eikon, authors' calculations.

Therefore, the rise of inflation in 2022 is not only related to the potential consequences of the war on energy and food prices but is also due to the past increases of 2021. Due to base effects and because core inflation increased in 2022, headline inflation would have increased under any circumstances in 2022.

These results are mostly illustrative of the past dynamics of inflation and therefore indicate that, even without a war, headline inflation would have certainly risen sharply. We acknowledge that building a counterfactual scenario without the Russian invasion of Ukraine remains hazardous as there are many alternative paths for the raw prices of energy goods and food products. Prices might have been higher or lower than the level observed after February 2022. Hence, we do not claim that the impact of the war can be fully captured by our hypothesis of constant prices. Rather, we argue that a lower increase in the prices of energy and food products would not have prevented a sharp rise in HICP inflation.

## 2.3. Transmission to other sub-indices of inflation

Another limit of the former exercise is that it considers that core inflation – all other sub-indices of the HICP excluding energy, food, beverage and tobacco – has not been affected by the rise of prices of energy and food products. We now relax this hypothesis and provide an assessment of the effect of energy and food prices on other sub-components of the HICP. The increase in raw energy and food prices may indeed progressively be passed-through other prices as those items enter as intermediate products in the production of other final products. The effect may not be instantaneous because firms may revise their prices slowly (e.g. to remain competitive) and they may also delay the transmission by cutting mark-ups (e.g. also to remain competitive).

To assess the transmission on other consumer prices, we estimate an equation related each item of the HICP at the 3-digit level Classification of Individual Consumption According to Purpose (COICOP) to 12-month moving average of the y-o-y change in oil prices (in EUR), electricity and HWWI-food index.[7] The equation and the results of the estimations are detailed in the appendix (See Table 2 and Table 3).

Consistently with the previous analysis, the prices of energy and food products influence the food sub-indices (items CP011 and CP012 respectively) as well as the item "electricity, gas and other fuels sub-indices" (CP045), which include food and energy items.[8] The changes in the oil price also appear to pass-through to "goods and services for routine household maintenance" (item CP056), "transport services" (CP073) and "personal care" (CP121). At the same time, the price of electricity has a significant and positive impact on "maintenance and repair of the dwelling" (CP043), "water supply and miscellaneous services related to the dwelling" (CP044), on 3 out of 6 items of "furnishings, household equipment and routine maintenance of the house" (CP05), "health" (CP06). "Other major durables for recreation and culture" (CP092) and "newspaper & books" (CP095). Regarding the transmission of raw agricultural goods prices, we also find some items for which a positive correlation is identified.

These results suggest that the Russian war in Ukraine may also have had some effects on inflation beyond its direct impact on food and energy sub-indices. The counterfactual can therefore also be calibrated by considering for each sub-index the difference between a baseline scenario – built from the out-of-sample dynamic forecast for 2022 – and the scenario with constant oil, electricity and HWWI-food prices. The diffusion – excluding items for which the effect of these prices is already embedded in the energy and food sub-indices – might have accounted for around1.5 p.p. of additional inflation on average since May 2022 (Figure 3). At constant prices for energy and food products, and taking diffusion to core inflation into account, inflation in the euro area would have reached a peak at 7.8% in October (instead of 10.6%) and would have receded below 7% in December. Considering the direct and indirect effects, inflation in the euro area would have been 3 p.p. lower in June 2022. Considering the recent reduction in energy prices, the difference would now be mitigated, as energy prices now converge towards those in the counterfactual scenario.

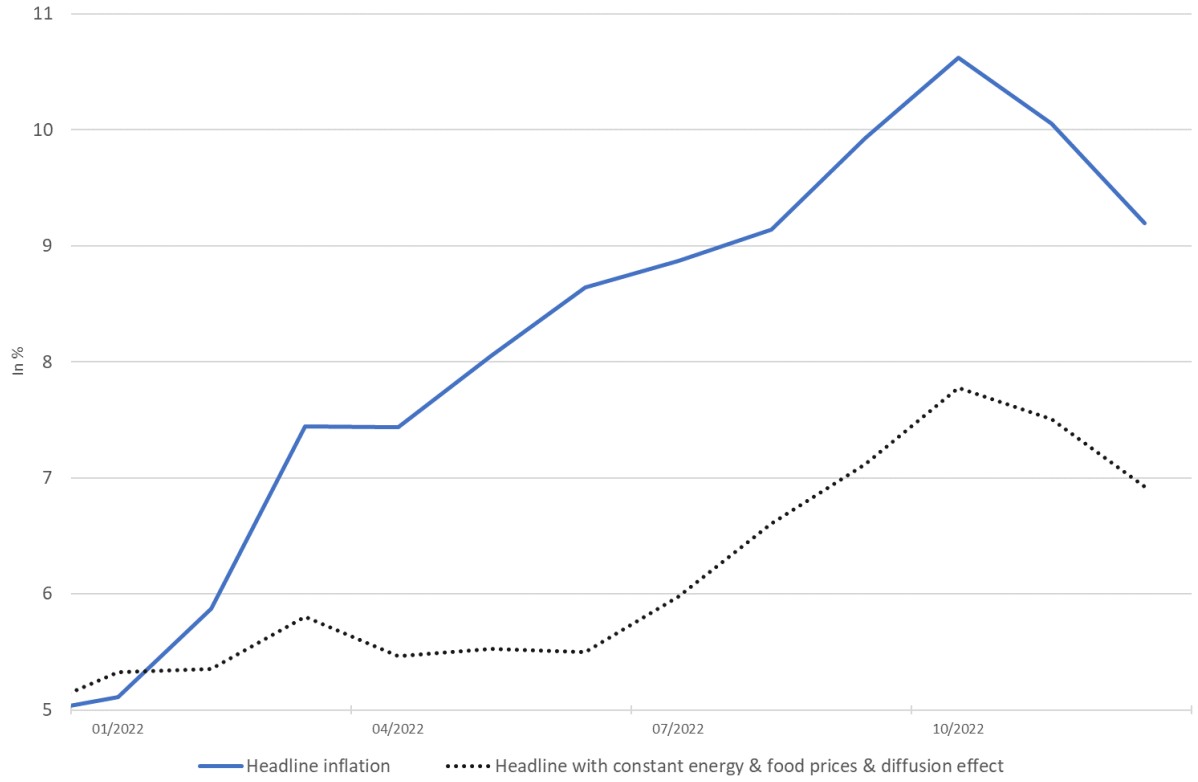
Drawing on the recent dynamics of energy prices, our analysis suggests that not only the inflation driven by energy but, to a lesser extent, the food sub-indices are also expected to decline in 2023, as it has already been observed since October. Due to some delays in the transmission, the slowdown of

[7] The 3-digit decomposition of the HICP includes 42 items. See https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:COICOP_HICP for details. However, due to missing data for some items, we estimate the effect of energy and food prices on 36 sub-indices representing 97.5% of the total index. For health items, we have considered the aggregate index at the 2-digit level.

[8] See at end of the Annex for the details on the COICOP classification.

energy prices should also be transmitted to the other items of the HICP, therefore contributing to an acceleration in the decline of HICP inflation.

**Figure 3:** The dynamic of headline inflation at constant oil, electricity, coal and food prices – with a diffusion effect




Sources: Eurostat, HWWI, Refinitiv Eikon, authors' calculations.

## 2.4. Principal component analysis

As the former analysis has shown, energy prices may have direct effects not just on headline inflation, but also on core inflation. Therefore, core inflation is not a good measure of underlying potential inflationary pressures which may spread beyond the energy and food sector. Indeed, energy and food may have effects on core inflation through various mechanisms which one would like to ideally wash out when evaluating whether inflationary pressures have become more widespread.

First, as was mentioned previously, through the input/output table: energy but also food show up in core inflation because both are an input for the production of other goods and services. Energy, and more importantly natural gas (the price of which has increased substantially for a few months), are used almost in all sectors. Many manufacturing sectors use natural gas extensively, both as material (for example in the chemical sector) but also as an energy source. Therefore, many goods prices might increase if firms are able to pass on these higher costs to customers (other firms, or final consumers). In the service sectors, energy is used extensively for heating but also for transportation.

Second, in many European countries, there remains some direct indexation of wages. In few countries, this indexation is general (such as in Belgium), but in many countries, minimum wages are somewhat indexed to inflation. As a consequence and depending on the share of workers who are on minimum wages as well as the sectors which employ minimum wage earners, one may expect inflationary pressures to spread through this mechanism. The restaurant sector, for example, which relies heavily

on workers earning minimum wages, will be impacted twice by the increase in the price of food: first, through input-output tables because food is an important input for them and, second, through the increase in minimum wages.

Third, some automatic indexation of goods and services exists in many countries. For example, rents are sometimes indexed on headline inflation – with however some discretion on the part of governments and landlords to apply these increases mechanically. In France, the prices of tolls on highways is also indexed on inflation.

In order to disentangle these mechanisms, one might want to investigate further the behaviour of inflation through a principal component analysis approach performed on 2-digit COICOP classification with 12 components. The objective here is to highlight more precisely the contribution to the variance of different sub-indices of inflation on other sub-indices. It permits to gauge more precisely the direct and indirect impacts of prices on energy and food products on other components of the HICP. It helps extracts more information on the volatile determinants of core inflation (whose computation is based on the – false – idea that it is not sensitive to volatile prices).

The original COICOP classification is slightly changed because more volatile components of inflation appear only at the 3-digit level: for example, energy is present both in housing costs (CP04) and those related to transportation (CP0722) although they have very similar determinants. Thus, for the principal component analysis it makes sense to put them together[9].

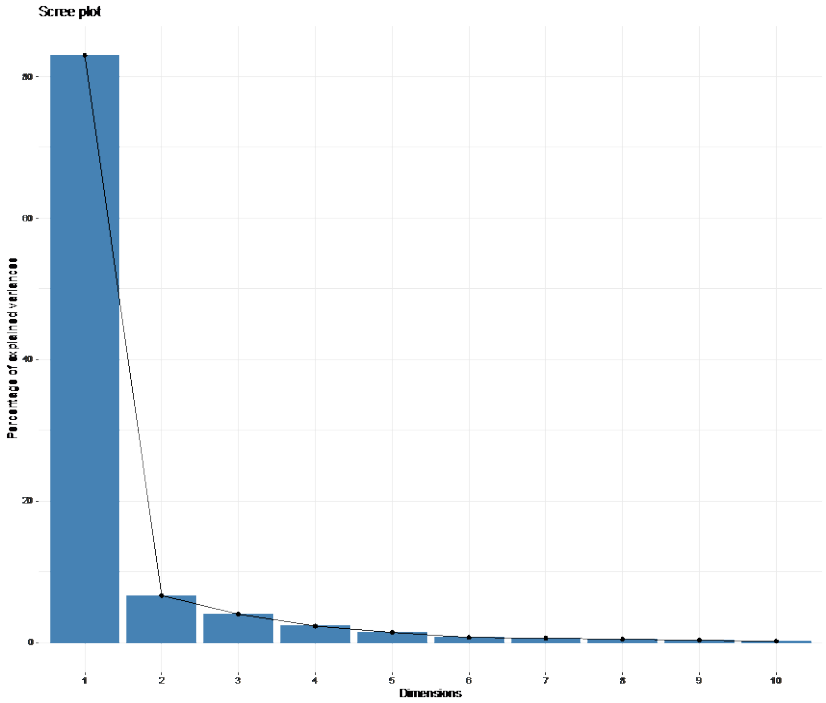
Figure 4 illustrates the amount of information retained by each principal component, as measured by the percentage of the explained variance of inflation by each. This percentage is large for the first principal components and becomes larger for the next principal components (see Table 4 in and Table 5 the Annex for the exact numbers). In our example, the first principal component explains more than 80% of the variance.

Figure 5 shows what the principal component mostly correlates with, and more importantly how the first two principal components explain the different time series. The distance between the origin and the arrow measures how well a given inflation series is explained by the first two principal components. Which direction the arrows are pointing measures which of the two dimensions explains the time series best. This graph shows that the first dimension is overwhelmingly representing the importance of energy (NRG), and that the second dimension overwhelmingly corresponds to food (CP01). Interestingly however, it should be noted that *all* items actually correlate with these first two components, and that these correlations are intuitive: CP10 corresponding to education correlates mostly with food, certainly because of the price of restaurants for children, while CP11 corresponding to restaurants and hotels also correlates with food (but also with energy), as accommodation and restaurants use energy and food as important inputs.

This analysis therefore complements our earlier estimates and shows that the core inflation is not disconnected from the volatile prices of energy and food and that it is of utmost importance to refine the computation of a *genuinely* core (or free-from-volatile-prices) inflation index that the ECB would be better able to control and target (see Blot et al., 2016).

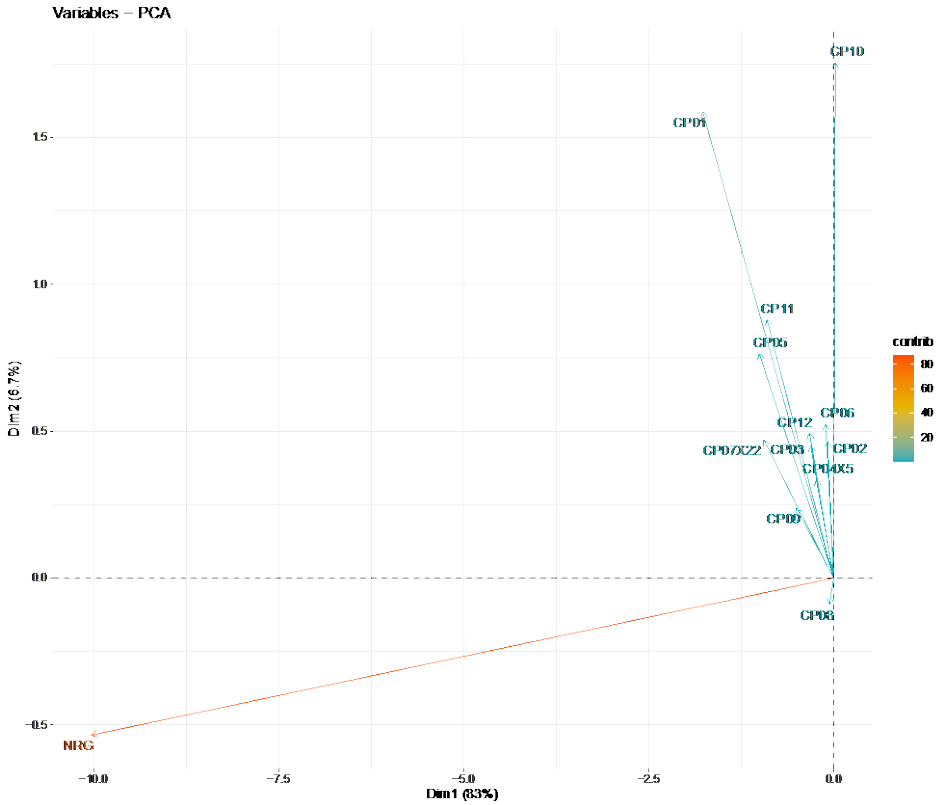
[9] Box 1 in the Annex explains more in detail the methodology for the principal component analysis, with some additional figures.

**Figure 4:** Percentage of explained variance by the principal components




Sources: Eurostat, authors' elaboration.

**Figure 5:** Correlation plot with the first two principal components




Sources: Eurostat, authors' elaboration.

# 3. MEDIUM-TERM INFLATION PROSPECTS AND EFFECTIVENESS OF EXISTING MONETARY POLICY MEASURES

## 3.1. Medium-term inflation prospects

Assessing the medium-term inflation prospects in the euro area is challenging because the geopolitical and economic environment is very uncertain, so the evolution of the main factors driving inflation either directly or indirectly, mainly energy and food, remains unknown at this stage. However, there has recently been a strong decline in energy prices, particularly for natural gas. This implies that there should be not only a slowing down of inflation pressures (if prices had reached a high "plateau" and stayed there, this would already be deflationary) but that energy could become a deflationary force in the next few months. This force clearly should lead inflation to drop in the next few months.

At the same time, as we discussed in sections 2.3 and 2.4, there are some elements of inflation persistence: the input-output table which implies that production prices may respond to input prices with some delay, various indexations of both goods and services and wages, which (depending on institutional details) have not been completely built in.

Also, price shields which have been put in place by governments will be made less generous going forward, which could contribute to make inflation higher in the next few quarters.

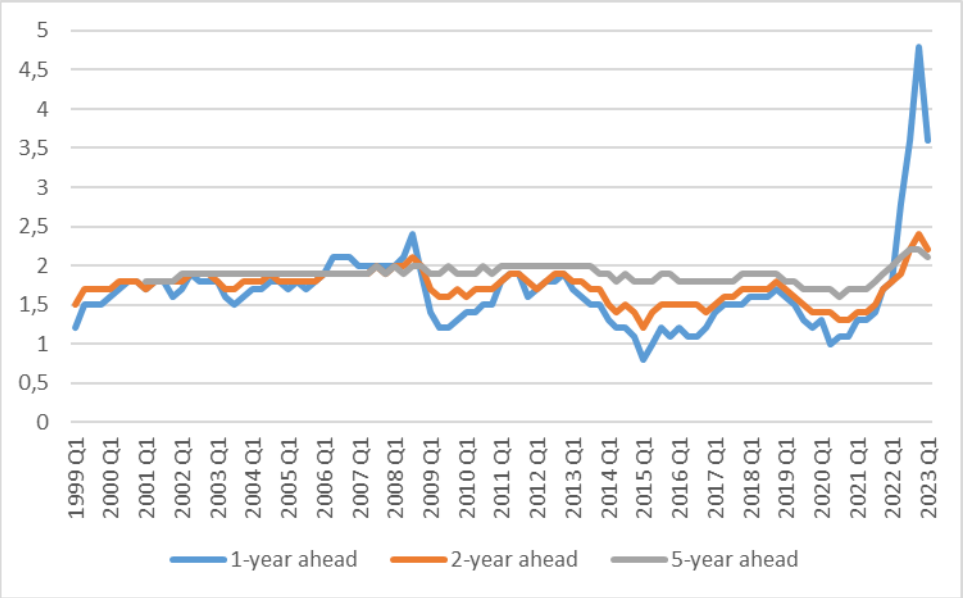
It remains that so far, potential second-round effects have been rather muted (see e.g. Blot et al., 2022) so our assessment is that one may as well abstract from them when assessing the inflation outlook, at least for now.

## 3.2. Effectiveness of existing monetary policy measures

The rise in the HICP inflation rate has finally triggered a sharp rise in the ECB policy rates. Since July 2022, the rate on main refinancing operations has increased by 3 p.p. and it will rise by 0.5 p.p. more in March 2023, following Ms Lagarde's statement in February 2023[10]. After the ECB decided to end net asset purchases under its asset purchase programme (APP) as of 1 July 2022, the policy stance has clearly shifted towards contraction. While some may argue that *real* interest rates remain negative (if inflation expectations follow closely actual inflation, which is usually not the case at a more than 2-year horizon, see Figure 6), the *change* in real interest rates since July 2022 is positive. Has this policy been effective so far?

[10] See remarks from 2 February 2023 press conference
https://www.ecb.europa.eu/press/pressconf/2023/html/ecb.is230202~4313651089.en.html

**Figure 6: Inflation expectations at different horizons**




Source: Survey of Professional Forecasters (ECB)

### 3.2.1. Effectiveness on financial variables

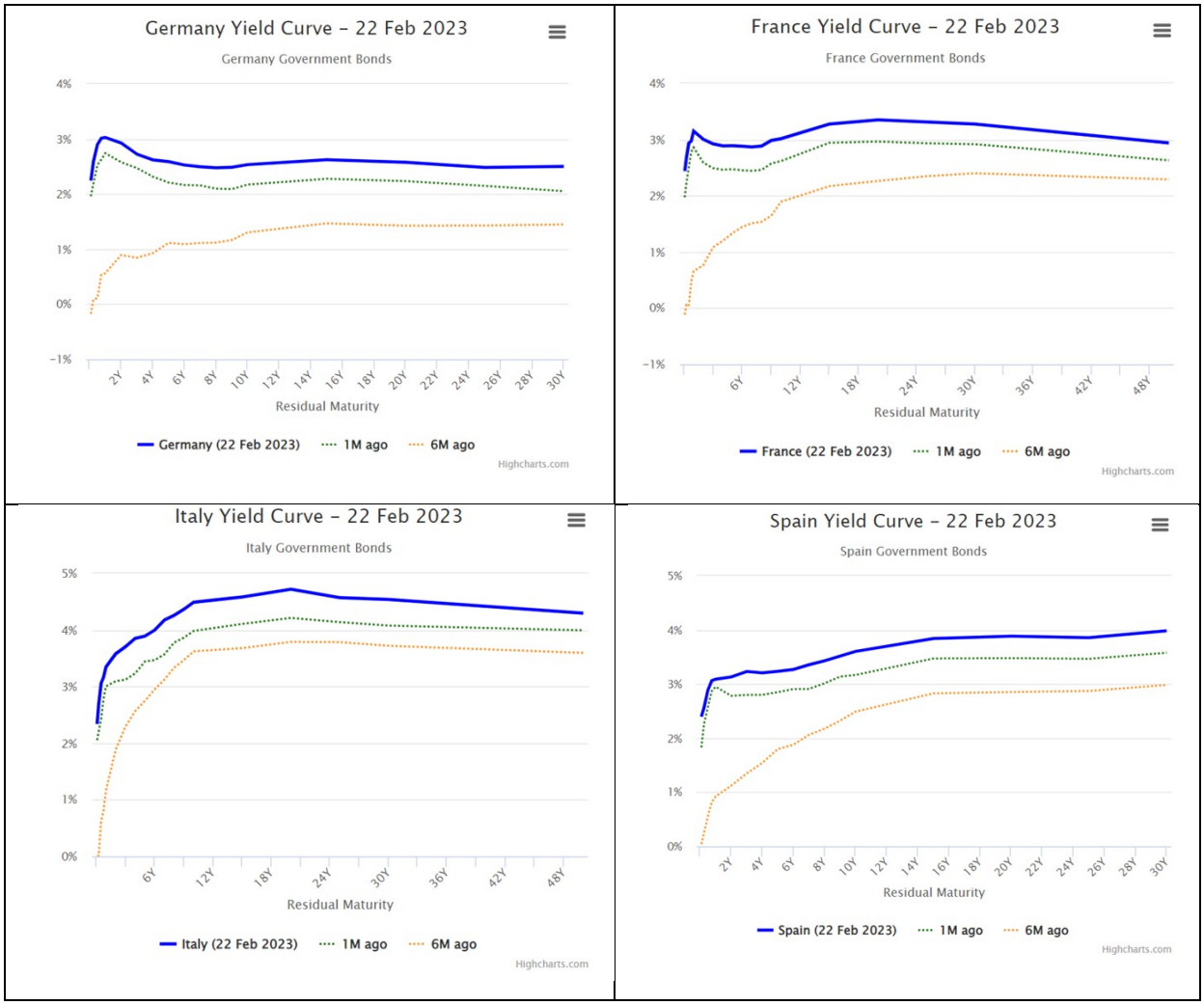
Clearly, for credit flows (volumes) as well as the costs of financing (prices), the effectiveness of monetary policy measures is undisputed. The yield curve has moved up and bank lending rates have increased as well. To spare space, we only report the data for the yield curve of 4 euro area countries in Figure 7. Over the last 6 months, the rise has been quite substantial.

Overall, there has been a sharp increase in the cost of credit for households, governments, and corporations alike in the wake of recent hikes in interest rates. House price growth is slowing down in many countries and, in some countries, house prices are even declining. All of this is signalling that monetary policy is having substantial effects on finance and on households.

Regarding volumes, information from the latest euro area bank lending survey (2022Q4)[11] point to a decrease of loan demand by firms and a strong decline of loan demand by households that is attributed to higher interest rates and uncertainty. Credit standards, that involve increased funding costs, higher risk perceptions and declining risk tolerance, are also reported to have tightened.

[11] See survey at https://www.ecb.europa.eu/stats/ecb_surveys/bank_lending_survey/html/ecb.blssurvey2022q4~e27b836c04.en.html

**Figure 7: Yield curve, government bonds**




*Sources*: worldgovernmentbonds.com and Highcharts.com

### 3.2.2. Is monetary policy effective in slowing down inflation?

Whether such monetary policy measures are effective in slowing down inflation is more subject to question. Monetary policy can work through to the extent that lower demand implies also less demand for energy. This is the conclusion that may stem from the analysis of Gonçalves and Koester (2022) as they report a growing contribution of demand factors to core inflation during 2022. However, the indirect effects of monetary policy, through expectations and wage growth, are less certain.

It is important to remember that a rise in the price of energy is not just a supply shock (as is often assumed) but rather is also a drag on purchasing power and consumer demand. Consistent with this, consumer demand has recently been quite anaemic if we keep in mind that some euro area countries are still recovering from the economic and social consequences of the pandemic, the *former* crisis. This is the case for Spain, whose real GDP is on 2022-Q4 still 0.9% below 2019-Q4 according to Eurostat. It is also, to a lower extent, the case for Germany, whose real GDP is very slightly below its 2019-Q4 value. Moreover, consumer confidence is low according to the OECD Consumer Confidence Index[12].

[12] See OECD Consumer Confidence Index at https://data.oecd.org/leadind/consumer-confidence-index-cci.htm

# 4. CONCLUSION

The Russian invasion of Ukraine and the related energy crisis have undoubtedly had a significant impact on the euro area economy and inflation. Yet, the extraordinary circumstances and the simultaneity of different shocks make it challenging to say how much of the inflation is due to the reopening of the economy after COVID-19 and how much is due to the war. Despite attempting to shed some light on this debate, we deem it too complicated to give a precise quantitative answer to this question.

In the current uncertain environment, policy makers should perhaps err more on the side of caution. Energy and food prices spill over to core inflation through input-output tables, automatic indexations of goods and services, and automatic indexations of wages. An increase in core inflation is not necessarily a sign that monetary policy should be more restrictive. This indicator needs to be complemented with others for a full diagnosis.

Although energy and food shocks are often interpreted as "supply shocks", and so would seem to warrant a substantial decrease in aggregate demand to bring demand in line with supply, it is important to remember that an increase in energy and food prices comes together with a significant reduction in households' purchasing power. In such a context, an increase in policy interest rates might be unwarranted.

Finally, there is little monetary policy can do to mitigate the losses in purchasing power coming from a deterioration in the terms of trade. Monetary policy might potentially help with second-round effects, but thus far, these second-round effects through a "wage-price spiral" and de-anchoring of inflation expectations have been rather muted.

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# ANNEX: TABLES, FIGURES AND BOXES

**Table 1:** Explaining the energy and food components of the HICP

| | *Δenergy* | *Δfood* |
|---|---|---|
| *Δenergy / Δfood (t-j)* | 0.0811** | 0.2590*** |
| | [0.039] | [0.078] |
| *Δoil (t)* | 0.1180*** | |
| | [0.007] | |
| *Δoil (t-j)* | 0.0720*** | |
| | [0.007] | |
| *Δelectricity (t-j)* | 0.0025* | 0.0012** |
| | [0.001] | [0.000] |
| *Δelectricity (t-k)* | 0.0019* | |
| | [0.001] | |
| *Δcoal (t-j)* | 0.0186** | |
| | [0.008] | |
| *Δhwwi-food (t-j)* | | 0.0069** |
| | | [0.003] |
| *Δwheat (t-j)* | | 0.0046** |
| | | [0.002] |
| *Δvix (t)* | 0.0087*** | 0.0015 |
| | [0.002] | [0.001] |
| *Unemployement gap* | | -0.0707** |
| | | [0.035] |
| *Constant* | 0.0782 | 0.1240*** |
| | [0.051] | [0.022] |
| *N* | 265 | 268 |
| *r2* | 0.7355 | 0.15 |

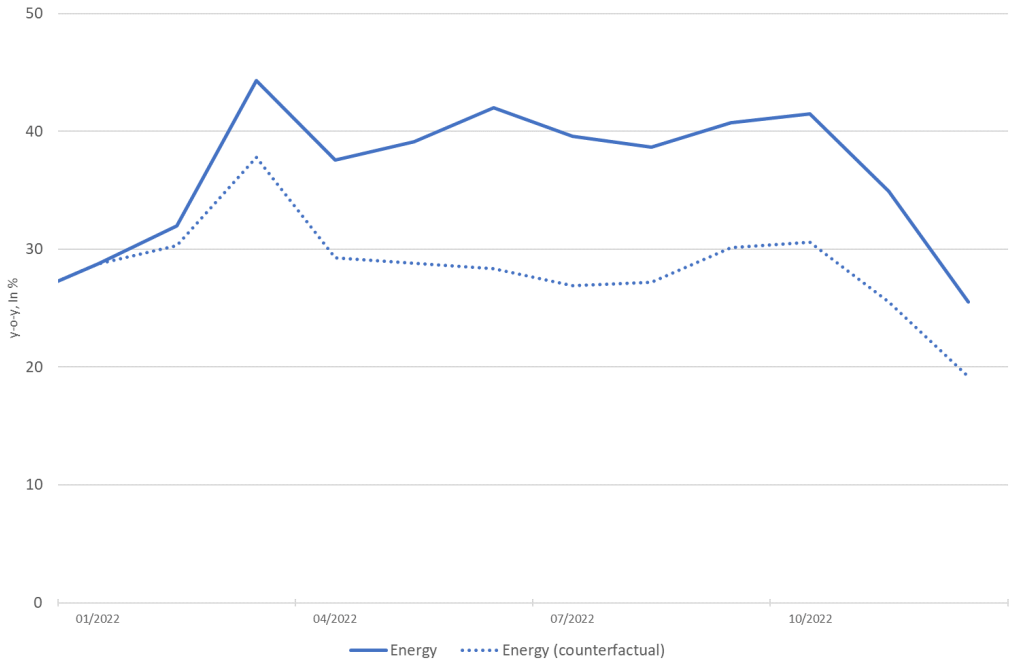
*Standard errors in brackets*

$^{*}p<0.1, ^{**}p<0.05, ^{***}p<0.01$

Source: Eurostat, authors' estimations.

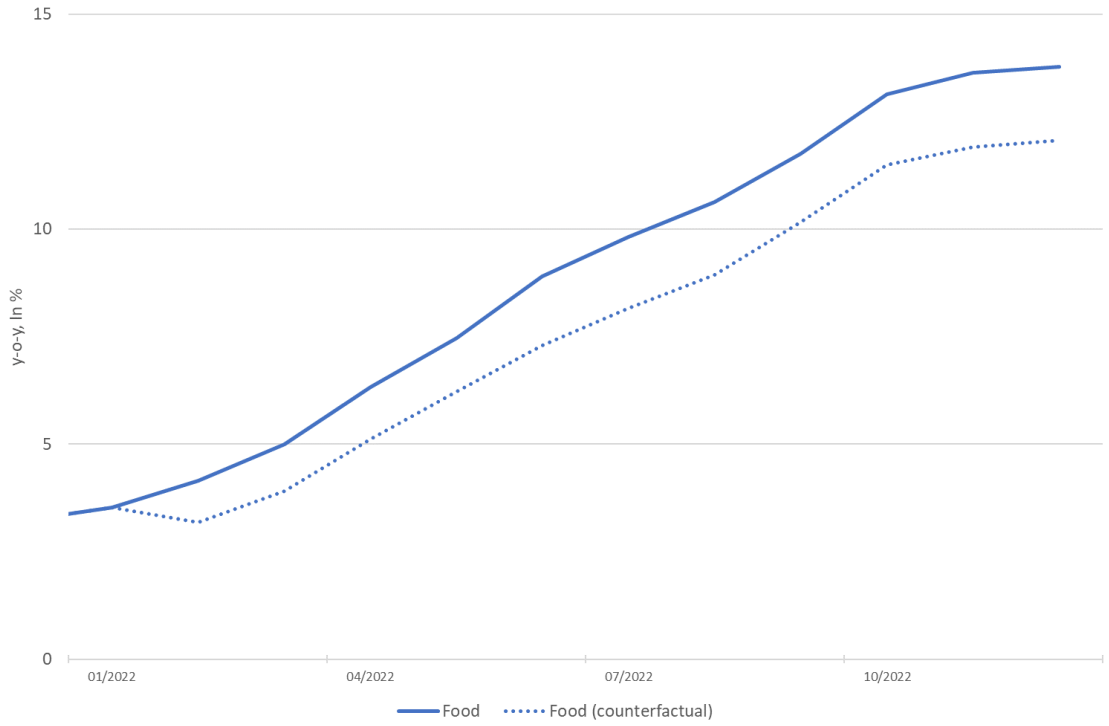
Note: Note: the sample for estimation is May 1999 / December 2021. The price of oil and wheat are expressed in euros and the unemployment gap is the cyclical component of the unemployment rate estimated with a Hodrick-Prescott filter.

**Figure 8:** The dynamics of energy inflation, a comparison between observed inflation and a counterfactual at constant oil, electricity, coal and food prices




Sources: Eurostat, HWWI, Refinitiv Eikon, authors' calculations.

**Figure 9:** The dynamics of food inflation, a comparison between observed inflation and a counterfactual at constant oil, electricity, coal and food prices




Sources: Eurostat, HWWI, Refinitiv Eikon, authors' calculations.

**Table 2:** The impact of energy and food prices on the HICP sub-indices (From COICOP data CP011 to CP06)

| | Food and non-alcoholic beverages | | Alcoholic beverages and tobacco | | Clothing and footwear | | Housing, water, electricity, gas and other fuels | | | | Furnishings, Household equipment and routine maintenance of the house | | | | | | Health |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | cp011 | cp012 | cp021 | cp022 | cp031 | cp032 | cp041 | cp043 | cp044 | cp045 | cp051 | cp052 | cp053 | cp054 | cp055 | cp056 | cp06 |
| ma12oil (t) | 0.0041*** | 0.0029*** | 0.0003 | -0.0031 | -0.0019 | -0.0004 | 0.0001 | 0.0003 | -0.0007 | 0.0158** | -0.0004 | -0.0004 | -0.0012** | -0.0014* | -0.0003 | 0.0010** | -0.0042* |
| | [0.001] | [0.001] | [0.001] | [0.004] | [0.003] | [0.003] | [0.000] | [0.001] | [0.000] | [0.006] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.000] | [0.002] |
| ma12electricty (t) | -0.0012 | -0.0011 | 0 | 0.0013 | -0.0001 | 0.0012 | -0.0001 | 0.0014** | 0.0009*** | 0.0014 | 0.0010** | 0.0003 | 0.0011** | 0.0009 | 0.0006 | 0.0002 | 0.0034* |
| | [0.001] | [0.001] | [0.001] | [0.003] | [0.003] | [0.002] | [0.000] | [0.001] | [0.000] | [0.004] | [0.000] | [0.001] | [0.000] | [0.001] | [0.001] | [0.000] | [0.002] |
| ma12hwwi-food (t) | 0.0039 | 0.0092*** | 0.0038** | -0.0038 | 0.0092 | 0.0006 | 0.0001 | 0.0019* | -0.0006 | 0.0220** | 0.0032** | 0.0122*** | 0.0025** | 0.0047*** | 0.0029* | 0.0020** | -0.0031 |
| | [0.003] | [0.003] | [0.002] | [0.005] | [0.009] | [0.008] | [0.000] | [0.001] | [0.001] | [0.009] | [0.001] | [0.003] | [0.001] | [0.002] | [0.002] | [0.001] | [0.003] |
| dvix | -0.0023 | -0.0004 | 0.0001 | -0.0011 | -0.0006 | 0.0022 | 0.0001 | -0.0002 | -0.0003 | -0.001 | 0.0005 | 0.0020* | 0.0001 | 0.0008 | -0.0002 | 0.0001 | 0.0003 |
| | [0.002] | [0.001] | [0.001] | [0.002] | [0.002] | [0.002] | [0.000] | [0.000] | [0.000] | [0.003] | [0.000] | [0.001] | [0.000] | [0.001] | [0.000] | [0.000] | [0.001] |
| Unemployment gap | -0.2063*** | -0.0669* | -0.0588* | -0.0069 | -0.0373 | -0.0959 | -0.0064 | 0.0018 | 0.0236 | 0.4204** | 0.0014 | 0.0357 | -0.0136 | -0.0134 | -0.0036 | -0.0522** | -0.0792 |
| | [0.064] | [0.036] | [0.033] | [0.096] | [0.145] | [0.132] | [0.010] | [0.023] | [0.020] | [0.177] | [0.028] | [0.064] | [0.028] | [0.035] | [0.030] | [0.023] | [0.058] |
| cp0ij(t-1) | 0.9029*** | 0.9037*** | 0.9572*** | 0.9258*** | 0.2649** | 0.5350*** | 0.9769*** | 0.9732*** | 0.9910*** | 0.9089*** | 0.9457*** | 0.8138*** | 0.9521*** | 0.9352*** | 0.9515*** | 0.9511*** | 0.9492*** |
| | [0.022] | [0.018] | [0.016] | [0.038] | [0.127] | [0.094] | [0.013] | [0.014] | [0.011] | [0.031] | [0.029] | [0.040] | [0.020] | [0.021] | [0.024] | [0.011] | [0.053] |
| Constante | 0.1584*** | 0.0834*** | 0.047 | 0.3981** | 0.3979*** | 0.3609*** | 0.0349* | 0.0465 | 0.0167 | 0.1124 | 0.0537 | 0.0892** | -0.0314 | 0.0746** | 0.0233 | 0.0515*** | 0.0818 |
| | [0.046] | [0.024] | [0.029] | [0.163] | [0.098] | [0.102] | [0.020] | [0.031] | [0.024] | [0.093] | [0.039] | [0.037] | [0.019] | [0.038] | [0.023] | [0.017] | [0.069] |
| N | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 |
| r2 | 0.9283 | 0.9647 | 0.9421 | 0.8621 | 0.0875 | 0.2926 | 0.9521 | 0.969 | 0.9785 | 0.9519 | 0.9241 | 0.8026 | 0.9143 | 0.9195 | 0.9291 | 0.9693 | 0.8856 |

$$\pi_t^i = \rho.\pi_t^i + \alpha_1.ma12oil_t + \alpha_1.ma12elec_t + \beta.ma12hwwi_t + \theta.ugap_t + \phi.\Delta vix_t$$

where $\pi_t^i$ stands for the year-on-year (y-o-y) inflation rate for the item (i). $ma12oil_t, ma12elec_t$ and $ma12hwwi_t$ are the 12-month moving average of the y-o-y change in oil prices (in euros), electricity and HWWI-food index.[13] $ugap_t$ captures the effect of activity on inflation measured by a Hodrick-Prescott filter on the unemployment rate. Finally, $\Delta vix_t$ measures the effect of financial uncertainty.

Standard errors in brackets. * p < 0.1, ** p < 0.05, *** p < 0.01.

Sources: Eurostat, authors' estimations.

[13] The diffusion of prices for raw energy and food products to other items of the HICP may not only take several months but may also differ across the items. Including moving averages instead of several lags of energy and food prices enables to reduce the number of parameters to be estimated.

**Table 3:** The impact of energy and food prices on the HICP sub-indices (From COICOP data CP071 to CP127)

| | Transport | | | Postal services | Recreation and culture | | | | | | Education | Restaurants and hotels | | Miscellaneous goods and services | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | cp071 | cp072 | cp073 | cp081 | cp091 | cp092 | cp093 | cp094 | cp095 | cp096 | cp10 | cp111 | cp112 | cp121 | cp123 | cp124 | cp125 | cp126 | cp127 |
| ma12oil (t) | 0.0003 | -0.008 | 0.0055* | -0.0037* | -0.0027** | -0.0034** | -0.0002 | 0.0006 | -0.0011* | -0.0024 | 0.0017 | 0.0003 | 0.0003 | 0.0006* | 0.0019 | -0.0008 | 0.0002 | 0.0004 | -0.0001 |
| | [0.001] | [0.007] | [0.003] | [0.002] | [0.001] | [0.002] | [0.001] | [0.001] | [0.001] | [0.012] | [0.001] | [0.000] | [0.003] | [0.000] | [0.001] | [0.001] | [0.001] | [0.002] | [0.001] |
| ma12electricty (t) | 0.0007 | -0.0006 | -0.0006 | 0.0021 | 0.0009 | 0.0040*** | 0.0013 | 0.0001 | 0.0009** | 0.0069 | -0.0021 | 0.0003 | 0.004 | 0.0003 | -0.0002 | 0.0001 | 0.0002 | 0.0002 | 0.0005 |
| | [0.001] | [0.004] | [0.002] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.000] | [0.007] | [0.001] | [0.000] | [0.003] | [0.000] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| ma12hwwi-food (t) | 0.0008 | -0.0061 | 0.0157** | -0.0043 | 0.0002 | 0.0009 | 0.0044** | 0.0013 | 0.0009 | 0.0108 | -0.0018 | 0.0003 | -0.0021 | 0.0008 | 0.001 | 0.0023 | -0.0007 | -0.0049 | 0.0011 |
| | [0.001] | [0.010] | [0.007] | [0.003] | [0.003] | [0.003] | [0.002] | [0.001] | [0.001] | [0.020] | [0.003] | [0.001] | [0.007] | [0.001] | [0.005] | [0.002] | [0.002] | [0.005] | [0.001] |
| dvix | -0.0007 | -0.0088* | -0.0026 | 0.0003 | -0.0009 | -0.0001 | 0.0002 | -0.0003 | -0.0002 | -0.0051 | 0.0005 | 0.0001 | -0.0044* | 0.0003 | 0.0021* | 0.0004 | -0.0012 | 0.0023 | -0.0011 |
| | [0.000] | [0.005] | [0.003] | [0.001] | [0.002] | [0.001] | [0.001] | [0.001] | [0.001] | [0.008] | [0.002] | [0.000] | [0.002] | [0.000] | [0.001] | [0.001] | [0.001] | [0.002] | [0.001] |
| Unemployment gap | 0.0447 | 0.161 | -0.0302 | -0.0234 | 0.062 | -0.0019 | -0.0152 | -0.0206 | -0.0405 | -0.9505* | -0.018 | -0.0543*** | -0.1624 | -0.0412*** | -0.0301 | 0.0344 | -0.0405 | -0.0605 | -0.0348 |
| | [0.031] | [0.215] | [0.147] | [0.068] | [0.054] | [0.061] | [0.041] | [0.027] | [0.033] | [0.516] | [0.127] | [0.014] | [0.186] | [0.015] | [0.068] | [0.050] | [0.045] | [0.090] | [0.030] |
| cp0ij(t-1) | 0.9969*** | 0.9964*** | 0.7715*** | 0.8935*** | 0.9916*** | 0.8474*** | 0.8506*** | 0.9136*** | 0.8929*** | 0.4566*** | 0.9500*** | 0.9733*** | 0.7977*** | 0.9691*** | 0.9701*** | 0.9486*** | 0.9222*** | 0.9457*** | 0.9445*** |
| | [0.026] | [0.032] | [0.048] | [0.044] | [0.011] | [0.099] | [0.032] | [0.036] | [0.031] | [0.104] | [0.034] | [0.015] | [0.053] | [0.010] | [0.020] | [0.040] | [0.024] | [0.031] | [0.025] |
| Constante | 0.003 | 0.1785 | 0.4417*** | 0.3067** | 0.0036 | 0.2274* | 0.0964*** | 0.1621** | 0.2290*** | 1.1640*** | 0.1086 | 0.0554* | 0.4234*** | 0.0250* | 0.0514 | 0.1304 | 0.1550*** | 0.1161 | 0.1033** |
| | [0.031] | [0.127] | [0.131] | [0.130] | [0.076] | [0.134] | [0.035] | [0.074] | [0.072] | [0.267] | [0.076] | [0.030] | [0.129] | [0.013] | [0.049] | [0.108] | [0.053] | [0.080] | [0.048] |
| N | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 252 | 260 | 260 | 260 |
| r2 | 0.9095 | 0.8849 | 0.7136 | 0.8773 | 0.9789 | 0.724 | 0.7781 | 0.854 | 0.8145 | 0.2691 | 0.9039 | 0.9822 | 0.6933 | 0.9794 | 0.9634 | 0.9218 | 0.9046 | 0.9087 | 0.903 |

$$\pi_t^i = \rho.\pi_t^i + \alpha_1.ma12oil_t + \alpha_1.ma12elec_t + \beta.ma12hwwi_t + \theta.ugap_t + \phi.\Delta vix_t$$

where $\pi_t^i$ stands for the year-on-year (y-o-y) inflation rate for the item (i). $ma12oil_t, ma12elec_t$ and $ma12hwwi_t$ are the 12-month moving average of the y-o-y change in oil prices (in euros), electricity and HWWI-food index.[14] $ugap_t$ captures the effect of activity on inflation measured by a Hodrick-Prescott filter on the unemployment rate. Finally, $\Delta vix_t$ measures the effect of financial uncertainty.

Standard errors in brackets. * p < 0.1, ** p < 0.05, *** p < 0.01.

Sources: Eurostat, authors' estimations.

[14] The diffusion of prices for raw energy and food products to other items of the HICP may not only take several months but may also differ across the items. Including moving averages instead of several lags of energy and food prices enables to reduce the number of parameters to be estimated.

Box 1: Methodology: data transformation

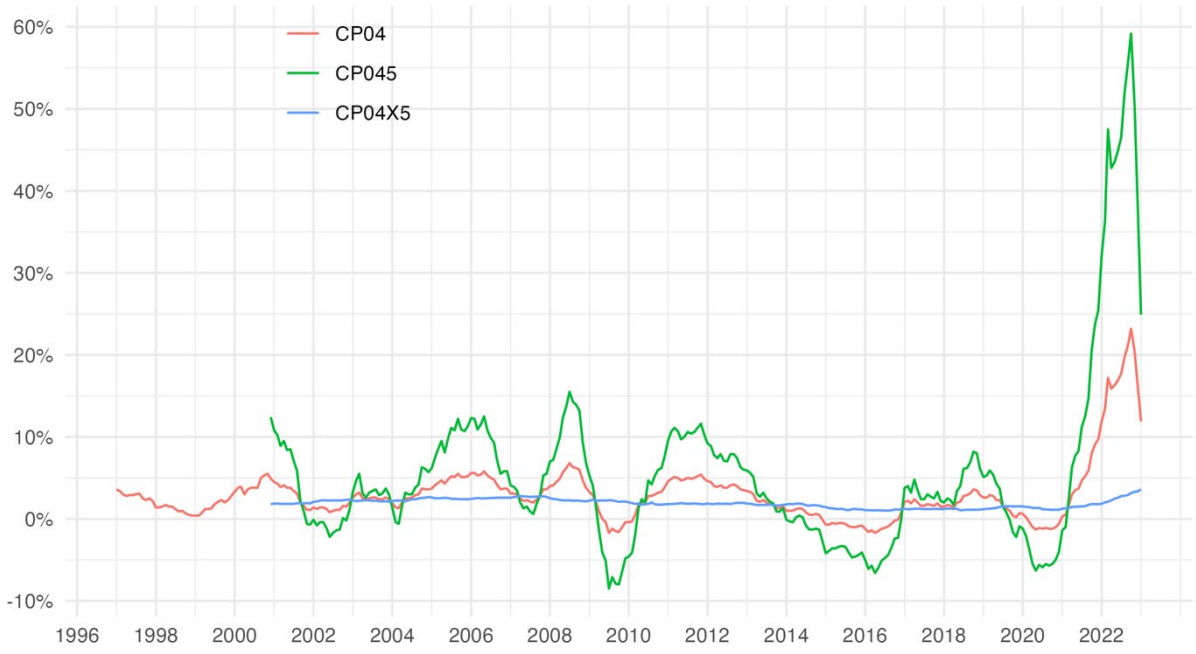
For readability of the results, performed a principal component analysis on the 2-digit classification (12 items composing the HICP). However, some components such as CP04 (Housing, water, electricity, gas and other fuels) and CP07 (Transport) contain some more volatile components such as CP045 (electricity, gas and other fuels for households), and CP0722 (fuels and lubricants for personal transport equipment) which should be analysed separately from the rest.

Therefore, before we perform the principal component analysis, we first create an alternative CP04 category named CP04X5 (CP04 excluding CP045) and another named CP07X22 (CP07 excluding CP0722), for which we compute inflation rates which are not given by Eurostat, using yearly component weights, as well as inflation for sub-indices.

We then group CP045 and CP0722 in a separate NRG sub-index, which we add as a 13th item composing the HICP, and keep CP04X5 and CP07X22 outside. Note that NRG sub-index already exists in the Eurostat database, while CP04X5 and CP07X22 do not. One could have chosen to group CP01 (Food and non-alcoholic beverages) and CP02 (Alcoholic beverages, tobacco and narcotics) into a food sub-index, so we would then have 12 sub-categories. Doing so does not meaningfully alter the results qualitatively and quantitatively.

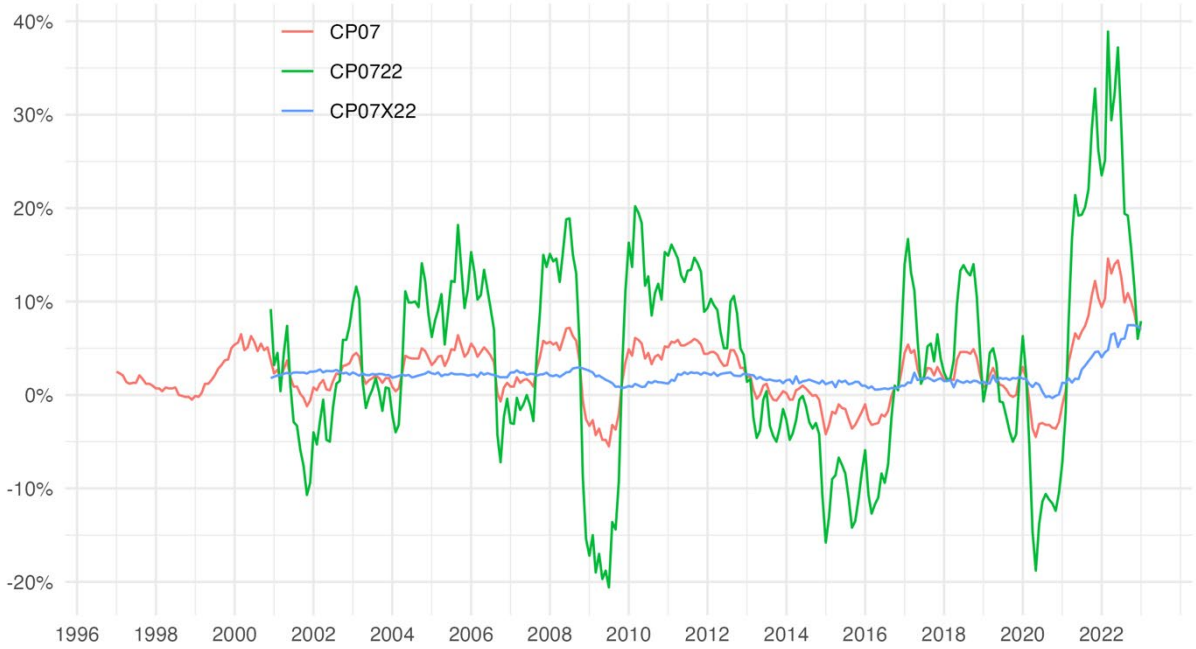
Source: Authors' own elaboration.

**Figure 10:** Construction of CP04X5




Sources: Eurostat, authors' calculations.

**Figure 11:** Construction of CP07X22




Note: CP07X22 is constructed by excluding CP0722 (Fuels and lubricants for personal transport equipment) from CP07 (Transport).

**Table 4:** Table of eigenvalues, variance, cumulative variances

| | eigenvalue | variance.percent | cumulative.variance.percent |
|---|---|---|---|
| *Dim.1* | 107.18 | 83.04 | 83.04 |
| *Dim.2* | 8.59 | 6.65 | 89.7 |
| *Dim.3* | 5.17 | 4 | 93.7 |
| *Dim.4* | 2.99 | 2.32 | 96.02 |
| *Dim.5* | 1.84 | 1.43 | 97.45 |
| *Dim.6* | 0.93 | 0.72 | 98.17 |
| *Dim.7* | 0.8 | 0.62 | 98.78 |
| *Dim.8* | 0.62 | 0.48 | 99.26 |
| *Dim.9* | 0.43 | 0.33 | 99.59 |
| *Dim.10* | 0.23 | 0.18 | 99.77 |
| *Dim.11* | 0.17 | 0.13 | 99.9 |
| *Dim.12* | 0.09 | 0.07 | 99.97 |
| *Dim.13* | 0.03 | 0.03 | 100 |

Sources: Eurostat, authors' own elaboration.

**Table 5:** Table of coordinates for the first 10 principal components (3 omitted)

| | Dim.1 | Dim.2 | Dim.3 | Dim.4 | Dim.5 | Dim.6 | Dim.7 | Dim.8 | Dim.9 | Dim.10 |
|---|---|---|---|---|---|---|---|---|---|---|
| *NRG* | –10.04 | –0.54 | 0.32 | 0.1 | 0.04 | –0.01 | 0.01 | 0.01 | –0.02 | 0 |
| *CP01* | –1.77 | 1.59 | –1.13 | 0.03 | –0.36 | 0.25 | 0.3 | 0.28 | –0.12 | –0.01 |
| *CP02* | –0.08 | 0.47 | 0.77 | –0.86 | –0.27 | 0.11 | 0.36 | –0.41 | –0.18 | –0.08 |
| *CP03* | –0.31 | 0.45 | –0.17 | –0.26 | 0.21 | –0.87 | 0.27 | 0.11 | 0 | –0.04 |
| *CP04X5* | –0.23 | 0.34 | 0.21 | –0.01 | 0.01 | 0 | –0.03 | –0.11 | 0.17 | 0.05 |
| *CP05* | –1.01 | 0.76 | –0.47 | –0.21 | 0.06 | 0.02 | –0.04 | –0.21 | 0.21 | 0.24 |
| *CP06* | –0.11 | 0.52 | 0.98 | –0.89 | –0.28 | 0 | –0.31 | 0.44 | 0 | 0.1 |
| *CP07X22* | –0.95 | 0.47 | –0.25 | –0.2 | 0.02 | –0.08 | –0.2 | –0.13 | 0.2 | 0.03 |
| *CP08* | –0.05 | –0.09 | –0.3 | –0.67 | 1.14 | 0.27 | 0.1 | 0.11 | –0.05 | –0.01 |
| *CP09* | –0.5 | 0.24 | –0.71 | –0.2 | 0.02 | –0.17 | –0.47 | –0.23 | –0.42 | 0.09 |
| *CP10* | 0.02 | 1.76 | 1.1 | 0.86 | 0.44 | 0 | –0.06 | –0.03 | –0.13 | 0.01 |
| *CP11* | –0.9 | 0.88 | –0.28 | –0.24 | 0.03 | 0.02 | –0.33 | –0.1 | 0.2 | –0.35 |
| *CP12* | –0.33 | 0.49 | 0.05 | –0.1 | 0.02 | 0.02 | 0.13 | –0.13 | 0.18 | 0.15 |

Box 2: 3-digit COICOP classification

FOOD AND NON-ALCOHOLIC BEVERAGES – CP01
- CP011 - Food
- CP012 - Non-alcoholic beverages

ALCOHOLIC BEVERAGES AND TOBACCO – CP02
- CP021 - Alcoholic beverages
- CP022 - Tobacco

CLOTHING AND FOOTWEAR – CP03
- CP031 - Clothing
- CP032 - Footwear

HOUSING, WATER, GAS, ELECTRICITY AND OTHER FUELS – CP04
- CP041 - Actual rentals for housing
- CP043 - Regular maintenance and repair of the dwelling
- CP044 - Other services relating to the dwelling
- CP045 - Electricity, gas and other fuels

FURNISHINGS, HOUSEHOLD EQUIPMENT AND ROUTINE MAINTENANCE OF THE HOUSE – CP05
- CP051 - Furniture, furnishings and decorations, carpets and other floor coverings and repairs
- CP052 - Household textiles
- CP053 - Household appliances
- CP054 - Glassware, tableware and household utensils
- CP055 - Tools and equipment for house and garden
- CP056 - Goods and services for routine household maintenance

HEALTH – CP06
- CP061 - Medical products, appliances and equipment
- CP062- Outpatient services
- CP063 - Hospital services

TRANSPORT – CP07
- CP071 - Purchase of vehicles
- CP072 - Operation of personal transport equipment
- CP073 - Transport services

COMMUNICATIONS – CP08
- CP081 - Postal services
- CP082/3 - Telephone and telefax equipment and services

RECREATION AND CULTURE – CP09
- CP091 - Audio-visual, photographic and information processing equipment
- CP092 - Other major durables for recreation and culture
- CP093 - Other recreational items and equipment, gardens and pets
- CP094 - Recreational and cultural services
- CP095 - Newspapers, books and stationery
- CP096 - Package holidays

EDUCATION – CP10

RESTAURANTS AND HOTELS – CP11
- CP111 - Catering services
- CP112 - Accommodation services

MISCELLANEOUS GOODS AND SERVICES – CP12
- CP121- Personal care
- CP123 - Personal effects n.e.c.
- CP124 - Social protection
- CP125 - Insurance
- CP126 - Financial services n.e.c.

CP127 - Other services n.e.c.

The paper explores the possible direct and indirect impacts of the Russian war in Ukraine on different measures of inflation in the euro area. It notably shows that the core inflation index is sensitive to energy and food prices, and questions its reliability for policy decisions. Finally, we discuss medium-term inflation prospects and the effectiveness of monetary policy measures.

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