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A FORECAST ERROR DECOMPOSITION OF INFLATION IN THE EURO AREA: CAUSES, EFFECTS AND BEST POLICY RESPONSES

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Abstract

This paper analyses the recent trends in the inflationary shock hitting the Euro Area since the onset of the Covid-19 pandemic up to nowadays. The aim is to understand its causes and identify its main drivers, its possible long-term impact on the Euro Area economy and best policy responses. This will be done by employing a New Keynesian 3-equation model as well as a Bayesian VAR model. It results that demand factors are increasingly driving inflation dynamics alongside historical supply-side factors, and that a stronger coordination between monetary and fiscal policies is needed in order to make ends meet.

Keywords: inflation, supply shock, demand shock, New Keynesian 3-equations model, Structural VAR, monetary policy

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1. Introduction

Understanding why inflation has been so high, what are its causes and the main drivers behind, is essential for policy makers to decide upon the best strategy to follow. These questions have been at the center of academic and policy debates for a while by now, since the type and efficacy of any policy response is highly dependent on the nature of the shock they are meant to address. We know, both from theory and practice, that monetary policy is much more effective in answering demand-side shocks, while fiscal and structural policies are needed in order to address supply-side ones. Moreover, in a monetary union such as the Euro Area (EA), policy makers at the European Central Bank (ECB) must keep in mind another important factor: inflation differentials across EA member states, when they start to diverge widely, render a common monetary policy less effective. In face of different economic outlooks across EA countries, no common policy response will any longer be optimal for any of them. Therefore, in order to give these questions above a proper answer and find out what the best policy response is, we ought to go back to the origin of this inflationary shock, when inflation rates first started to diverge.

Throughout the course of this work project, the path followed by inflation in the EA will be analysed from the onset of the Covid-19 pandemic up to nowadays, following its evolution through the post-pandemic economic reopening and the ongoing energy crisis. It will be shown how it was possible for inflation rates to drop to a low of 0.2% (annual rate of change of headline HICP in the EA registered in November 2020) to then spike to a maximum of 10.6% (as of October 2022), with a current, decreasing level of 7% dated April 2023 (Eurostat, 2023). It will also be shown how the interactions between monetary and fiscal policies, and the economy have evolved over time. From an initially too lax monetary policy under the illusion of dealing with temporary shocks, to highly uncoordinated national fiscal policies, and the sharpest increase in nominal interest rates in the history of the ECB. These policies' evolution will be linked to the acute divergence in inflation rates across EA countries, alongside other, more structural causes and their implications in policy making.

The aim of the paper, therefore, is to shed light on the complexity of this inflationary shock and its evolution over the last 3 years, in order to enrich a debate too often focused solely on energy prices. The paper argues that both demand and supply factors contributed to output and inflation dynamics, although in different manners and directions over time – and as such, policy makers should act accordingly. It will be proven how price pressures, the pass-through from one sector to all others, and a demand that remained too accommodative in face of consecutive negative supply shocks, all contributed to shape the current economic dynamics. Moreover, ongoing inflation differentials, a still present risk of de-anchoring in inflation expectations, and the persistence of these shocks, are all relevant additional factors that must be kept in mind when deciding over the best policy mix to put in place.

To better analyse the evolution over time of these economic dynamics, the paper distinguishes three different chronological phases:

(I) the Covid-19 shock and economic lockdown (Q1 and Q2 2020);

(II) the post-pandemic economic reopening (from Q3:2020 to Q4:2021);

(III) the Russian war in Ukraine and energy shock (from Q1:2022 onwards).

The remainder of the paper is structured as follows: section 2 decomposes inflation dynamics using a New Keynesian 3-equations model. Through this model, it will be possible to conjecture how demand- and supply-side shocks have contributed to the inflationary process from one phase to the next, from a theoretical standpoint. It will be shown how output and inflation dynamics are consistent with: a negative demand shock in phase I and consecutive positive demand shocks in phases II and III, on the one side, and a negative supply shock in phase I, a positive supply shock in phase II followed by another negative supply shock in phase III, on the other. Throughout section 2, the model will be accompanied by a constant comparison with data; causes behind inflation differentials and evolution in policy stances will be recurring themes as well. Section 3 decomposes inflation dynamics using a Structural Vector Autoregressive model identified with sign restrictions, meant to support the paper's hypotheses with empirical evidence. In addition, a one-step forecast analysis from 2020:01 to 2023:04 is provided as a robustness check. The econometric model proves that demand factors have been increasingly relevant as a driving force behind inflation dynamics in the EA as a whole, accounting for around half of the current inflation gap on average. Section 4 concludes with reflections on the best policy responses and policy mix to put in place, in light of the models' findings as well as current economic risks and opportunities.

2. Decomposing Inflation: A New Keynesian 3-Equation Model

Before turning to its application, let us first spend few words on the theory that lies behind this New Keynesian 3-equations model. It is a model based on Carlin and Soskice (2015), and includes: (i) the Investment-Savings (IS) equation, which models aggregate demand in an output-interest rate plane; (ii) the Philips curve, which reflects wage- and price-setting behaviour in the economy into an output-inflation plane; and (iii) the Monetary Rule (MR) equation, which portrays the best policy response behaviour of an inflation targeting central bank. Two elements are of particular interest here: the slope of the Phillips curve, which depends on national economic structures, and how it shifts on the plane, which depends instead on the inflation-expectations process formation. For convenience, let us generalise and assume a single, common economic structure for the whole EA. According to the studies carried out by Benigno et al. (European Parliament, 2023), the slope of the Phillips curve is currently quite flat for the EA, mainly reflecting a rather stickiness in wage adaptations. As a matter of fact, wages decreased by 0.6% in July 2021, and have been increasing at rates between 2 and 5% from then onward, against an increase in headline inflation of more than 8%. This flatness implies that the sacrifice ratio and adjustment costs are high – i.e., a stronger hike in interest rates is needed in order to reduce inflation compared to a 'regular' economic scenario, implying also a stronger, negative impact on employment and the real economy. Specifically, according to those studies cited above, a 10% increase in unemployment is needed in order to bring down inflation by 1%. Obviously, this has important implications in policy making, as the flatter the Phillips curve, the less effective monetary policy will be and the more difficult it is for the ECB to tackle inflation through the demand channel. It follows that, the more inflation gets entrenched in the economy, the less powerful the ECB becomes. For these reasons, it is all the more important for policy makers to focus as well on other tools left available – namely, the inflation-expectations channel, the fiscal policy, and structural policies channels.

Lastly, the New Keynesian theory implies that rational, forward-looking behaviour is included into the equation when modelling inflation-expectations formation. Rational expectations, contrary to backward looking expectations, usually imply a faster and smoother adjustment process towards economic equilibrium. However, according to current studies carried out by a variety of central banks around Europe, in periods of high uncertainty such as this one, agents tend to form their inflation- and wage-expectations in a rather backward looking manner instead. This attempt to recover previous periods' losses in purchasing power, however, carries the risk of protracting the high inflation rates – for example, through wage-price spirals and second round effects (Visco, 2023). In turn, this would possibly lead to a de-anchoring in inflation expectations, with higher inflation rates becoming entrenched into wage and price processes and with a tighter monetary policy response required to fight it thereafter. As of now, however, evidence shows that long term inflation expectations have remained firmly anchored at 2% for both firms and households, while in the short and medium term horizons, although still slightly higher than 2% and very volatile, they are clearly on a downward trend for both agents (ECB Survey of Monetary Analysts, 2023). Nevertheless, keeping an eye on inflation expectations and making sure they remain anchored is essential for an effective policy response. For what follows, it will be assumed for convenience that shifts in the Phillips curve are driven by entirely backward looking inflation expectations, although in reality it is a mix of backward and forward looking behaviours.

2.1 Phase I: the Covid-19 shock and economic lockdown

The Covid-19 pandemic and the economic lockdown that followed everywhere in Europe is usually associated with a combination of a negative supply shock on one side, and a negative demand shock on the other. The many restrictions that forced households at home significantly decreased private consumption, while their effects on workers and the workplace led to an overall decrease in productivity. With numerous businesses shutting down as a natural consequence, both supply and demand contracted further. Let us assume that both demand and supply shocks were of temporary nature, as economic lockdowns were envisaged to be temporary measures. According to the New Keynesian 3-equations model, a negative demand shock (Figure 1 – left panel) shifts the IS curve to the left (from IS to IS'), reducing the output gap and putting pressure on inflation to decrease: the Phillips curve shifts down (PC to PC') and the MR equation suggests a decrease in nominal interest rates in order to boost the economy back to equilibrium. On the other hand, instead, a negative supply shock (Figure 1 – central panel), due to a decrease in productivity, shifts the price-setting curve down (from PS to PS'), leading to higher unemployment, a negative output gap, and pressure on inflation to increase: the Phillips curve shifts up (PC to PC') and the MR equation suggests an increase in nominal interest rates in order to cool down the economy. Solely from a theory standpoint, however, it is not possible to determine a priori the overall effect on inflation, which depends on the relative sizes of the two shocks.

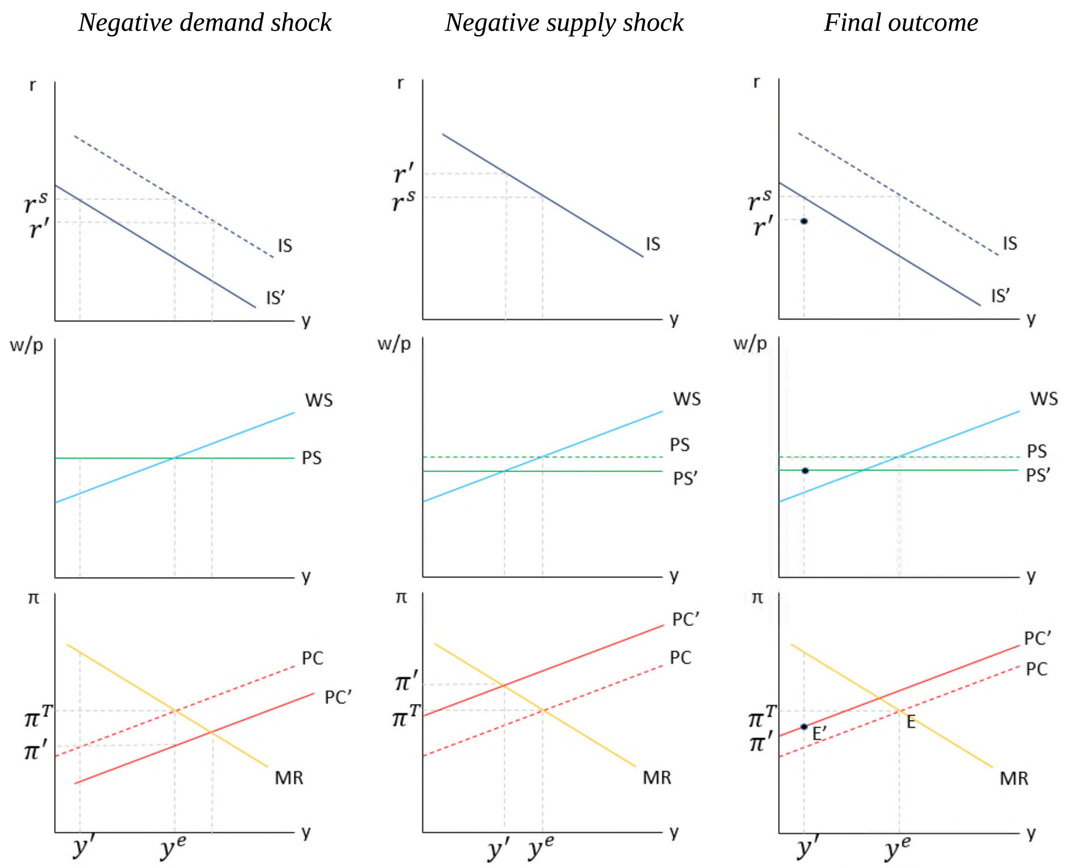


Figure 1. Phase I: the Covid-19 shock and economic lockdown

Looking at the data (Figure 2), we can clearly see a reduction in inflation rates during the pandemic months: this suggests that, in phase I, the deflationary pressure from the negative demand shock more than offset the inflationary pressure coming from the negative supply shock – that is, the demand shock resulted larger than the supply one (point E' in Figure 1 – right panel). For what matters the policy response, instead, the ECB behaved in accordance to the theoretical model, keeping interest rates low and negative (the 3-month interbank rate reached -0.42 as of March 2020). This expansionary monetary policy was justified by the exceptional circumstances, economic and social, created by the pandemic, which called for an increase in borrowing and public spending, while trying to relieve the negative pressure on production and economic growth due to the many anti-Covid restrictions. Another interesting aspect to note is the relation between the asymmetric effects of the pandemic and the heterogeneous national lockdown policies, on the one side, and the origin of inflation divergences across EA member states, on the other. There is evidence that output (and to a lower degree inflation as well) decreased more in those countries hit the hardest by the pandemic – for example, countries with a larger share of tourism such as Italy and Spain.

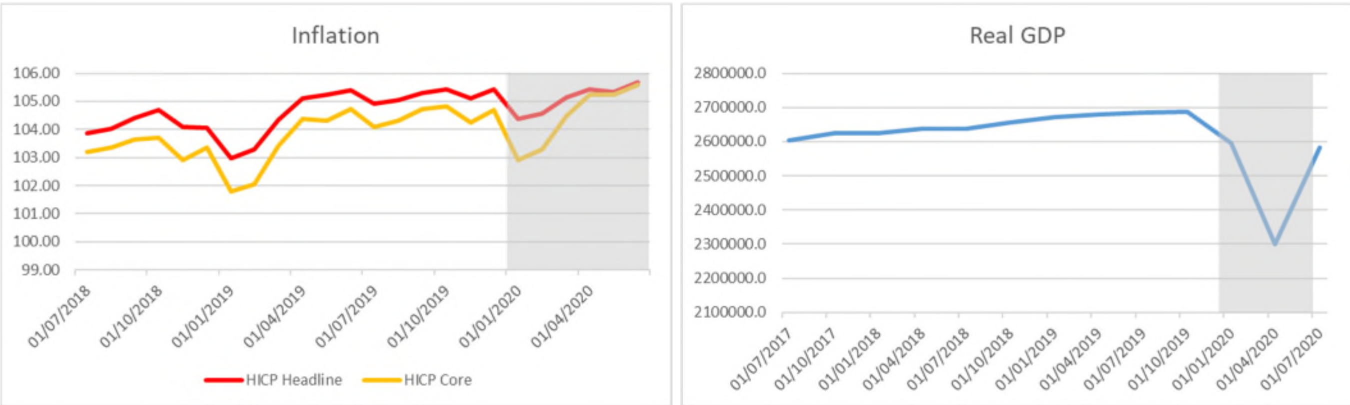


Figure 2. Left panel: headline and core HICP in the EA, Index 2015 = 100, monthly data. Right panel: real GDP in the EA, quarterly data. The grey shaded area represents Phase I.

Source: Eurostat

2.2 Phase II: the post-pandemic economic reopening

The gradual uplifting of lockdowns and all restrictive measures can be seen as a radical change in terms of economic conditions compared to the first two quarters of 2020. The economic reopening was followed by a skyrocketing in private consumption, which reached pre-pandemic levels in 2021:Q3, as well as by a more gradual restoring of production and productivity levels. Government expenditure increased notably as well, following a variety of stimuli put in place by all national governments in an attempt to support economic recovery. By October 2021, the average real government expenditure for the EA was 5.7% larger than in the pre-Covid period and has kept growing thereafter (Eurostat, 2023). For what matters investment, instead, its recovery has been slower and is yet to reach pre-pandemic levels. On the supply side, the picture is a bit more complex. Initially, as restrictions on workers and the workplace were uplifted, production picked up alongside productivity levels. Once firms' stocks had been depleted and storehouses emptied, however, firms started to lag behind a too fast paced demand. Supply shortages and trade bottlenecks worldwide disrupted the international supply chains, slowing down and partially offsetting the positive recovery in production, while putting pressure on input prices that was then passed on to consumers. From here, we can conclude that the increase in aggregate demand, both private and public, can be modelled as a positive demand shock, while the pick-up in production as a positive supply shock, although small due to the abovementioned supply chains disruptions.

According to the 3-equations model (Figure 4), a positive demand shock leads to a rightward shift in the IS curve (from IS' to IS''), which translates into an upward shift in the Phillips curve (i.e., pressure on inflation to increase). Assuming the economy was initially in equilibrium, the optimal policy response in this case is an increase in interest rates in order to bring output back to equilibrium. On the contrary, a positive supply shock (in this case caused by an upward shift in the price-setting curve, from PS' to PS'') leads the Phillips curve to shift down with consequent pressure on inflation to decrease. Extrapolating from this context, it is safe to assume that the positive demand shock more than offset the positive supply shock, with year-on-year core inflation increasing from 0.2% to 1.9% between August and September 2021. Real GDP, on the other hand, increased by 5.3% (annual percentage growth in 2021), stalled for a couple of months, to then reach pre-pandemic levels by the end of phase II. These data can be seen in the final point E'' in Figure 4, where output levels are comparable to pre-pandemic levels, but with higher inflation.

Another reason why inflation reached the levels it did is to be imputed to the policy stance adopted by the ECB. Monetary policy remained highly accommodative throughout phase II, with the ECB leaving unaltered all key interest rates at their negative levels. In face of economic reopening and historically low unemployment rates in the EA (from

Final outcome of a positive demand shock and a positive supply shock

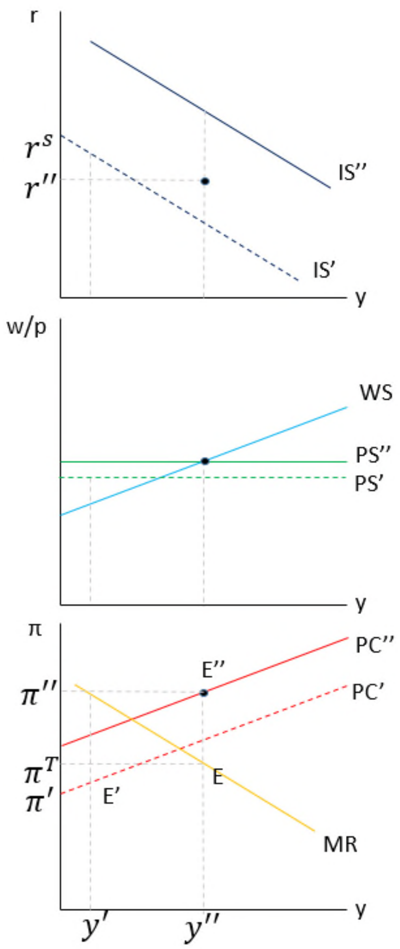


Figure 3. Phase II: the post-pandemic economic reopening

8.6% in August 2020 down to 7% in December 2021), the ECB was confident in a healthy restore in demand. Coupled with the assumption that supply-side pressures on inflation would fade out by spring 2022, the ECB did not envisage any tightening in its policy stance. It did envisage instead to conclude the Pandemic Emergency Purchase Programme (PEPP) by March 2022, as well as a gradual scaling down of purchases and reinvestments of securities thereafter. In terms of how inflation differentials behaved throughout the EA during phase II, it can be said that differences in the timing of post-pandemic reopening led to very different starting points for each nation. The uncoordinated lifting of national restrictions on travel and consumption resulted in heterogeneous economic outlooks across European countries. Coupled with differences in national economic structures, on average, it can be said that inflation picked up faster in those countries less impacted by the pandemic (where the economy declined less) and where labour shortages were felt more strongly in terms of wage-pressures (e.g., Eastern European and Baltic states).

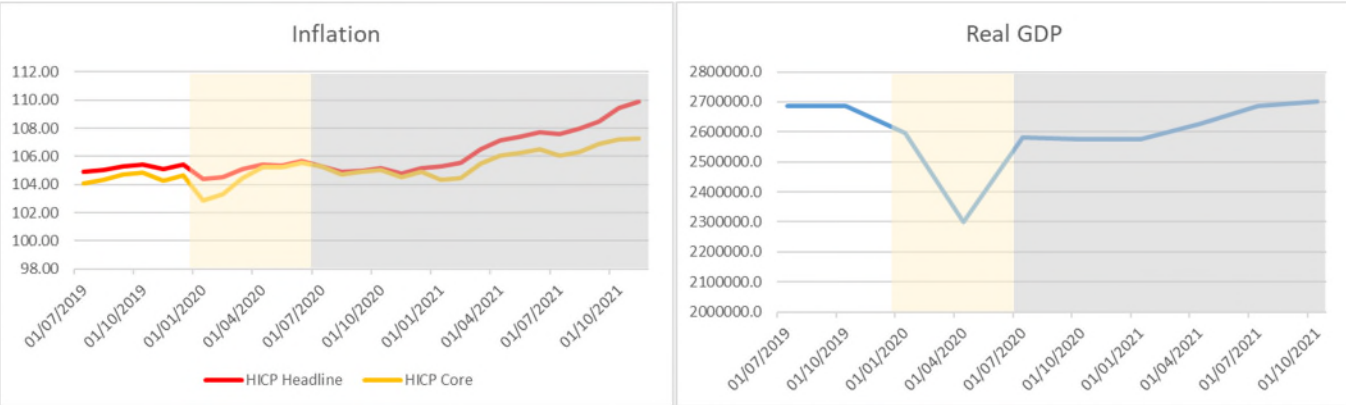


Figure 4. Left panel: headline and core HICP in the EA, Index 2015 = 100, monthly data. Right panel: real GDP in the EA, quarterly data. The grey shaded area represents Phase II.

Source: Eurostat

2.3 Phase III: the Russian war in Ukraine and energy shock

The general expectations of a smooth recovery toward equilibrium and the temporary nature of those shocks were blurred by a series of additional, external events: namely, the Chinese zero-Covid restrictions and, especially, the Russian war in Ukraine with the consequent spike in energy prices. This latter can be modelled as a region-specific shock, experienced by the EA, which swiftly propagated into all sectors. Higher energy prices passed-through the whole production process, sharply increasing input prices, and flowing into final, consumption prices. Consumer and producer energy prices have increased between September 2021 and October 2022 by 49.5 and 93.4%, respectively (ECB, 2023). It has been calculated that energy prices have contributed by 4.8% to the total increase in inflation in the EA on average (Eurostat, 2022), while 3.3 percentage points of the increase in non-energy inflation is still to be attributed to indirect energy costs (Rabobank, 2022). It has also been observed that the pass-through effect to retail prices was 40% for oil, 13% for gas, and 4% for electricity (baseline scenario by the

European Commission, 2022). This energy shock followed a series of other dynamics which were already building upward pressure on inflation. By the end of 2021, supply shortages aggravated further due to both trade bottlenecks and accelerated attempts to replenish the stock of inventories. Commodity prices were on the rise globally, more than doubling between April 2020 and October 2021 (IMF, 2022). On top of all, households increased further their consumption from mid-2022 onward, due to pent-up demand and extra savings accumulated from the lockdown period onward (households saving rate was at 15% by the end of 2021), while government expenditure remained high in order to provide fiscal support against skyrocketing energy bills.

Final outcome of a positive demand shock and a negative supply shock

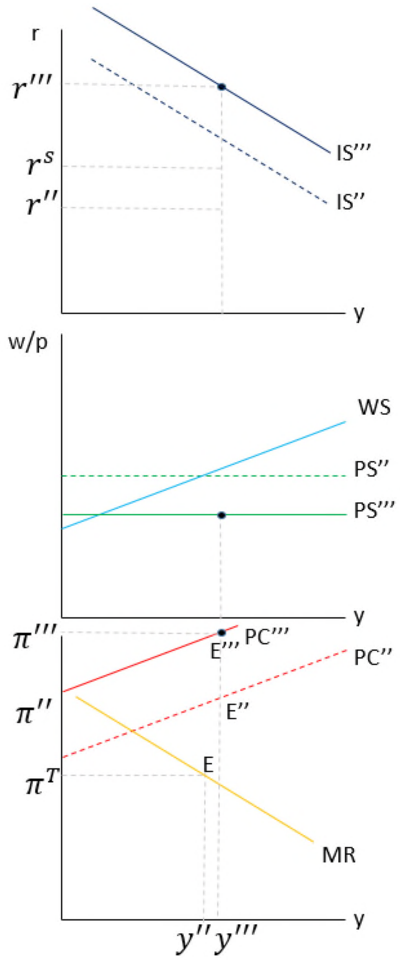


Figure 5. Phase III: the Russian war in Ukraine and energy shock

All in all, we could safely model these events as a positive demand shock on the one hand, and as a negative supply shock on the other. In terms of our 3-equations model (Figure 5), assuming both shocks are temporary in nature, this implies that: (i) the positive demand shock leads to a further rightward shift in the IS curve (from IS'' to IS'''), an increase in output and an upward shift in the Phillips curve, while (ii) the negative supply shock, due to a downward shift in the price-setting curve (reduction in productivity, from PS'' to PS'''), shifts the Phillips curve further up, although moving output in the opposite direction. Both shocks contribute to the upward pressure on inflation (from PC'' to PC'''), and both prescribe an increase in interest rates as best policy response (r''').

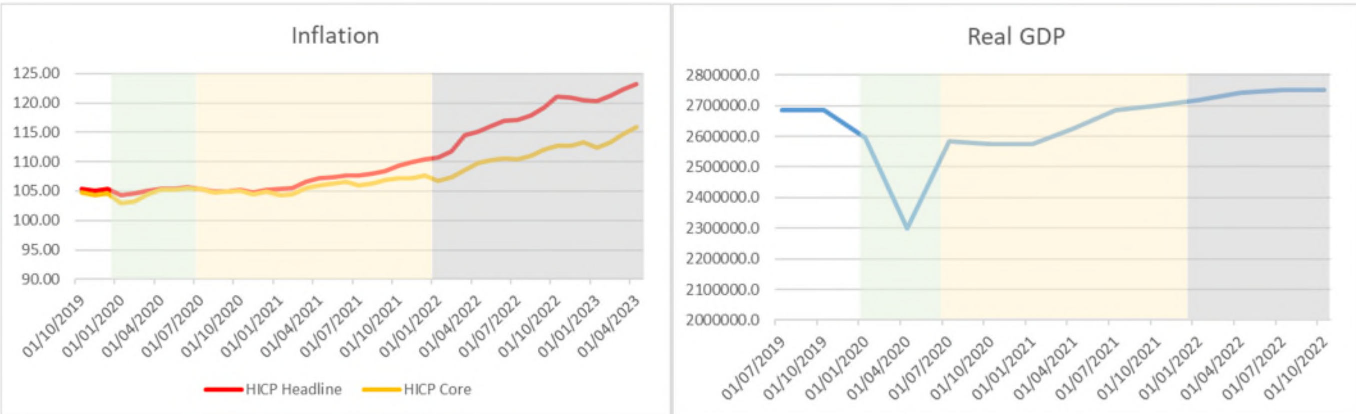


Figure 6. Left panel: headline and core HICP in the EA, Index 2015 = 100, monthly data. Right panel: real GDP in the EA, quarterly data. The grey shaded area represents Phase III.

Source: Eurostat

Looking at the data, we can easily confirm these dynamics: headline inflation in the EA reached a peak of 10.6% in October 2022 and is now stationed at 7% as of April 2023. Core inflation increased from 1.9% to 5.6%, while real GDP went slightly above pre-pandemic levels (point E''' in figure 5). For what matters the policy response, it soon became clear among policy makers at the ECB that those shocks resulted to be much more persistent than first expected, and much higher in terms of inflation they brought about. Starting from July 2022, the ECB started its monetary policy tightening with the first increase in official interest rates – an increase that is yet ongoing and has so far reached a total of 3.5 basis points as of March 2023 (Figure 7 – right panel), the sharpest increase in the history of the monetary union. Quantitative tightening was started as well in July 2022, when net asset purchases in APP got negative for the first time. All in all, as of now, we find ourselves in a situation with higher output compared to pre-Covid levels, but much higher inflation as well.

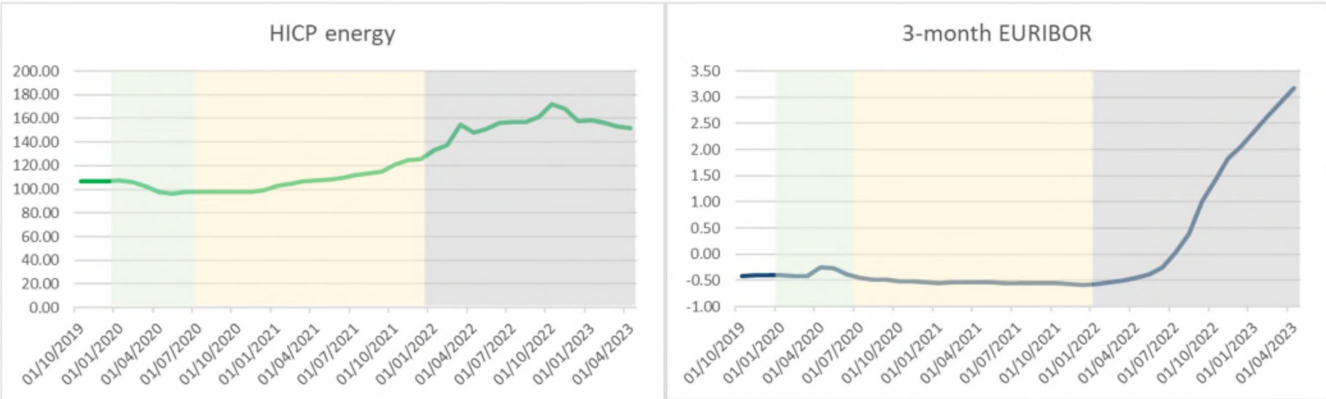


Figure 7. Left panel: energy prices in the EA, Index 2015 = 100, monthly data. Right panel: 3-month interbank interest rate in the EA, monthly data. The grey shaded area represents Phase III.

Source: Eurostat

For what matters inflation differentials, phase III is when inflation rates started to severely diverge across EA countries, and for a series of reasons. Namely, differences in the consumption baskets and energy mixes (countries with higher shares of energy and energy-related products in their consumption baskets suffered more, as well as countries more dependent on Russian gas and oil); differences in national business cycles and economic structures; differences in price setting mechanisms (very flexible in some countries and more sticky in others); as well as differences in the national fiscal measures adopted and the extent to which energy prices have been regulated (price caps, energy bills' discounts, households' support, etc…). All these factors led to wide divergences between national inflation rates, ranging from a low of 6% in France to a high of 20.3% in the Baltic States. Certainly, as long as inflation differentials across EA countries will remain this high, it will continue to be problematic for the ECB to carry out its policy stance as smoothly and as optimally as possible.

3. Decomposing Inflation: A Structural VAR Model

After having decomposed inflation from a theory point of view, let us now turn to practice, bringing forward empirical evidence in support of what has been stated before. The empirical model employed is based after the applications of Shapiro on US data (2022) and of Ascari et al. (2023) on Euro Area data. The approach is twofold: first, a Structural Vector Autoregressive model (SVAR) identified via sign restrictions, following Ascari et al., and a classification mechanism of headline HICP components as robustness check, following Shapiro, as second. The idea behind both approaches is, nonetheless, the same as it is their objective: to decompose inflation into its main drivers. This twofold approach will be applied to each of the three chronological phases, as well as to attempt a forecast of future developments in inflation dynamics in the EA, in order to assess its persistency and those of its main drivers.

Starting with the first approach, it is a VAR of order 6 – SVAR(6) – and three variables: headline HICP, industrial production as a proxy for output, and 3-month interbank interest rates (i.e., EURIBOR). A VAR is a n-equations and n-variables linear model. In this model, every equation is explained by its lagged values in addition to the past values of the remaining n-1 variables. It helps analysing the dynamics in multiple time-series all at once. The advantage of using a SVAR here is to exploit simple economic theory on demand and supply shocks in order to link variables together, imposing a specific structure to the model, and setting the required restrictions. In our case, the model has been identified via sign restrictions, which allow for a certain degree of parsimony and are of less controversial interpretation compared to other types of non-sign restrictions (Fry and Pagan 2011). However, while sign restrictions indicate whether inflation dynamics are demand- or supply-driven at any point in time, they do not pin down the degree to which demand or supply is impacting on inflation. For this reason, the second approach will be needed and complementary, as robustness check. Following this model's specifications, a forecast error decomposition is computed for both output and inflation, respectively, and for each chronological phase in turn, decomposing these two variables into demand and supply shocks.

For what matters the second approach, instead, it is inspired after the work of Shapiro and the Federal Bank of San Francisco, being the first in decomposing the inflationary shock in the United States into demand and supply factors. Their approach is based upon two simple VAR regressions: one for price and one for quantity. For simplicity, the regressions are here limited to a single proxy for quantity (that is, industrial production) and a single HICP component per turn (namely, energy, non-energy industrial goods, services, food, and housing). Starting with a sample that ranges from January 2000 to December 2019, it is enough to forecast next month's values and compare them with the actual values of price and quantity: if the forecasted values are both either above or below the actual values, then it will be said that price and quantity dynamics are demand-driven in that month, and they will thus be classified as demand shock. Vice versa, if one forecasted value is above and the other below their actual values, it is said to be a supply shock for that month. Such method for classification relies on the simple economic theory that demand shocks move output and inflation in the same direction, while supply shocks on opposite ones. This one-step forecast has been carried out for each month on a rolling basis, up until April 2023, enlarging the sample progressively. After this classification into supply and demand shocks, by taking into account the specific weights of each HICP component on headline HICP, the overall impact of demand and supply drivers on headline inflation for each chronological phase can be computed. In this sense, this second approach is meant to serve as robustness check and support the results obtained through the SVAR model.

Let us start with the first approach. The idea here, from a practical standpoint, is to isolate the role of demand and supply factors by relying on the model forecast errors. For the first phase it will go as follows: run the model till time 2019:12, produce the forecast with horizon 2020:01-2020:06 (6 months' period), and then compute forecast errors for both inflation and output using realized values. Conditional on the information set at time 2019:12, the model forecast errors are generated by unexpected shocks that can be decomposed into demand and supply, according to the relative movements in inflation and output as set by the sign restrictions. These steps will then be repeated for the two remaining chronological phases and for the month to follow till the end of 2023. Alongside forecast error decompositions, a historical decomposition of both inflation and output is provided as well for the full sample (Figure 11), allowing for a clearer picture of the magnitude and direction of demand and supply shocks. More on both the SVAR model and the one-step forecast analysis can be found in the Appendix.

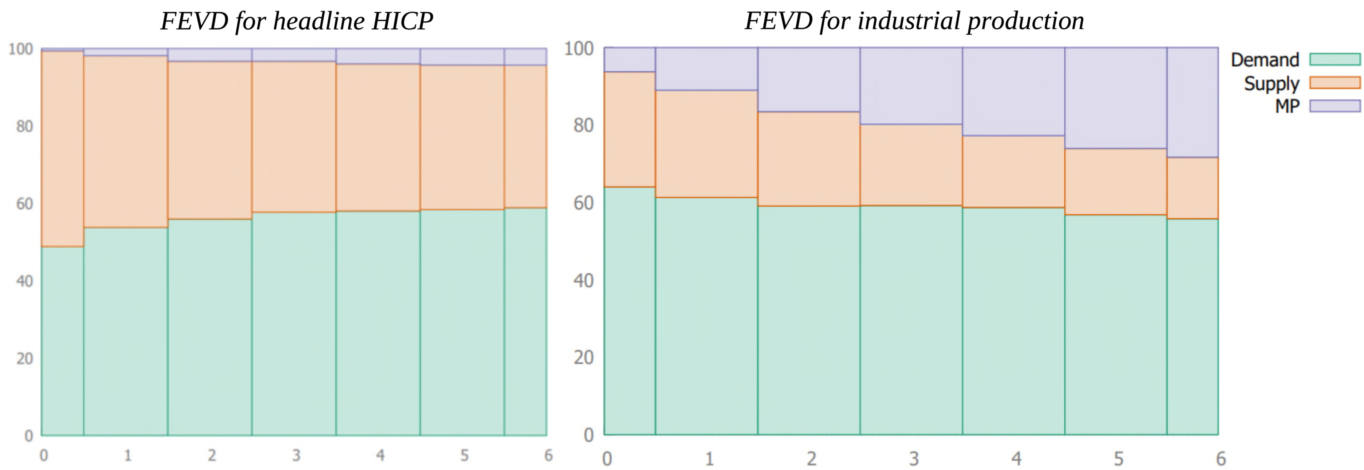


Figure 8. Output and inflation forecast error decomposition for phase I (2020:01-2020:06)

Figure 8 displays the results for phase I. The forecast error decomposition for inflation (left panel) displays a mainly demand driven shock, accounting for between 45 and 60% in the variation in headline HICP, and consistent with the dominating negative demand shock modelled in theory. The impact of a supply shock, on the other hand, slightly decreases (30%

by the end of the period) while the accommodative monetary policy acquires some driving force over the months. Looking at the forecast error for output (i.e., industrial production), its variation is similarly mainly driven by a demand shock, accounting for around 60% – followed by a supply shock with 30% decreasing to 20% by the end of the second quarter of 2020.

The results for phase II are to be found in Figure 9. Here, contrary to phase I, the variation in inflation is mainly driven by a supply shock, accounting for slightly less than 50%, while the impact of a demand shock stays at 30%. This result is, however, counterintuitive with respect to what has been modelled in theory, with the positive demand shock being larger than the positive supply shock. Such a difference is probably to be imputed either to the imperfection of the empirical model or to the fact that a monetary policy shock is taken into account as well, which substantially behaves as a demand shock moving inflation up when the 3-month EURIBOR decreases (as set by sign restrictions). The monetary policy shock, indeed, accounts

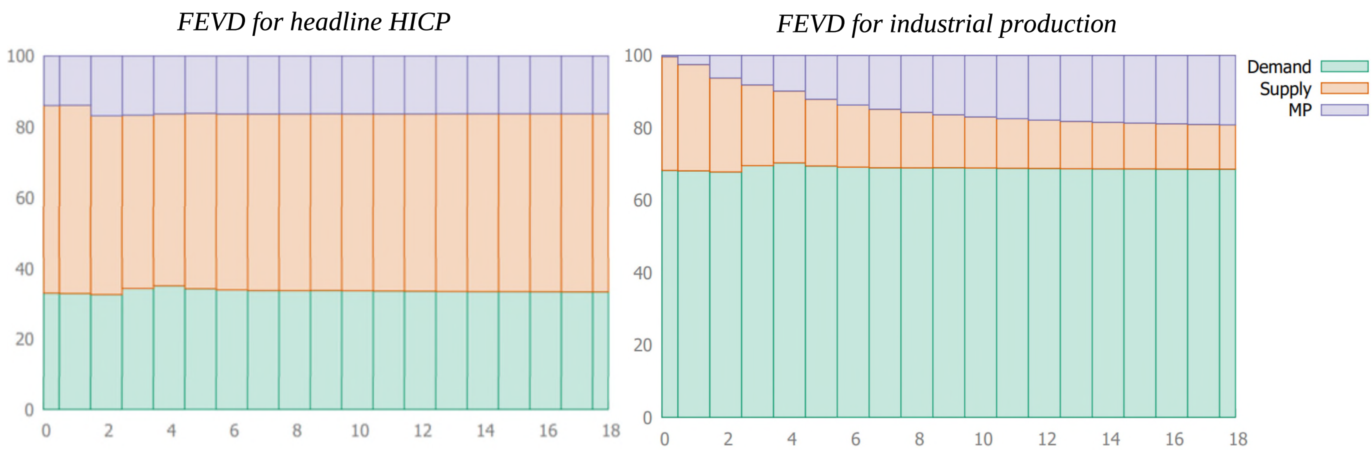


Figure 9. Output and inflation forecast error decomposition for phase II (2020:06-2021:12)

for almost 20% of variation in inflation, and if summed with the demand shock, they fully counterbalance the supply-induced variation. For what matters the forecast error for output, its variation is mainly driven by the demand side as expected, accounting for around 65%, followed by a decreasing supply shock and an increasing monetary policy shock.

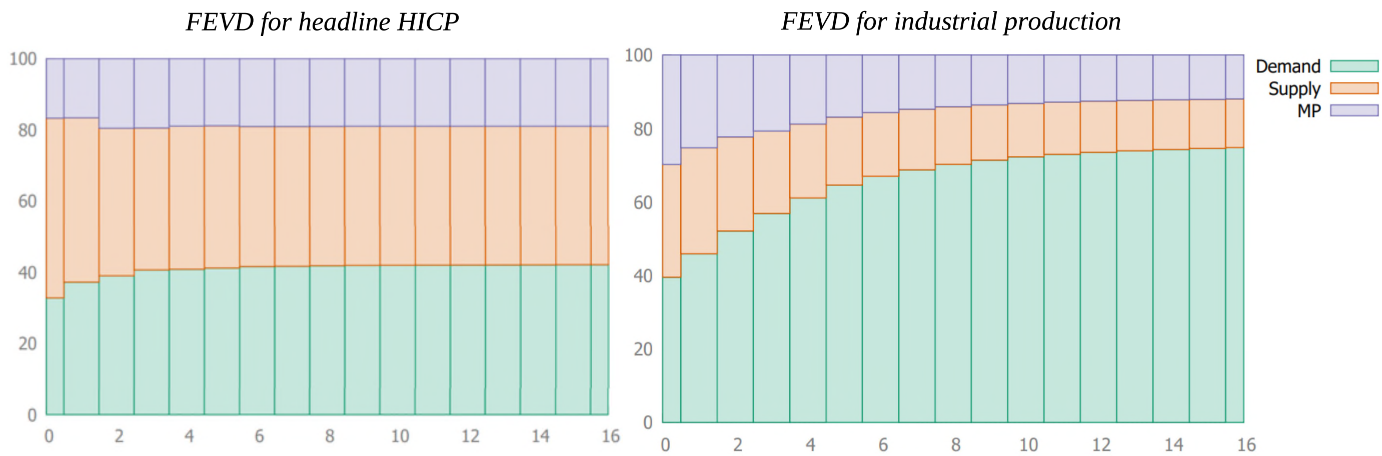
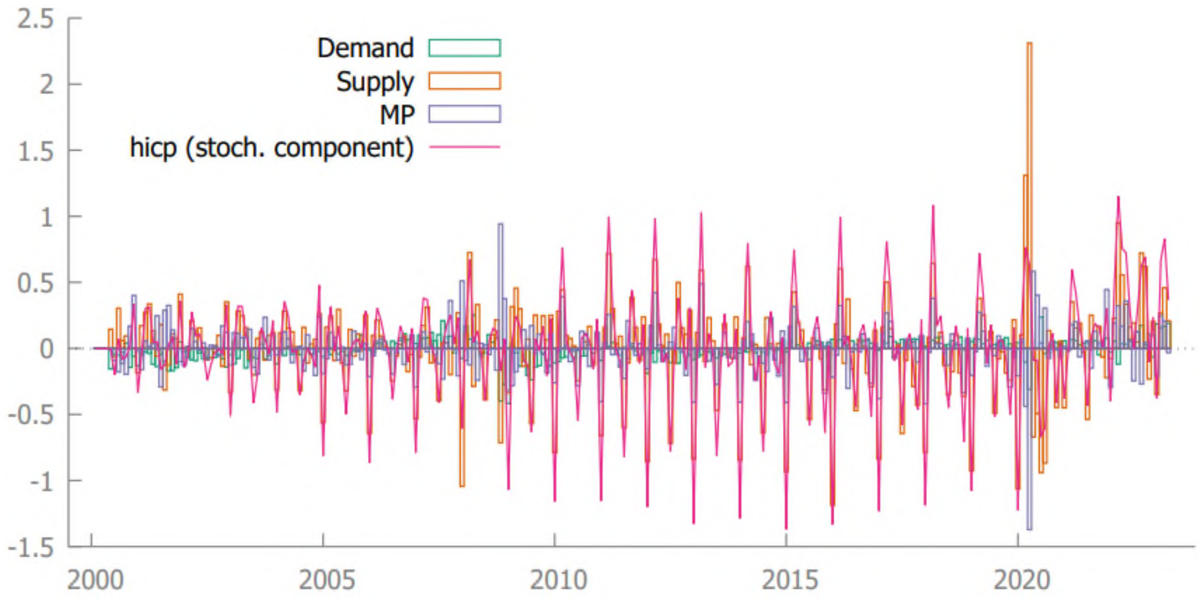


Figure 10. Output and inflation forecast error decomposition for phase III (2021:12-2023:04)

Last but not least, Figure 10 displays the results for phase III. The variance of inflation is driven by a demand and supply shock in roughly equal parts, around 40% each, while the remaining 20% is explained by changes in monetary policy. The forecast error decomposition for output, on the other hand, displays that it is mainly driven by a demand shock, in an increasing manner throughout the 16 periods under analysis, from 40 to more than 60%. Contrarily, the supply- and monetary policy- driven variation in output decreases to around 15% each by the end of the period.

These results for all three phases are further proved by the historical decomposition obtained through the full sample model and displayed in Figure 11. According to the top panel of figure 11 – HD of headline HICP, for the last year and a half, inflation has been mainly supply-driven, with however an evident growing importance played by demand factors. Slight changes between forecast error decompositions and historical decompositions are probably due to the model reconfiguration that takes place in the former whenever resampling. As of now, looking at the very last bar of the graph, it seems that demand and supply have same force as drivers of inflation, each contribution for around 50% of the inflationary pressure, thus ultimately proving this paper's thesis. Looking instead at the lower panel of Figure 11 – HD of industrial production, the historical decomposition of output shows a mainly demand-driven industrial production, in line with the growing trend in European GDP as pushed up by a positive demand shock which more than offset the negative supply shock.

HD of headline HICP



HD of industrial production

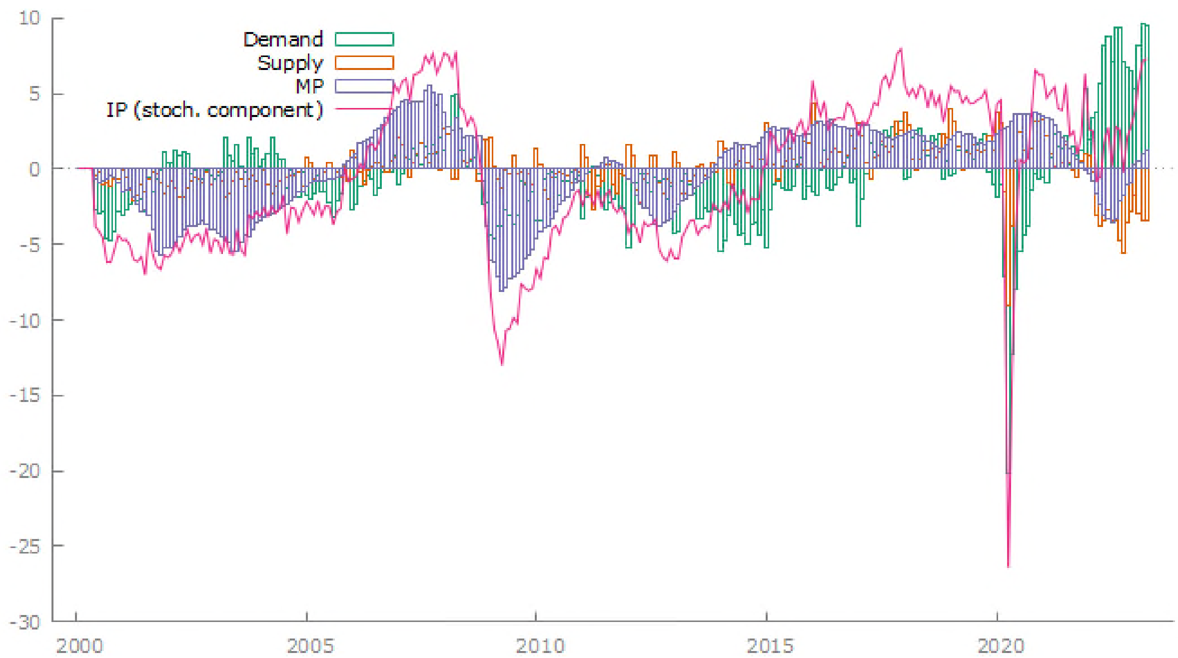


Figure 11. Historical Decomposition of inflation and output, full sample (2000:01-2023:04)

To conclude, let us turn to the second approach, the one-step forecast analysis. Five VAR models have been run for this – all of order 6 and with 2 variables – one for each of the five main components of headline HICP plus industrial production as a proxy for output. The 5 main components of headline HICP are the following: energy (10%), food, alcohol and tobacco (22%), non-energy industrial goods or NEIG (25%), services (38%), and housing, electricity, gas, etc. (5%). In parenthesis there are the HICP components' weights, defined as the annual percentage change by the ECB.

For phase I, the one-step forecast analysis yields that: (i) energy prices are 67% demand-driven and 33% supply-driven; (ii) food prices are 83% demand-driven and 17% supply-driven; (iii) NEIG prices are driven by demand and supply 50% each; (iv) same goes for prices of services; and (v) housing prices are 67% demand-driven and 33% supply-driven. Multiplying these percentages by their respective components' weights and adding them together by category, it results that in phase I EA inflation was 60% demand-driven and for the remaining 40% supply-driven. For phase II, the results yield that: (i) energy prices are 67% demand-driven and 33% supply-driven; (ii) food prices are driven by demand and supply 50% each; (iii) NEIG prices are 56% demand-driven and 44% supply-driven; (iv) prices of services are 44% demand-driven and 56% supply driven; and (v) housing prices are 61% demand-driven and 39% supply-drive. It follows that, in phase II, EA inflation was 52% demand-driven and for the remaining 48% supply-driven. Repeating the analysis one more time for phase III, it yields that: (i) energy prices are 37% demand-driven and 63% supply-driven; (ii) food prices are 43% demand-driven and 57% supply-driven; (iii) NEIG prices are 40% demand-driven and 60% supply-driven; (iv) prices of services are 66% demand-driven and 34% supply driven; and last but not least (v) housing prices are 31% demand-driven and 69% supply-driven. All in all, these numbers result in a EA inflation driven by demand for the 48% and by supply for the remaining 52% for the whole of period III.

These results are all in line with both the theoretical model and the empirical SVAR model. In turn, they reflect a negative demand shock outgrowing a negative supply shock in phase I, a positive demand shock larger than a positive supply shock during phase II, and a more even match between a positive demand shock and a negative supply shock throughout phase III. As such, these results provide an additional answer to the research questions of this present paper and further prove the importance of a demand-driven inflationary pressure that ought not to be neglected.

4. Best Policy Responses and Concluding Remarks

Having assessed, approximatively, the impact of demand and supply as drivers of inflation throughout these last 3 years, it is now time to draw conclusions as what these results imply for policy-makers and best policy responses. As stated before, monetary policy is more effective against demand shocks, while supply shocks are better addressed through fiscal and structural policies. The fact that demand factors are increasingly driving output and inflation dynamics is, in this sense, a good thing, since it allows the ECB to have more control over inflation and makes monetary policy more effective in fighting it. Further increases in key interest rates are envisaged and thus welcomed, as they provide relief against demand-driven inflation. However, policy makers at the ECB ought to be careful in finding the right balance between two risks: on one side, the risk of overtightening monetary policy, which would imply severe effects on economic activity, employment, financial stability, and medium-term price developments; and the risk of stopping too early on the other hand – a too loose monetary policy, which would lead inflation to remain high and persistent, entrenched into price and wage setting processes (Visco, 2023). Moreover, to a certain extent, it can be said that the ECB is constrained on its actions by the Federal Reserve of America, given that the euro cannot afford to undergo further depreciation against the US dollar that would only fuel European inflation rates.

Besides this delicate balancing task, a tightening monetary policy alone, although necessary still, would not be enough to bring back both inflation *and* output to target, and for a number of reasons. First, supply factors contribute for around a half of the inflationary pressure: if supply chain disruptions are not solved through structural policies or any other mean, they will keep production prices up. Second, national fiscal policies ought not to fuel excessively demand, especially in those sectors most affected by supply shortages, in that expansionary fiscal policy moves in diametrically opposite directions with respect to monetary policy. Third, there is a potentially heavy trade-off between bringing inflation down through higher interest rates and suppressing economic growth while increasing unemployment. Last but not least, inflation differentials, a de-anchoring of inflation expectations, and second-round effects, all still threatens the process of converging back to the 2% target as fast and as smoothly as possible.

In order to address all these issues, a wise mix of different policies is the best way forward. In order to counterbalance the degrading effects of negative supply shocks on output, positive supply shocks are needed. At the national and Euro Area levels, they can be induced through a series of structural economic policies to boost production and productivity, as well as through a higher level of cooperation between member countries. Economic convergence needs to be strengthened, in order to better align national business cycles, build resilience, and reduce the impact of asymmetric, idiosyncratic shocks. A higher degree of cooperation in structural economic matters would also be beneficial in terms of price and wage setting processes: regulations can be imposed on a maximum (as well as minimum) velocity of wage increases across the EA, while firms' mark-ups can and ought to be nudged to follow the decreasing trend in inflation. A common European industrial policy, on the other hand, would help to coordinate state aid rules in a more structured and efficient manner, and strengthen European strategic autonomy while preserving firms' competitiveness. Furthermore, investments in the energy sector at the EU level would improve the interconnection between national electricity grids, reduce energy costs, and improve energy security (OECD, 2022).

For what matters fiscal policy, on the other hand, it is imperative that national measures move in the same direction as monetary policy: an excessively expansionary fiscal policy, indeed, would only fuel inflation, create frictions with monetary policy, and force the ECB to further tighten the latter. Instead, national fiscal policies should be aimed at mitigating supply-driven inflation and preventing excessive demand from heating up supply-constrained sectors. Obviously, and rightly so, fiscal policies have been used so far by every country in order to support their economies, firms and households, against the pandemic first and during the energy crisis later. However, it is advisable for these fiscal measures to be strictly temporary in nature and well targeted. Means-tested transfers to households generally meet these criteria, although the OECD has offered finer targeting mechanisms that go beyond income, based for example on house location and quality (OECD, 2022). On the contrary, fiscal measures that distort supply and demand mechanisms, favouring the consumption and/or production of goods whose quantity is getting scarce – that is, price caps on oil and gas, for example – should be avoided, in that they only further fuel prices and distort market adjustments. Moreover, given the heterogeneity of national fiscal policies that have been put in place so far, and looking at how they have contributed to diverging inflation rates across EA countries, a stronger coordination and harmonisation of such measures is definitely more than needed as well. Common European guidelines could also be used to prevent negative spillovers effects of national fiscal policies, and thus avoid distortions in competition.

All in all, the paths that will be followed by monetary and fiscal policies will largely depend on the interaction between the two. In the best case scenario – one in which the ECB and national fiscal authorities are able to coordinate themselves and work together toward common objectives – the path toward economic equilibrium will be smoother and faster. Monetary policy could gradually loosen-up in the medium term, while output growth would be preserved and purchasing power re-established. For this scenario to materialise, it is essential not to lose the momentum built in these last couple of years while facing such unprecedented challenges of common breath, and the solidarity drive that came with it. As the ancient Greeks said, from every *κρίσις* (crisis) there is a new opportunity. Let us not waist it.

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6. Appendix

The first model is specified as a VAR at monthly frequency with three variables: the harmonised index of consumer prices for headline inflation, the industrial production index as proxy for output, and the 3-month interbank lending interest rate or EURIBOR as a measure of monetary policy. Defining Y_t as the vector of observed variables at time *t*, we have:

$\alpha_0 Y_t = c_0 + \alpha(L)Y_{t-1} + \beta\varepsilon_t$ with $\varepsilon_t \sim N(0, I)$

where $\alpha(L)$ is a polynomial matrix in the lag operator L restricted to ensure stable dynamics and assuming 6 lags, c_0 is a $k\ x$ 1 vector of constants, α_i is a $k\ x\ k$ matrix for every $i = 0, \dots, 6$, and ε_t is a $k\ x$ 1 vector of white noise error terms, also known as structural shocks. The main diagonal terms of the α_i matrix are scaled to 1. Assuming the approach first proposed by Villoresi (2009), this model can be re-written as:

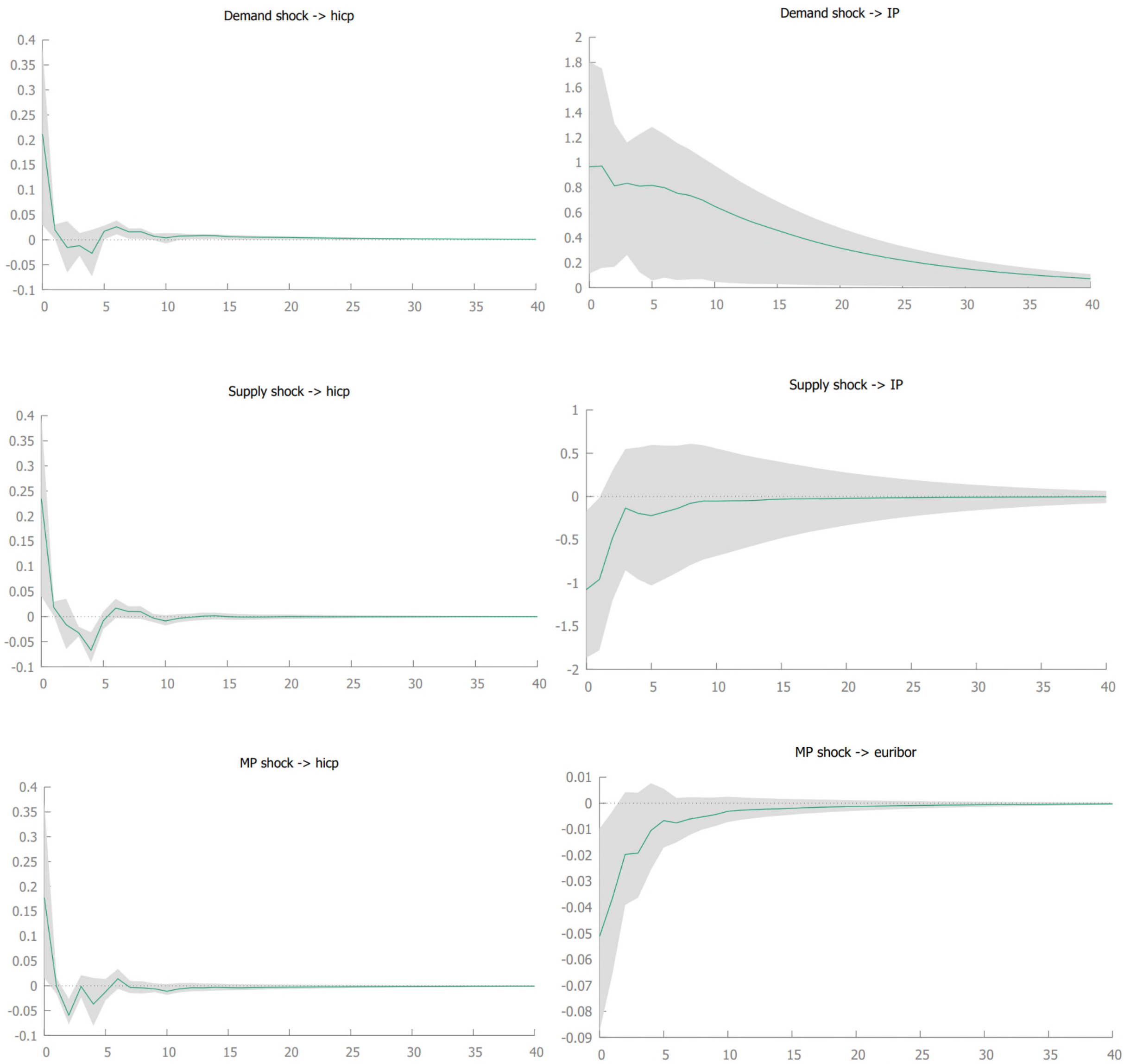
$\alpha(L)(Y_t - Y_t^E) = \beta\varepsilon_t$

where Y_t^E is a vector containing the counterfactual values of Y_t when there are no shocks hitting the economy. The sample goes from January 2000 until April 2023. Variables are made stationary, when necessary, by taking first differences and transformed in log form (with exception for EURIBOR). No structural breaks or time dummies are needed. The model parameters are jointly estimated using Structural VAR methods identified via sign restrictions. All restrictions are imposed on impact and they read as follows:

	Demand Shock	Supply Shock	Monetary Policy Shock
Headline HICP	+	+	+
Industrial Production	+	-	
EURIBOOR			-

These sign restrictions have been imposed following simple macroeconomic theory: a demand shock moves output and inflation in the same direction (in this case up, following a positive demand shock); a supply shock moves output and inflation in opposite directions (inflation goes up and output down: this is a negative supply shock); a monetary policy shock – a loosening of monetary policy, in this case – means a decrease in interest rates and an increase in inflation. These three shocks could have all been model the other way around: final results would not have changed.

The followings are the model’s resulting Impulse Response Functions for the full sample:



This model and these specifications are the result of a thorough selection process that compared a variety of different model and respective specifications, from short-run to long-run SVAR restrictions, passing through Bayesian methods and Cholesky identified VARs with more variables. For future research, it is suggested to perform the analysis through programmes able to process Bayesian methods (which better perform for smaller samples as this one) applied to a combination of both sign and zero restrictions. The persistence of sign restrictions should also be specified in order to guarantee a greater degree of accuracy, taking into account that supply shocks are more persistent than demand shocks and that monetary policy shocks lag behind the formers.

The second model, instead, is a one-step forecast analysis based after five different VAR models with two variables and 6 lags each. Industrial production index as a proxy for output is a variable common to all five VARs. For what matters, instead, the second variable of each model, they are respectively: HICP – energy; HICP – food, alcohol, and tobacco; HICP – non-energy industrial goods; HICP – services; and HICP – housing, electricity, gas, etc. These models are based after the simple macroeconomic assumption of a downward sloping demand curve and an upward sloping supply curve, for each variable i:

$q_i = \sigma^i p_i + \alpha^i$ (supply curve)

$p_i = -\delta^i q_i + \beta^i$ (demand curve)

where q_i represents quantity (i.e., output) and p_i the price level (i.e., inflation), σ^i is the slope of the supply curve, $-\delta^i$ the slope of the demand curve, and α^i and β^i are the intercepts. According to theory, a shift in α^i is interpreted as a supply shock, while a shift in β^i as a demand shock. If follows that shifts (or shocks) to the supply and demand curve can be represented, for each variable i, as:

$\varepsilon_i^S = \Delta\alpha^i = \left(q_{i,t} - \sigma^i p_{i,t}\right) - \left(q_{i,t-1} - \sigma^i p_{i,t-1}\right)$ (supply shock)

$\varepsilon_i^D = \Delta\beta^i = (p_{i,t} + \delta^i q_{i,t}) - (p_{i,t-1} + \delta^i q_{i,t-1})$ (demand shock)

This model can be estimated using time-series data by translating it into a VAR:

$\alpha_0 Y_t = \alpha(L) Y_{t-1} + \beta\varepsilon_t$ with $\varepsilon_t \sim N(0, I)$

The results of the one-step forecasts for each of the five HICP variables are reported here below:

HICP – energy			Industrial Production		
Date	Actual	Forecasted	Date	Actual	Forecasted
2020:01	0.791107	-0.146998	2020:01	464.631213	462.453668
2020:02	-1.635627	0.640231	2020:02	464.439090	463.652022
2020:03	-3.373260	-0.279397	2020:03	452.936847	463.871269
2020:04	-4.903873	-2.500922	2020:04	431.481788	455.160659
2020:05	-1.693031	-6.903482	2020:05	444.734610	418.929098
2020:06	1.723736	1.871486	2020:06	454.435805	452.836154
2020:07	0.469628	-0.030293	2020:07	459.005655	443.042349
2020:08	0.020369	-1.206740	2020:08	458.802403	447.913372
2020:09	-0.449072	-1.450190	2020:09	459.107126	453.922547
2020:10	0.367572	2.108564	2020:10	462.005880	459.282611
2020:11	-0.132579	1.265654	2020:11	465.014355	462.893901
2020:12	1.629673	0.681304	2020:12	465.109912	464.454269
2021:01	3.724936	0.818537	2021:01	466.060489	464.230637
2021:02	0.943494	1.748050	2021:02	464.727136	466.466127
2021:03	2.544955	0.143320	2021:03	465.681342	464.221770
2021:04	0.707440	1.286647	2021:04	466.249525	466.296834
2021:05	0.766925	-0.022767	2021:05	464.822968	465.886614
2021:06	1.262250	0.033848	2021:06	465.014355	463.943525
2021:07	2.015544	0.638984	2021:07	467.189382	464.813254
2021:08	0.975099	0.888753	2021:08	463.860496	467.209416

2021:09	1.366764	0.079588	2021:09	464.439090	462.537987
2021:10	5.460750	0.659812	2021:10	464.150212	464.842641
2021:11	2.890985	1.865239	2021:11	465.871095	464.932233
2021:12	0.367530	1.166647	2021:12	469.683737	465.849007
2022:01	5.989721	0.296022	2022:01	467.376298	468.686678
2022:02	3.389654	2.138928	2022:02	467.251174	467.749085
2022:03	11.497146	1.182859	2022:03	466.720558	468.015083
2022:04	-4.109172	5.142602	2022:04	465.681342	468.280938
2022:05	1.930265	0.067030	2022:05	467.842065	464.620148
2022:06	3.305226	-0.282214	2022:06	469.774937	467.106015
2022:07	0.287586	2.612931	2022:07	466.438205	469.993431
2022:08	0.293125	0.321949	2022:08	468.859179	464.001719
2022:09	2.854021	1.075117	2022:09	469.226489	467.758431
2022:10	6.023532	0.685672	2022:10	467.376298	469.044385
2022:11	-1.892616	2.036269	2022:11	468.767141	467.367162
2022:12	-6.832344	0.585721	2022:12	468.070884	467.376298
2023:01	0.582797	-1.597024	2023:01	468.398137	465.720820
2023:02	-1.124285	1.505490	2023:02	469.866053	467.961046
2023:03	-2.261078	-0.053950	2023:03	470.138904	468.180979
2023:04	-0.741060	-0.663017	2023:04	470.138904	468.435318

HICP – food			Industrial Production		
Date	Actual	Forecasted	Date	Actual	Forecasted
2020:01	0.676774	0.245911	2020:01	464.631213	462.218974
2020:02	0.341282	0.427807	2020:02	464.439090	463.524091
2020:03	0.330943	0.265282	2020:03	452.936847	464.193211
2020:04	1.104378	0.338840	2020:04	431.481788	455.260258
2020:05	0.280988	1.257407	2020:05	444.734610	418.605872

2020:06	-0.190261	-0.159168		2020:06	454.435805	452.559251
2020:07	-1.039207	-0.498567		2020:07	459.005655	443.390986
2020:08	-0.091676	-0.557128		2020:08	458.802403	448.943095
2020:09	-0.165229	-0.441967		2020:09	459.107126	454.362355
2020:10	0.311870	0.284715		2020:10	462.005880	459.848805
2020:11	0.201281	0.452639		2020:11	465.014355	462.735979
2020:12	-0.448863	0.444697		2020:12	465.109912	464.895429
2021:01	0.813793	0.326276		2021:01	466.060489	463.218123
2021:02	0.227407	0.509478		2021:02	464.727136	466.173521
2021:03	0.090818	0.300668		2021:03	465.681342	464.044254
2021:04	0.606364	0.358659		2021:04	466.249525	465.460081
2021:05	0.216314	0.274923		2021:05	464.822968	466.156724
2021:06	-0.189249	0.337245		2021:06	465.014355	463.695974
2021:07	0.018039	0.110361		2021:07	467.189382	464.789168
2021:08	0.261203	0.093195		2021:08	463.860496	467.272259
2021:09	-0.098997	0.206119		2021:09	464.439090	462.494407
2021:10	0.224851	0.169234		2021:10	464.150212	464.569277
2021:11	0.439246	0.173139		2021:11	465.871095	463.863848
2021:12	0.579712	0.331523		2021:12	469.683737	465.621575
2022:01	1.087881	0.239467		2022:01	467.376298	468.874561
2022:02	0.832207	0.573414		2022:02	467.749085	465.744820
2022:03	0.894530	0.623184		2022:03	466.720558	467.444700
2022:04	1.875778	0.450030		2022:04	465.681342	466.293891
2022:05	1.281528	0.762820		2022:05	467.842065	465.782754
2022:06	1.124590	0.501480		2022:06	469.774937	467.609158
2022:07	0.866021	0.626432		2022:07	466.438205	469.338611
2022:08	0.988772	0.557272		2022:08	468.859179	465.262015
2022:09	0.922710	0.512893		2022:09	469.226489	469.572188
2022:10	1.447736	0.318849		2022:10	467.376298	469.193372
2022:11	0.877580	0.855197		2022:11	468.767141	466.932453
2022:12	0.705941	0.608858		2022:12	467.376298	468.755816
2023:01	1.358558	0.614811		2023:01	468.398137	466.783353

2023:02	1.666960	0.766921	2023:02	468.914600	469.866053
2023:03	1.250958	0.848659	2023:03	470.138904	469.579516
2023:04	0.239360	1.003138	2023:04	470.138904	469.627357

HICP – NEIG

Date	Actual	Forecasted
2020:01	-3.456303	-3.411478
2020:02	0.181214	0.090678
2020:03	2.933808	2.977134
2020:04	0.555205	0.671319
2020:05	-0.009714	0.263962
2020:06	-0.360080	-0.161395
2020:07	-1.969149	-3.071487
2020:08	-1.634040	0.292725
2020:09	2.741536	2.312975
2020:10	0.832400	1.250416
2020:11	0.039002	0.423403
2020:12	-0.390702	-0.019053
2021:01	-1.449086	-1.854722
2021:02	-0.238592	-1.633842
2021:03	2.195294	2.374573
2021:04	0.679285	0.573771
2021:05	0.212540	-0.098025
2021:06	0.115741	-0.653587
2021:07	-2.419630	-1.906838
2021:08	0.217027	-0.252879
2021:09	2.308582	2.039041
2021:10	0.719600	0.209855
2021:11	0.372156	0.141290
2021:12	0.123745	-0.301791

Industrial Production

Date	Actual	Forecasted
2020:01	464.631213	462.230097
2020:02	464.439090	463.521818
2020:03	452.936847	464.037821
2020:04	431.481788	455.335430
2020:05	444.734610	419.108838
2020:06	454.435805	453.523685
2020:07	459.005655	444.212092
2020:08	458.802403	448.271678
2020:09	459.107126	454.260454
2020:10	462.005880	460.037688
2020:11	465.014355	463.310161
2020:12	465.109912	465.828094
2021:01	466.060489	464.316029
2021:02	464.727136	466.409658
2021:03	465.681342	462.707688
2021:04	466.249525	465.080555
2021:05	464.822968	465.495317
2021:06	465.014355	463.796814
2021:07	467.189382	464.024899
2021:08	463.860496	467.084535
2021:09	464.439090	461.949470
2021:10	464.150212	463.900243
2021:11	465.871095	463.774621
2021:12	469.683737	465.263356

2022:01	-2.231720	-2.701148	2022:01	467.376298	468.912606
2022:02	0.726923	-0.108043	2022:02	467.749085	465.454515
2022:03	2.470439	1.731206	2022:03	466.720558	466.977961
2022:04	1.077647	0.473046	2022:04	465.681342	465.528201
2022:05	0.604007	-0.058135	2022:05	467.842065	466.168697
2022:06	0.203610	-0.344263	2022:06	469.774937	467.329289
2022:07	-2.272294	-2.452335	2022:07	466.438205	469.161070
2022:08	0.847622	0.326988	2022:08	468.859179	464.694641
2022:09	2.113582	2.701617	2022:09	469.226489	468.924078
2022:10	1.233800	1.069372	2022:10	467.376298	468.237393
2022:11	0.431850	0.438549	2022:11	468.767141	466.970248
2022:12	0.456806	-0.115045	2022:12	467.376298	468.734251
2023:01	-1.930945	-2.239270	2023:01	468.398137	466.915993
2023:02	0.762393	0.539151	2023:02	468.442175	469.866053
2023:03	2.314773	2.699636	2023:03	470.138904	469.248518
2023:04	0.730605	1.026828	2023:04	470.138904	469.208021

HICP – services			Industrial Production		
Date	Actual	Forecasted	Date	Actual	Forecasted
2020:01	-0.711072	-0.069208	2020:01	464.631213	462.140275
2020:02	0.493547	0.545711	2020:02	464.439090	463.463149
2020:03	0.113550	0.498249	2020:03	452.936847	464.367307
2020:04	0.847543	0.996757	2020:04	431.481788	455.036135
2020:05	0.000000	0.457448	2020:05	444.734610	419.009158
2020:06	0.710151	-0.847604	2020:06	454.435805	452.539687
2020:07	0.686650	1.136305	2020:07	459.005655	443.218778
2020:08	0.027738	0.224095	2020:08	458.802403	449.084118
2020:09	-1.209092	-1.568068	2020:09	459.107126	455.432916
2020:10	-0.281110	-0.084613	2020:10	462.005880	459.558468
2020:11	-0.829177	0.417146	2020:11	465.014355	462.869667

2020:12	0.829177	0.627734	2020:12	465.109912	464.532963
2021:01	0.037527	-0.047680	2021:01	466.060489	463.881354
2021:02	0.299710	0.549434	2021:02	464.727136	464.737463
2021:03	0.186864	0.350787	2021:03	465.681342	464.178238
2021:04	0.437760	0.417202	2021:04	466.249525	465.085968
2021:05	0.194977	0.434841	2021:05	464.822968	466.071040
2021:06	0.351852	-0.042986	2021:06	465.014355	464.126485
2021:07	0.810094	-0.005896	2021:07	467.189382	465.022391
2021:08	0.302101	0.077729	2021:08	463.860496	467.213583
2021:09	-0.614314	0.175250	2021:09	464.439090	462.831259
2021:10	0.027587	-0.214523	2021:10	464.150212	464.963402
2021:11	-0.184060	0.004858	2021:11	465.871095	463.714257
2021:12	0.560328	0.571726	2021:12	469.683737	465.724735
2022:01	-0.054975	-0.176317	2022:01	467.376298	469.212444
2022:02	0.429833	0.262156	2022:02	467.749085	465.164109
2022:03	0.382549	0.139645	2022:03	466.720558	467.616102
2022:04	1.040027	0.230985	2022:04	465.681342	466.008274
2022:05	0.377156	0.303811	2022:05	467.842065	465.962358
2022:06	0.259589	-0.057939	2022:06	469.774937	467.717247
2022:07	1.173138	-0.049862	2022:07	466.438205	469.467075
2022:08	0.352796	-0.092691	2022:08	468.859179	465.119679
2022:09	-0.158604	0.047134	2022:09	469.226489	469.973255
2022:10	0.096955	-0.455395	2022:10	467.376298	469.109349
2022:11	-0.282312	0.136619	2022:11	468.767141	466.585742
2022:12	0.713063	0.154091	2022:12	467.376298	468.788583
2023:01	-0.087758	-0.132513	2023:01	468.398137	466.928021
2023:02	0.848018	0.415367	2023:02	469.866053	467.933740
2023:03	0.607535	0.002683	2023:03	470.138904	469.170835
2023:04	1.152800	0.426199	2023:04	470.138904	469.130734

HICP – housing		
Date	Actual	Forecasted
2020:01	0.303203	0.049265
2020:02	-0.265252	0.179748
2020:03	-0.504019	0.051891
2020:04	-0.929081	-0.244668
2020:05	-0.269802	-1.392782
2020:06	0.250554	0.330719
2020:07	-0.202322	-0.489045
2020:08	0.077123	-0.568901
2020:09	0.000000	-0.186930
2020:10	0.327112	0.330966
2020:11	0.191920	0.397850
2020:12	0.373188	0.350936
2021:01	1.262296	0.197167
2021:02	-0.037732	0.493914
2021:03	0.583257	0.180095
2021:04	0.421211	0.549864
2021:06	0.446346	0.244771
2021:07	0.721090	0.498095
2021:08	0.523682	0.274372
2021:09	0.739493	0.279516
2021:10	2.239604	0.459482
2021:10	2.239604	0.459482
2021:11	1.184806	0.599804
2021:12	0.909972	0.740238
2022:01	3.306794	0.950069
2022:02	1.247766	1.299700
2022:03	3.948955	1.093699
2022:04	-0.779027	2.631165
2022:05	0.570810	2.000809

Industrial Production		
Date	Actual	Forecasted
2020:01	464.631213	462.469425
2020:02	464.439090	463.756047
2020:03	452.936847	463.977346
2020:04	431.481788	455.057229
2020:05	444.734610	418.182836
2020:06	454.435805	452.959399
2020:07	459.005655	443.736688
2020:08	458.802403	448.345380
2020:09	459.107126	454.688228
2020:10	462.005880	459.972876
2020:11	465.014355	463.083427
2020:12	465.109912	464.907985
2021:01	466.060489	464.331185
2021:02	464.727136	466.640051
2021:03	465.681342	463.874071
2021:04	466.249525	465.997409
2021:06	465.014355	463.390375
2021:07	467.189382	464.514386
2021:08	463.860496	467.303737
2021:09	464.439090	462.450323
2021:10	464.150212	464.827759
2021:10	464.150212	464.827759
2021:11	465.871095	464.976715
2021:12	469.683737	465.648656
2022:01	467.376298	469.066163
2022:02	467.749085	467.691085
2022:03	466.720558	467.075022
2022:04	465.681342	467.452344
2022:05	467.842065	464.509037

2022:06	0.981221	0.973345	2022:06	469.774937	465.027808
2022:07	1.450100	0.853511	2022:07	466.438205	468.574917
2022:08	2.174756	0.870391	2022:08	468.859179	463.314465
2022:09	1.940925	1.407449	2022:09	469.226489	467.777761
2022:10	3.938531	0.739776	2022:10	467.376298	470.036907
2022:11	-0.935569	1.831285	2022:11	468.767141	468.326884
2022:12	-2.777956	1.917515	2022:12	467.376298	467.690024
2023:01	-0.473098	-0.201494	2023:01	468.398137	464.866260
2023:02	-0.467784	0.208443	2023:02	469.866053	467.556805
2023:03	-1.102631	0.818221	2023:03	470.138904	467.947884
2023:04	-0.590515	0.198309	2023:04	470.138904	467.105933

For future works, more complex models than a VAR can be considered to carry out such analysis – models with a higher forecasting accuracy and that better fit the data, such as SVARs or others. Ideally, an equal number of proxies for quantity (i.e., output) as for prices (i.e., HICPs) would be needed – however, Eurostat does not provide such measures for output in real time, nor does it publish them contemporaneously to HICP measures. Lastly, a third category could be inserted, alongside the 'demand shock' and 'supply shock' categories, which would include all those components for which the unexpected changes in prices and activity are not significantly different from model predictions and that would be classified as 'ambiguous.'