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The impact of the EU's sanctions on Russia and their monetary policy implications for the ECB

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Academic Year 2024-2025

Master in Economics – 120 credits – Focus: Professional

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Abstract

Were the European sanctions on Russia responsible for the unprecedented high inflation inside the euro-area? Using a Phillips Curve and Bayesian SVAR models, we determined that these sanctions impacted the EU's economy by causing negative supply shocks across both the energy and industrial goods channels, affecting core inflation. We capture these using the gas price and producer price index (PPI) growths inside the euro-area. However, by using the newly created Geopolitical Risk (GPR) index, we find that the origin of these supply shocks can be traced to the general tensions between the EU and Russia, which had already started to rise during 2021. This highlights the relationship between geopolitical risk and inflation. Furthermore, our results also show that both the sanctions and the high GPR are sources of higher inflation persistence across the euro-area.

The European Central Bank (ECB)'s reaction to this shock was to tighten monetary policy, suggesting that when geopolitical tensions are high, they affect monetary policy decisions and should thus be kept in mind. Incorporating a measure of this risk in forecasting models could give some beneficial insights to policymakers.

Acknowledgements

First, I would like to thank my supervisor, Mrs. Yuliya Rychalovska from the Economic School of Louvain. She was present and available to answer my questions whenever I needed it. She also provided me with interesting sources to improve my knowledge of the subject and guided me through the creation of this thesis.

I would also like to thank my close ones for their support and encouragement during the writing of this thesis, particularly my brother and sister, for having read it and provided me with some insight.

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1. Introduction

It is no secret that the Russo-Ukrainian war has and continues to severely impact the world we live in. For more than three years now, the world and its geopolitics have undergone radical changes, and, like many other sectors, the economy was reshaped by this event.

During the year 2022, inflation rose sharply worldwide, reaching levels not seen in decades across many countries. This increase in inflation was like no other, given the unprecedented state in which the world was. COVID-19 and the lockdown shut down the economy for months across the globe. Then the subsequent post-COVID recovery of the economy started to push inflation upward. When 2022 began, Russia invaded Ukraine, starting a war still ongoing at the time of writing these lines, a war that disrupted the global market, as countries were forced to take positions and supply lines were ruptured.

This study aims to analyze a key economic component of this war: the impact of the sanctions imposed on Russia by the EU on the euro area itself. We will explore the ways in which they participated in this unprecedented inflation shock in the euro area and the dynamics at play.

The focus on the sanctions is chosen to reflect the impact that geopolitical tensions can have inside an economy and why central banks may need to care about their significant effects on inflation. From a theoretical standpoint, this relationship between geopolitical tensions and inflation is ambiguous. The broad impact of these tensions on the economy, from supply and demand to economic activity, made it hard to determine which effects would dominate. However, the correlation between the arrival of the war and subsequent sanctions with the rise in inflation seems to indicate that geopolitical risk increases inflation. The aim of this analysis will thus be to verify that this correlation reveals a link of causality between the two.

Furthermore, by analyzing the way the ECB responded to this crisis, we can also determine the effect of geopolitical tensions on the way monetary policies are handled. If such an effect can be found, we can provide insight into whether tracking geopolitical risk across the EU can give some insight into the way the central bank should handle its policies, whether it should tighten or relax them.

The paper starts first with a short summary of the context of the European economy before 2022. The delicate situation in which the EU was at the time can provide a better understanding of the way inflation evolved. Once the stage is set for the situation before the war, the next section will take a deep dive into the sanctions themselves, their timing, what they entailed for Russia and what the objectives driving each of them were. Doing so, the analysis will aim to identify and separate the different impacts of the sanctions on the euro area, classing them into three categories: energy, trade and finance. We will highlight different variables to extract and to use in the models to study the specific channels by which the sanctions transmitted back into the economy and fed into inflation and expectations.

The focus of this thesis is very much on inflation, as it is one of the most important economic variables. Price growth directly affects the purchasing power of money and the economic stability of a country. Inflation needs to be monitored to avoid undesirable

repercussions on economic activity. The ECB's target for price stability is here to ensure both the economy and confidence stay in good shape. By using monetary policies to regulate inflation, central banks support growth and the development of a healthy economy as well as employment. Therefore, the way the ECB handles its policy in reaction to the sanctions and the inflation shock is discussed in its own section, "*The ECB Policy Response*".

A better understanding of the dynamics between geopolitical tensions and inflation could help when choosing the monetary policy needed. Recent research tried to quantify these geopolitical tensions to create an index, which they could use to study this relationship using econometric models (Caldara, Iacoviello, 2022)[1]. This led to the creation of the GPR index, which we will discuss in this thesis, as we find a way to incorporate it in our own models to look at the way geopolitical risks interacted with inflation when the sanctions were released.

The models used in our work are the Phillips Curve and Bayesian Structural VAR model. Both use data that originates from the ECB's website, Eurostat and the FRED. The precise data sets from which they are taken are detailed inside the annex (*section 9.2*). This is also the case for the data used inside any of the graphs present inside this work.

Using an expectations-augmented Phillips Curve complemented with specific variables that capture the main impact channels of the sanctions, we can see that they are able to explain much of the inflation fluctuations during the period from 2014 to 2024. Moreover, using a dummy of the GPR index to reflect the geopolitical impact of the announcement and set up of the sanctions, we reveal a significant correlation between the GPR dummy and inflation inside the eurozone.

To delve deeper into the dynamics at play, a Bayesian Structural VAR model is constructed. Using this model to create IRFs and a FEVD for inflation, we find that the sanctions acted as a negative supply shock for both the energy and industrial goods sectors, raising their prices and feeding into inflation and inflation persistence. The unprecedented increase in inflation thus was due to the external structural shocks created by external supply shocks and geopolitical tensions brought about by the sanctions. This new model also shows that, as tensions with Russia continued to rise, the long-term persistence of these main drivers of inflation limited the efficiency of the deflationary pressures applied by the ECB's monetary policy.

The results shown in this thesis support the assumption that geopolitical tensions increase inflation and inflation persistence, to which the central bank reacts by tightening its monetary policy. We use the EU's 2022 inflation crisis created by the sanctions as proof of this dynamic. Thus, the creation of a geopolitical risk index tailored to the EU could increase forecasting capabilities for the Euro-zone.

[1] Caldara, D., & Iacoviello, M. (2022). Measuring Geopolitical Risk. *American Economic Review*, *112*(4), 1194–1225.

2. Literature Review

This thesis is related to the ongoing research around the economic crisis of 2022. As stated during the introduction, inflation increased to never seen levels inside the EU, led by an acute convergence of macroeconomic shocks. The recent war in Ukraine has put a strain on the EU's economic recovery after the COVID-19 pandemic, prompting the ECB to tighten its monetary policy. This multi-decade high inflation managed to consistently exceed the models of policymakers (Baba, Duval, Lan and Topalova, 2023)[2.]

These developments have thus renewed economists' interest in evaluating how macroeconomic shocks propagate through the economy and the predictive performance of existing macroeconometric models. The 2022 crisis provides a unique empirical setting to test new theories and models that could help better explain how this shock propagated through the economy and onto inflation.

The models present inside this work are inspired by existing literature, most of which focused on modeling inflation's reaction to shocks with the Phillips Curve. For decades, studies have been able to evaluate the role of specific variables in the ways economic shocks propagate to inflation by testing several specifications to augment a typical Phillips Curve model, such as the effects of oil price shocks (Hooker, 1999)[3] (Blacnhard, Gali, 2007)[4]. We use a similar methodology to find potential inflation drivers, as the 2022 shocks to inflation mainly came from a negative supply shock, affecting multiple parts of the economy, the energy sector included. Papers that discussed the breakdown of forecast models, such as the case of the missing disinflation during the 2010s (Coibion, Gorodnichenko, 2013)[5], also served as inspiration.

Once these variables were identified, we employed a Bayesian Structural VAR model to interpret the data and the dynamics at play during this period of crisis. The use of such model is influenced by previous studies on model breakdowns (Bobeica, Jarociński, 2019)[6] and even the recent supply chain disruption due to the war (De Santis, 2024)[7].

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[2] Topalova, P., Baba, C., Duval, R., & Lan, T. (2023). The 2020-2022 inflation surge across Europe: a Phillips-Curve-Based dissection. *IMF Working Paper*, *2023*(030), 1.

[3] Hooker, M. A. (1999). Are Oil Shocks Inflationary? Asymmetric and Nonlinear Specifications versus Changes in Regime. *Finance and Economics Discussion Series*, *1999.0*(65), 1–25.

[4] Blanchard, O. J., & Galí, J. (2007). The Macroeconomic Effects of Oil Price Shocks: Why are the 2000s so Different from the 1970s? *SSRN Electronic Journal*.

[5] Coibion, O., & Gorodnichenko, Y. (2013). Is the Phillips Curve Alive and Well after All? Inflation Expectations and the Missing Disinflation. *SSRN Electronic Journal*.

[6] Bobeica, E., & Jarociński, M. (2019). Missing disinflation and Missing inflation: A VAR perspective. *International Journal of Central Banking*, *15*(1), 199–232.

[7] De Santis, R. A. (2024). Supply chain disruption and energy supply shocks: Impact on Euro area output and prices. *SSRN Electronic Journal*.

By doing these models, we investigate the impact of geopolitical risks on inflation and its potential implications for monetary policy. In the past, because of the numerous ways in which geopolitical conflicts could impact the economy, their consequences for inflation and thus monetary policy were unknown. Both upward and downward pressure could be applied by different channels. However, recent discussions bring the idea that while it indeed pulls inflation both ways, the increase in inflation is greater than the deflation it creates. Thus, some argue that a positive correlation between geopolitical risks and inflation exists.

This thesis makes two distinct contributions to the current economic literature around the 2022 inflation crisis:

First, we take the assumption made by the paper, "*Do Geopolitical Risks Raise or Lower Inflation?"* (Iacoviello, Caldara, Conlisk, Penn; 2024)[8] that geopolitical risk boost inflation, and uses the European sanctions' role in their own inflation as a case study. Doing so, we verify that this relationship between the two indeed exists and correlates the rise in geopolitical risk with the thightegning of the monetary policy.

Second, we also verify that the sanctions, but more precisely the geopolitical tensions between the EU and Russia, were the main source of inflation during 2022 inside the EU's area. Our findings correlate with those made in several studies, as the main transmission channels of these tensions were supply chain disruption and energy supply shocks, which impacted euro-area prices and that the primary drivers of inflation were external pressures.

To create our link between geopolitical tensions and euro-area inflation, we use the newly created GPR index (Caldara, Iacoviello; 2022) [9]. While fitting it into our specific case study, we will also discuss its shortcomings when it comes to accurately reflecting the tensions to which the European Union is subjected. These caveats are not there to draw fault onto the GPR index, but to emphasize that the construction of a geopolitical risk index tailored to the EU could increase its forecasting capabilities for the Euro-zone.

[8] Caldara, D., Conlisk, S., Iacoviello, M., & Penn, M. (2024). Do Geopolitical Risks Raise or Lower Inflation?

[9] Caldara, D., & Iacoviello, M. (2022). Measuring Geopolitical Risk. *American Economic Review*, *112*(4), 1194–1225.

3. The EU economy before the war

To accurately analyze the impact of the war and the sanctions, it is important to first get a good grasp of the economic landscape of the EU before these. Like for any other analysis, a baseline needs to be established to accurately detect the shocks that later happened and the channels by which they propagated inside the economy. To this effect, the following sections will briefly depict the situation of the eurozone the years before the start of the war.

One look at the inflation in the eurozone area, indicated in the graph below, is enough to understand that there was a big disruption in 2022. But when looking further back, we observe a rather sluggish inflation, below the 2% medium-term target for most of the 2010s. This slow growth, always below 1%, is a trend that stuck in the EU for more than a decade. This issue stems from the 2008 financial crisis, which severely impacted the economy as well as the following sovereign debt crisis in late 2009 to early 2010. During this second crisis, members of the European Union suffered high debt levels, hindering not only their own GDP but also the growth of the EU, since several policies were created to provide financial assistance to countries in difficulty.

This resulted in rather constant inflation, helping anchor expectations and allowing the ECB to manage more flexibility in their monetary policies without risking deflation. Such inflation should be able to support stable economic growth despite the lower GDP growth. Looking further backward in time, this under control, despite being somewhat low inflation, seemed to be the trend for the years leading up to 2020.

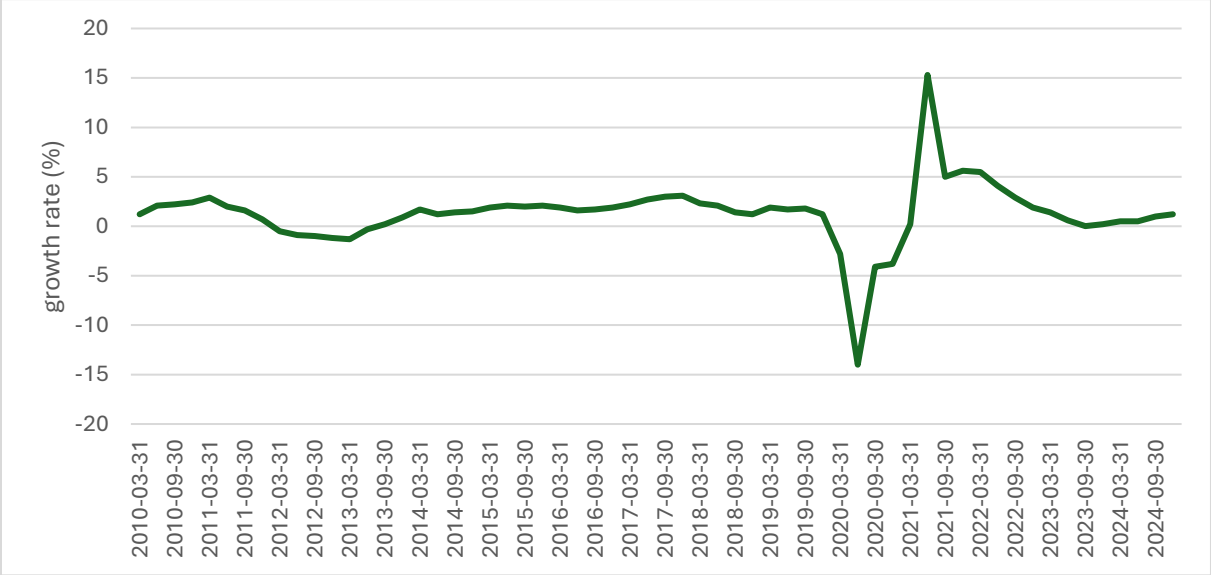
Figure 1: Inflation for All-item HICP from 2018 to 2024 (monthly)

But low inflation is not ideal. The main challenge of the ECB during these years was to avoid entering deflation (negative inflation) and to support economic growth. To these ends, the monetary policy was expansionary: the ECB kept all of its key interest rates low to encourage borrowing and investment and strengthen the economy. Since 2014 until the beginning of the war in Ukraine, the deposit facility rate was even negative, meaning banks would need to pay to deposit excess money to the central bank. Doing so, the ECB pushed banks to lend more to businesses and consumers instead of trying to store cash away. On the other hand, the lending facility rate was very low, and the main refinancing operations rate was

zero, allowing banks to borrow from the ECB easily by making credit cheap, once again pushing banks to lend more to stimulate both inflation and growth. These interest rates are one of the main instruments the ECB uses to communicate its policy stance and will be discussed more in another section of this thesis (*see "The ECB policy response"*).

Then came 2020 and, with it, COVID-19. The pandemic struck worldwide and forced its inhabitants into a massive lockdown to stop its spread, putting overall deflationary pressure on the EU.

Figure 2: GDP volume growth in the euro-area from 2010 to 2024 (quarterly)



The already slowing down growth of the European GDP collapsed in the first half of the year, as can be seen in the graphic above (*figure 3*). This was caused by the safety measures enacted across the EU and the world to contain the virus that spread uncontrollably at the time, such as the lockdown and closure of most businesses. Still, GDP growth experienced a big rebound the following quarter thanks to the easing of some of the restrictions to restart the economy. This was, however, short-lived, since a second wave of COVID-19 hit Europe, prompting a return to harsher restrictions. This explains the extremely high volatility in GDP growth during the year 2020.

In the meantime, public debt and deficits rose because of the spending needed to support the economy and to fight the pandemic. Tax revenue fell for the first time in years because of the decline in consumption caused by the restrictions imposed on the population to stop the pandemic. This also reduced revenue from corporations, again decreasing tax revenue, but also reducing wages, further shrinking consumption and investments. Demand dropped, resulting in contractionary pressure on the economy, decreasing further the already low inflation. It ended up being the final blow that propelled the EU into deflation in the latter half of 2020.

However, as the pandemic's economic repercussions seemed to fade, another global shock happened. Once the world adapted to COVID, the majority of the population becoming vaccinated and most firms having adapted to the restriction of their new environment with measures such as the normalization of remote work, the economy restarted. As demand rose

suddenly again after being artificially brought down by safety measures during the pandemic, so did inflation. This end to the deflation came first from the non-energy industrial goods as well as the services channels, as the lockdown restrictions began to be relaxed, and consumption and investment increased drastically.

This new shock came from the surge in demand, as people started to spend again, outpacing the supply capacity to follow. Global chains were indeed still not back at full capacity, since the restrictions brought about during 2020 were not totally lifted yet, creating a shortage that pushed prices higher. The restart of worldwide activity especially came with a surging demand for energy, as production and transport followed the renewed activity across the globe.

The increase in energy prices was so high that it dwarfed all others, going past the 20% inflation rate by the end of 2021. This is because, as this second shock shook the world, a third one also struck the EU: the increase in the prices of gas imported from Russia and its reduced supply. The cause of these restrictions on Russia's gas supply was the already rising tensions between the EU and Russia. Indeed, Russia was already preparing its invasion of Ukraine, amassing troops near its border. Blaming issues like a failure to refill storage facilities, Russia economically pressured a European Union heavily dependent on Russian natural gas, which accounted for around 40% of total EU gas imports at the time.

2021 was thus a year stuck between two crises. As the EU's economy began to slowly heal from the pandemic, still dealing with its consequences, another threat was looming on the horizon as Russia prepared its attack on Ukraine.

With this economic context in mind, we now can better understand the difficult position which the EU was in when the Russo-Ukrainian conflict began in February 2022, having been battling a sluggish economy during the 2010s, when the pandemic arrived and kicked it even further down. By the beginning of 2021, businesses had adapted, the worldwide lockdown ended, and the economy started to heal. However, this period of respite was short-lived, as by the end of this same year Russia's intention toward Ukraine was already creating rising tensions across Europe, tensions that would culminate in 2022 when the invasion began. These geopolitical tensions had already started to build upward pressure on inflation by the energy channel. The beginning of the war would not be the peak of this push on inflation, as the sanctions that arrived throughout the following month only increased it. The next section of this thesis will aim to take a closer look at these sanctions on Russia and their precise effect on the EU's economy, particularly its inflation.

4. The European sanctions

As stated previously, when the Russo-Ukrainian war began, the EU was already in a precarious position. Since the economy was still recovering from the pandemic when the conflict happened, it is hard to ensure that the shocks felt in 2022 were solely the results of the invasion of Ukraine. Furthermore, the first packages of sanctions enacted by the EU against Russia were announced before the end of February, only days after the war began. Given the close proximity of those two events, their respective global impacts will be conflated, preventing one from seeing the effect of the sanctions enacted by the EU at a first glance, only the accumulated results of the two.

Since identifying all the ways by which the war has directly or indirectly impacted the EU runs the risk of being a very broad and tedious process, a better suited approach is to identify the sanctions' repercussions and to ensure that these are not, instead, caused by the war. It nonetheless might be difficult to completely separate the two, as their bond is inextricably linked to their very nature as cause and consequences.

For more clarity, and to make the large number of sanctions easier to process in the context of this thesis, their impact on the EU will be separated not by packages but by type of effect. We also won't review all of these categories, since some of them are less related to the economic side of the sanctions or are not directed toward Russia. For example, during the release of the sanctions packages, several Russian media and individuals were suspended and punished in an attempt to fight against Russian propaganda and misinformation. Although these undoubtedly had an impact in the broader context, they fall outside the scope of this study and will therefore not be addressed.

Before going into an explanation of each category of sanctions and their impact on the EU's economy, you will find below a simplified timeline of the packages' release, their measures as well as the expected economic effect. The goal is to give you an overview of what happened, what actions the EU took and its objective in doing so, but without bloating this work too much by keeping it simple. The full table of sanctions was published by the EU on its official website and its link can be found in the bibliography (*section 9.1.2*) for a more complete and detailed view.

4.1 Simplified timeline of the sanctions' packages

Time	Measures taken	Expected effect
Q1 2022	• Blocking access to financial assets held in the EU • Prohibition to EU entities to provide funds and investments toward multiple Russian entities, such as banks and the Russian central bank • Exclusion of multiple Russian banks from the SWIFT system	➢ Cutting Russia off from the EU's financial and monetary systems ➢ Putting a financial strain on and severely disrupting Russia's banking system

	• Export ban of critical goods, services, and technologies toward Russia, especially for oil refining and military applications • Trade ban on luxury goods, iron and steel • Sanctions on government individuals and oligarchs from Russia	➢ Reducing Russia's military supplies and ability to produce oil
Q2 2022	• Ban on several fossil fuels, including crude oil and refined products • Road and sea transport bans for Russian-origin goods • Ban on crypto currency • Additional bans on export toward Russia • Additional bans on the import or transfer of luxury goods of Russian origin, such as gold.	➢ Loss of revenue from the energy sector and trade ➢ Further degradation of Russia's international financial ability and revenue
Q4 2022	• Addition of a price tag to the maritime transport of Russian oil and oil barrels • Further ban on military-related goods and technologies • Additional restrictions on trade	➢ Decreasing Russian oil and trade profits ➢ Reducing Russia's military supplies
Q1 2023	• Ban on exports of critical technology and industrial goods toward Russia • Ban on transit through Russia of EU exports	➢ Further erosion of Russia's industrial resilience
Q2 2023	• Prohibition of the transit of goods and technology via Russia • Price Cap on oil barrels from Russia • Additional export restrictions	➢ Continuing to isolate Russia
Q4 2023	• Even tighter export restrictions, especially for technologies • Further restrictions on imports of goods, which generate significant revenues for Russia • Restrictions on new mining sector investments	➢ Limiting Russian resource expansion plans
Q1 2024	• Further export restrictions on goods that have military and industrial applications	➢ Eroding Russia's military and industrial capacity
Q2 2024	• Ban on Russian LNG-related services and investments from the EU • Further import-export controls and restrictions	➢ Continuing the attack on Russia's energy export capabilities

When looking at this relatively brief timeline and description of the sanctions, we can see that the intensity of these was not constant. Being the first year of the war, 2022 was when most of the sanctions were released. Out of the fifteen packages announced during 2022 and 2024, nine of them were made during that first year. This intensity faded out progressively, as the majority of the harsher sanctions were already put in place by the second half of 2022.

4.2 Financial sanctions' impact

The main goal of the sanctions, on the financial side at least, is to sever the link between individual organizations like the banks and Central Bank of Russia and the European financial and monetary entities. As observed on the timeline above, this was one of the first objectives when the war happened. This was done by prohibiting transactions and the provisions of euro-denominated banknotes to Russia's financial system.

Most financial sanctions aimed at specific individual targets were asset freezes and prohibitions from providing funds. These targets ranged from oligarchs, government officials and companies to the Central Bank of Russia. This allowed to cripple financially specific parts of the country, mainly the upper class and politicians. The asset freeze for the central bank was aimed at their reserves stored in Europe.

The first wave of sanctions packages also prohibited certain Russian banks from entering the SWIFT system. The *Society for Worldwide Interbank Financial Telecommunication* (SWIFT) is a network used by financial institutions, such as banks, to send and receive information about financial transactions in a secure way. Removing Russia from this system meant further isolating its financial sector from international trade, again strengthening the blow to its economy. Nonetheless, since the EU still trades with Russia despite the new restrictions, this removal creates frictions in international payments. The import-export sector, be it Russian oil and gas imports or EU industries' exports, was thus negatively impacted.

Outside of these sanctions aimed at Russia's financial system, the sanctions also focused on people and institutions inside the EU. Investors are prohibited from providing funds to and investing in multiple Russian entities. Doing so allows the EU to effectively block the capital flow going into Russia, hindering its ability to raise money internationally and to try to "starve" its economy.

Banks in the EU who had relatively important Russian exposure were, of course, impacted, causing a decline in the equity market within the European Union, as proven by a decline in banking indexes such as the *EURO STOXX Banks Index*, which tracks the largest and most liquid European banking stocks. While the shock was not as big as the one encountered when the pandemic struck, it is still significant and lasts throughout 2022. The recovery from this shock would then take place during 2023, going back to its level before the sanctions by the end of that year. This shows a correlation between the intensity of the sanctions and the higher volatility this index encountered during the period when most packages were announced and enforced.

Figure 3: EURO STOXX Banks Index, 2015 to 2025

Source: Stoxx.com

European banks that had interests in these Russian financial institutions were thus exposed to a decrease in equity. This global equity reduction undermines the banking system's stability, as banks will now have access to less capital. As the banks' equity is reduced, their ability to lend is also diminished, creating a potential decline in consumption. Furthermore, since equity is there to serve as a buffer against losses, banks will be more susceptible to shocks, increasing the risk of solvency problems and decreasing confidence in the financial sector.

The exact magnitude of the impact on the EU financial sector is difficult to estimate, but despite what was explained previously, one can be optimistic. The banking sector's exposure to Russia is limited and mostly concentrated among a handful of significant banks. Furthermore, thanks to their size those bigger banks are also the most resilient to equity shocks, as they have greater access to capital markets to raise new capital, have higher trust from their investors and a more diversified revenue stream. The same logic can be applied to the ECB to explain the stability of its foreign reserves despite the sanctions.

Nonetheless, if the impact on our banking system could be mitigated by these factors, our financial system as a whole could still be severely impacted. Indeed, the sanctions also affect the investment flows coming and going from the EU. Investments are a source of capital for banks and as such have been targeted to further cripple Russia's economy. By banning investment into Russia, the EU will suffer a short-term financial loss because of its own entities that own Russian stock. In the longer-term, this means a redirection of investment flows, as these entities will seek new investing opportunities in other countries. However, this will still limit the possible diversification of portfolios, furthering the dependency of the EU on other economies, such as the U.S. On the other hand, this could also allow for a shift in investment to emerging economies or simply less capital outflow from the EU.

This reorganization of the investment market in the EU will cause uncertainty inside its financial market. If foreign investors perceive this as a risk, they might decide to limit their exposure to European stocks in favor of assets in other countries perceived as less risky. If this outflow is significant enough, it will weaken economic growth and further weaken the banking sector.

4.3 Trade Sanctions' Impact

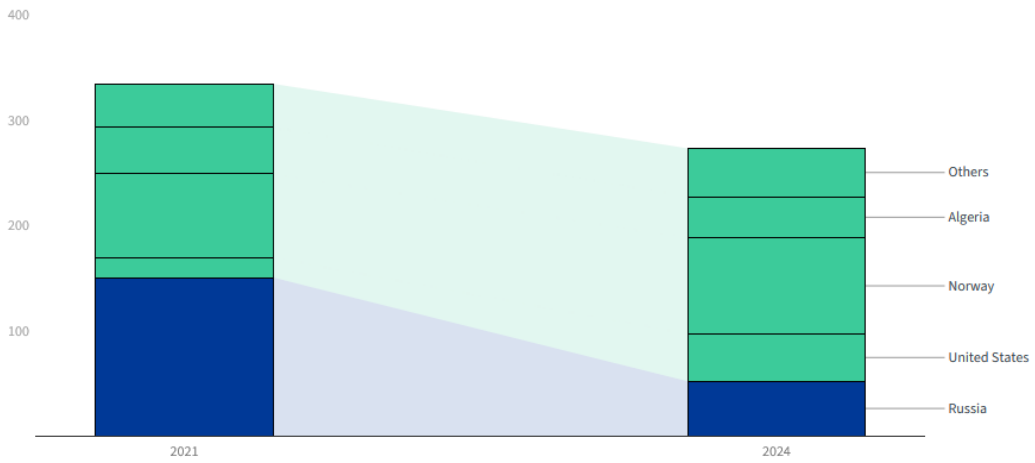
As seen in the simplified table of the sanctions, multiple bans were made to specifically target the Russian military. Exports toward Russia of technologies, goods and services that could be used in the war have been forbidden. Such measures are needed if the EU wants to position itself as an ally of Ukraine, as it would be hard to take this statement seriously otherwise.

Other types of exports that are banned are those related to the refining of oil, to prevent Russia from upgrading its oil refineries and to erode its capacity to fund itself in the long-term using its main exports, which consist of fuel and energy products.

Despite the legitimate reasoning justifying these export bans, they still will negatively impact European industries. Businesses that sold such assets in Russia have now lost a significant share of their customers. This reduction in sales will then create a decline in revenue that will, in turn, ripple into the economy as a whole, potentially reducing wages, investment and government revenue while increasing unemployment.

As for the imports, they also suffered their share of bans. The bans on imports of Russian oil and other energy sources were the ones that generated the most media attention and were widely discussed at the time of their announcement. As Russia was the main source of these resources for the EU, the supply shock to the energy sector is particularly significant. Not only does the total available supply of both resources decrease, but their origin is not so easily replaced. Contrary to other goods, the imports of oil and especially gas need special infrastructure to convey them from one country to the other. Thus, changing suppliers is no small feat and comes with a price of its own. Furthermore, non-renewable energy sources are coveted by most countries and their finite quantities only exacerbate those needs, making them a pricy asset.

Figure 4: Volume of gas imported by the EU in billion cubic meters:



Source: European Commission

But energy goods were not the only imported goods banned. Steel, gold and other materials essential for the European industry were also targeted. Once again, this supply shock

will increase the price of these resources, increasing production costs. This will further reduce the revenue of the EU's industries, further deepening the economic downturn already explained for the export bans.

These restrictions will impact the trade balance. They will reduce the total available demand for EU exports and increase import prices, at least in the short-term, as the EU needs to find new partners to trade with. Economic growth will slow down, as one of its key components suffers from a negative shock, while the deficit increases, mainly for countries like Germany that rely on their trade surplus to stimulate their economy. This is especially ill-timed given the impact of the pandemic on the recent GDP growth and deficit of countries, which had to hinder the first while furthering the latter to stop the spread of the virus.

Figure 5: EU trade in goods with Russia, Q1 2021 to Q4 2024 (% share in extra-EU trade, seasonally adjusted)

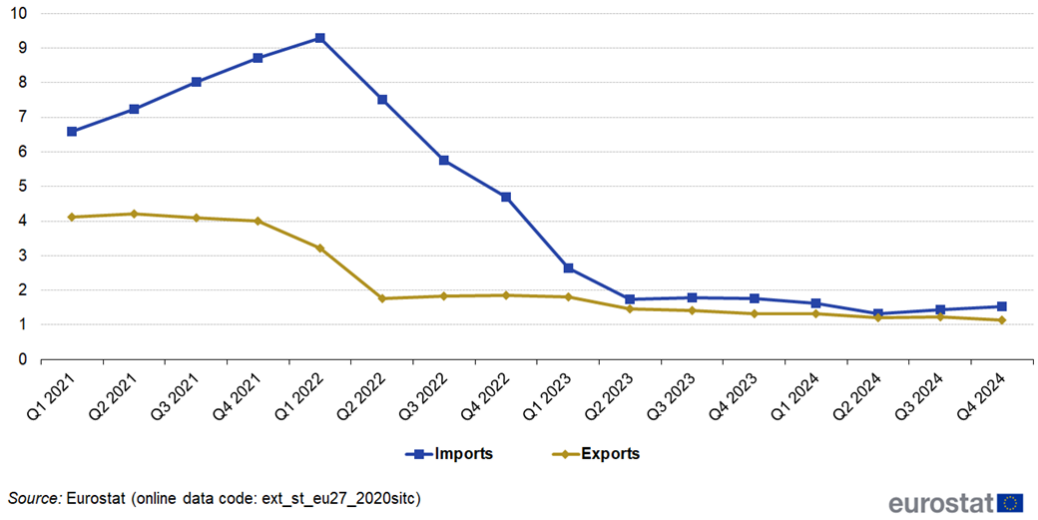


Figure 6: EU trade in goods with Russia, Q1 2021 to Q4 2024 (€ billion, seasonally adjusted)

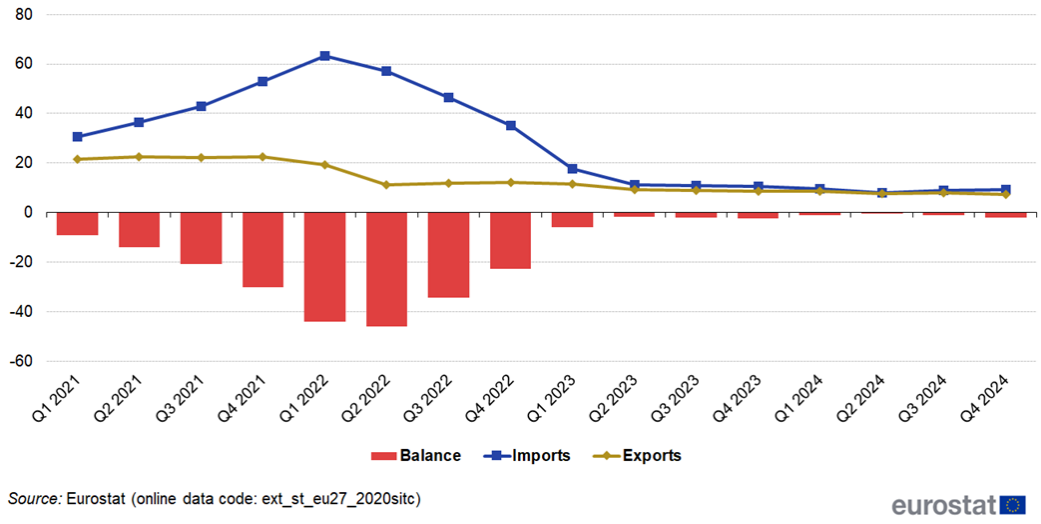
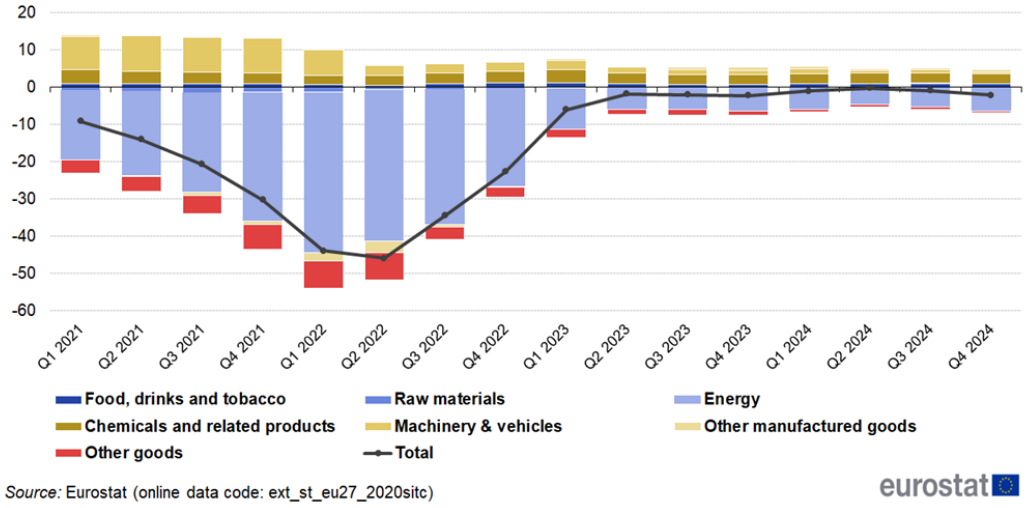


Figure 7: EU-Russia trade balance by product group, Q1 2021 to Q4 2024 (€ billion)



Furthermore, as the import price increases because of the available supply shock, inflation starts to rise alarmingly. Industries have higher production costs, resulting in an increase in prices to offset the lost revenue, and energy is now more expensive than ever. Both these factors increase inflation, in a cost-push phenomenon that risks leading to a spiral of rising prices and wages. This high inflation also increases uncertainty, delaying investment and consumption all the while eroding savings.

4.4 Energy sanctions' impact

In the previous section, we already discussed the oil and other energy products import bans. They were the most notable impact on the energy sector, and perhaps the biggest consequence on the EU's economy. But these were not the only types of sanctions that impacted the energy sector inside of the EU.

In December 2022, the idea of a price cap on barrels of Russian oil was discussed and agreed upon. This price cap would be enforced during the 12th package of sanctions a year later, in December 2023. It sets an upper limit on the price of barrels of oil originating from Russia. The goal was to reduce Russia's trade revenues without disrupting the global energy market too much. However, given that the EU had already banned petroleum imports from Russia by that point, this price cap was mostly used as an additional extraterritorial tool, extended on the global market and not only the European market. Indeed, while this measure appears inside the sanctions packages, this was an international effort supported by the G7.

During the second quarter of 2024, the 14th package of sanctions introduced new restrictions on Russian LNG-related services and investments from the EU. This effectively banned the reloading services for Russian liquefied natural gas (LNG) on EU territory. Operations where Russian LNG was transferred from one ship to another, or some intermediary storage facility, were banned inside the EU. This does not ban direct import of gas into the EU but rather prevent its territory from being used as a platform for transshipment operations to third countries. The package also prohibited new investments in already ongoing LNG projects.

These additional sanctions, others than the trade bans, were effective at further attacking Russia's main export, its energy products. They align with the EU's plan of the continuous erosion of Russia's main source of revenue, aiming to, in turn, reduce its financing capabilities for the war. Nonetheless, while important, their impact is mainly on the world market, and their ripples are not likely to be felt inside the EU, since they had already banned a lot of energy products coming from Russia in 2022. This earlier ban had already severed the transmission channels by which these additional sanctions could have impacted the EU.

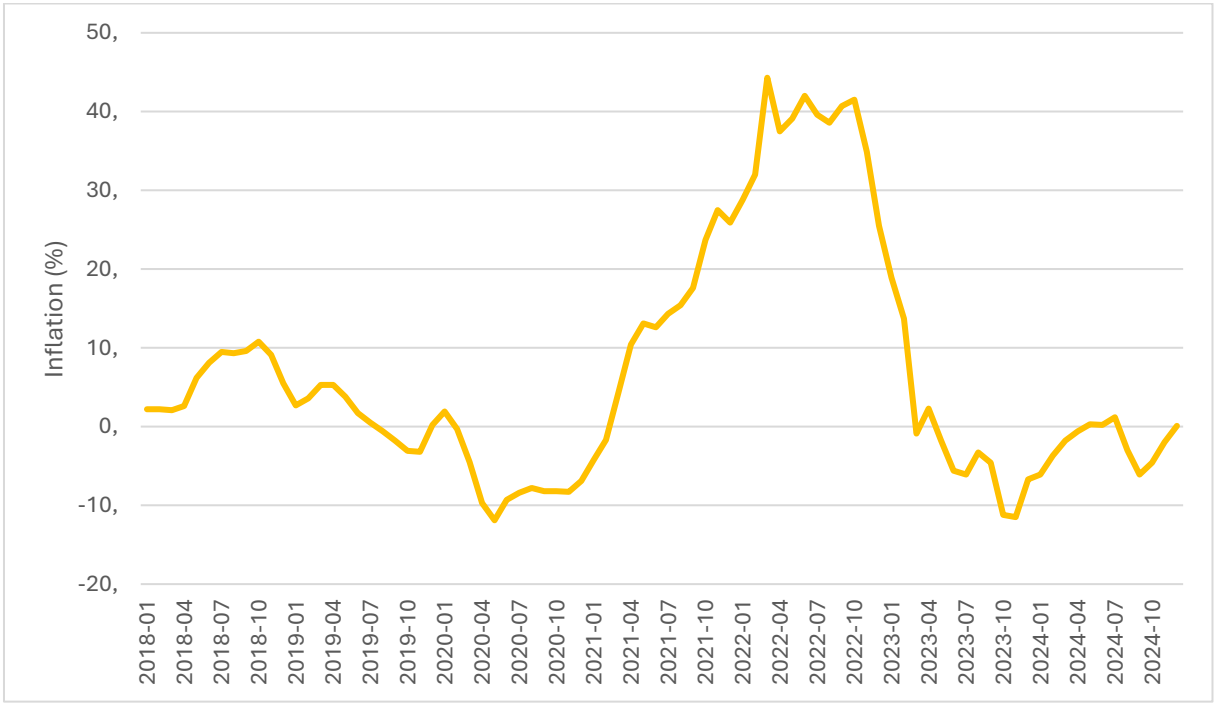
4.5 Sanctions' transmission channels

In this next section, the goal will be to find specific channels by which we can observe the different impacts of the sanctions on the EU's economy. By finding these, we will be able to better isolate and analyze their effects and by doing so be able to have concrete variables in the prevision of our models.

• 4.5.1 Energy

The energy sector was the one most exposed to Russia, as it was the EU's main trade partner for energy products. The ban of most oil and petroleum imports from Russia thus acted as a negative supply shock for the EU's energy market, driving prices up. This, in turn, directly impacted inflation in the EU, with energy price growth being the main increase. This reasoning seems to fit empirically, as we can see a sharp inflation increase from January to February 2022, when the war and the sanctions started.

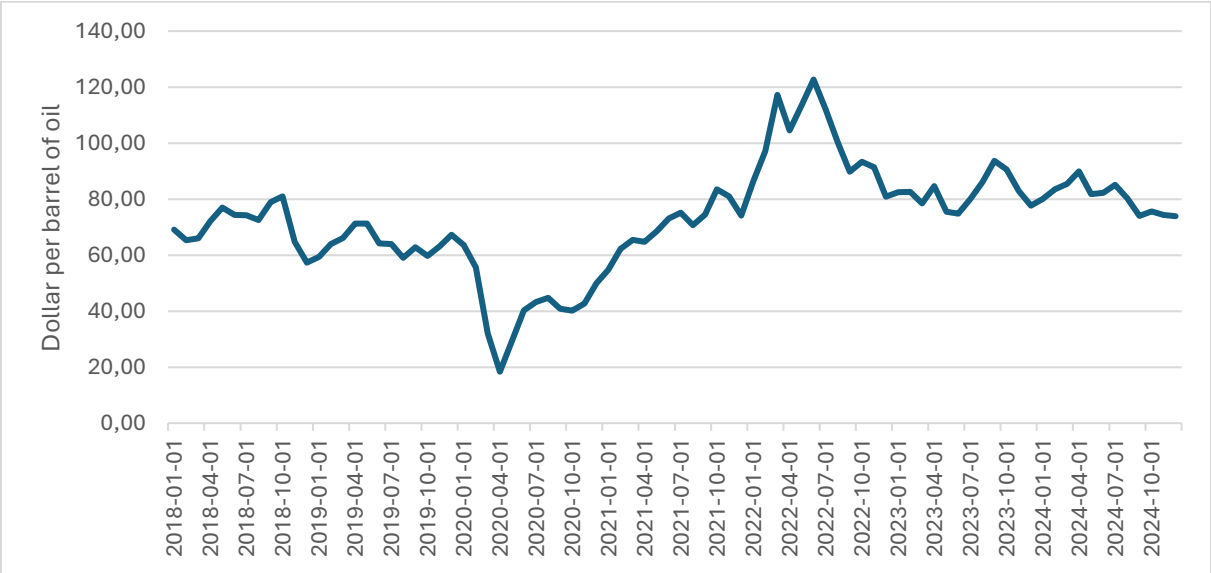
Figure 8: Energy-related inflation from 2018 to 2024 (monthly)



But as seen on figure 10, energy-related inflation has been sharply increasing since the beginning of 2021. Then, while the sanctions certainly played a role in the upward pressure on energy prices, other factors must have been at play.

In this case, Russia put pressure on the EU in the months leading up to the war by decreasing the available supply of oil, driving up inflation in the energy sector. The official reason for this supply chain disruption was issues on the Russian side. Furthermore, oil prices were severely negatively affected by the lockdown during the COVID crisis, and it is possible part of this inflation is also due to the economic recovery that came after.

Figure 9: Oil price in the EU from 2018 to 2024

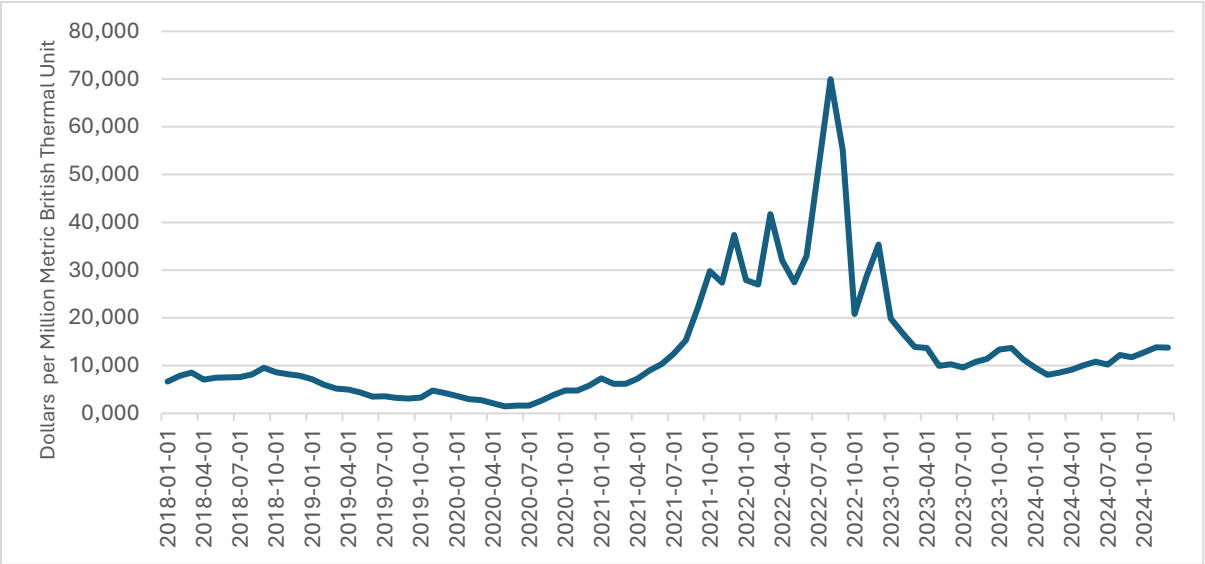


Despite this, we could still assume that energy prices, or more specifically, oil prices are a good fit to estimate the impact of the bans on energy trade. Unfortunately, as seen by the high volatility inside this graph even before the geopolitical tensions with Russia, it seems oil prices are being influenced by a lot of different parameters. The oil market is indeed a worldwide market with a lot of different suppliers and factors at play, as evidenced by its constant volatility and previous crises, such as the one in the 1970s.

Oil prices being influenced by a lot of different parameters prevent us from drawing clear conclusions about the causality between the sanctions and oil price growth. While the impact the former had on the latter is certain, it risks being too hard to isolate. Unfortunately, this makes the energy price growth rate unsuited for the job too by association, since a large part of it is driven by oil price fluctuations. These two variables cannot be used as proxies for our research.

However, if oil may be a main component of the energy market in the EU, it is certainly not the only one and was not even the biggest concern in the EU's energy supply during 2022. We can turn to the second-biggest import from Russia made by the EU: natural gas. Gas prices are less volatile than oil prices, making it easier to isolate the cause of shocks in its growth. Regarding gas prices, the following graph demonstrates that its main variations correlated to the EU and Russia relation.

Figure 10: Gas price in the EU from 2018 to 2024 (monthly)



The first big increase happened during 2021, when Russia had supply chain issues for both energy imports to the EU. This driver of prices is the same as for oil, but the scale of it is superior to the oil price, proving the increased sensibility of gas price to trade with Russia. A second shock, bigger than the disruption seen in 2021, hit gas prices during March 2022, the month following the beginning of the war. This shock was the biggest since the 90s, but pales in comparison to the one of Augustus 2022, when the bulk of the sanctions was announced.

More than a correlation, we can even affirm a direct cause and effect between the relationship of the two geopolitical entities and gas price fluctuations. Whereas oil can be shipped by tanker from anywhere, gas is not so easily supplied and requires specific infrastructure, such as pipelines. This makes changing suppliers harder and increases the dependency of the importing entity on its main exporter. In this case, the EU was very reliant on Russia. The relationship and tensions between the two will then affect gas prices in a way that is not seen in oil prices, which are more flexible. Therefore, shocks to gas supply from Russia will be larger than the ones on oil prices and serve as a more sensitive reflection of the geopolitical situation.

One could argue that while the EU outright banned the import of a lot of products, gas is not among them. Nonetheless, it is possible to prove with more than correlation that the sanctions did cause this increase in gas prices.

Indeed, Russia used its export of energy products as a political weapon, even before the sanctions. This can be seen with the increase that happened in both oil and gas prices during 2021 and the beginning of 2022 ahead of the invasion. To attack the EU indirectly, Russia decreased its supply of gas, increasing its price. The pressure Russia put on the EU before the invasion was to assert this dependence, as tensions were already rising, making it clear that the EU's potential involvement would be met with economic warfare. The spike in price in July 2022 came from such restrictions on supply. Russia still sold gas to the EU, but by managing the amount it exported to the EU and the dependency of the latter on their partnership, it was able to artificially raise prices.

There are several tangible evidence supporting this reasoning. First, there is the correlation between the timing of the sanctions and Russia's gas supply. The main cutbacks in gas supply began shortly after the first packages of sanctions hit Russia. As time went on and as the packages succeeded one another, the flow of gas going to the EU dwindled. Gazprom, a Russian state-owned energy corporation that overviews most of the gas exports to the EU, stated that these were due to maintenance issues, caused by the problems in deliveries of material to Russia due to the sanctions. However, it is believed that these issues were false reasons, a thinly veiled retaliation for the EU's sanctions on Russia. This is supported by multiple claims from Germany to Canada that Gazprom's justifications were not credible. While one can be inclined to trust one side more than the other, the truth cannot be established. But in this case, it is of little interest, since both explanations lead to the same cause: the sanctions on Russia. Whether this decreased supply is the result of maintenance problems created by the sanctions or a direct retaliation to them does not matter for this work.

Second, this decreased supply through pipelines appears to be selective. While Germany saw its output severely reduced, other countries that also import gas from Russia did not suffer such a fate. For example, as late as in 2024, Hungary still receives a steady supply of gas from Russia and has even become a trading hub for Russian gas exports[10]. Since the sanctions by the EU, the Hungarian government has doubled down on its energy imports from Russia. This proves that Russia has seemingly no problem exporting gas.

Third, Russia made several official statements regarding the European sanctions. During those, energy supply was mentioned and linked to the sanctions. Russian president Vladimir Putin warned during March 2022 that unfriendly countries would be cut off from Russia's gas unless they opened an account in rubles to pay for it: "*They must open ruble accounts in Russian banks. It is from these accounts that payments will be made for gas delivered…"*[11]. Doing so would run against the EU's sanctions. As another example of such speeches, Dmitri Peskov, a Russian spokesperson, said in September 2021, "*[Gas] pumping problems arose because of the sanctions imposed against our country and against a number of companies by Western states, including Germany and the UK."*[12]

• 4.5.2 Trade

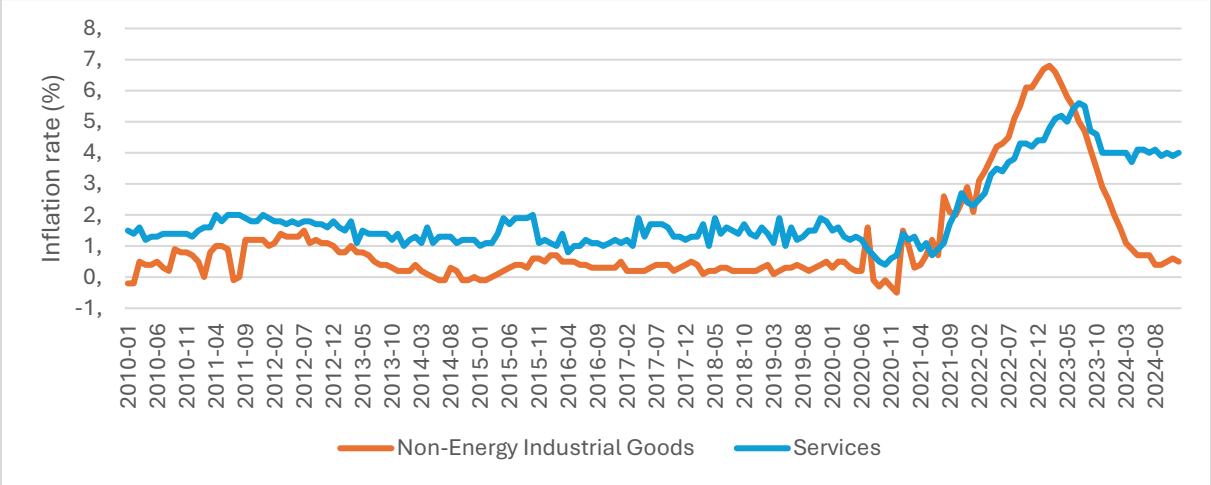
Energy-related goods were not the only items that got banned by the sanctions. As the trade bans continued to be imposed, steel, gold and other similar materials likewise could not be imported anymore. These meant that European factories could no longer count on Russia to get production materials. Energy once again has an impact, as a rise in its price also increased the cost of production for firms. Additionally, imported goods that were banned had to be found elsewhere, but the total supply from which they could be obtained was also decreased, leading

[10] Inotai, E. (2024). Hungary Turns Itself into Hub for Russian Gas. *Reporting Democracy*.
[11] Afp. (2025, May 29). Putin warns EU nations need ruble accounts to get gas. *The Moscow Times*.
[12] Jazeera, A. (2022, September 6). Gas flows to Europe won't resume until sanctions lifted: Russia. *Al Jazeera*.

to a price increase due to sanctions. Different materials would also mean different markets and reactions.

These trade bans thus affect production costs, which are then passed onto consumers by an increase in the price of goods if not absorbed by firms, creating a hike in inflation. This is true for both goods and service prices, which both sharply increased after the beginning of the war and the release of the sanctions packages. The focus on industrial goods reflects the import bans' targets, which were mostly raw materials used in the industry.

Figure 11: Goods and services inflation components from 2010 to 2024 (monthly)

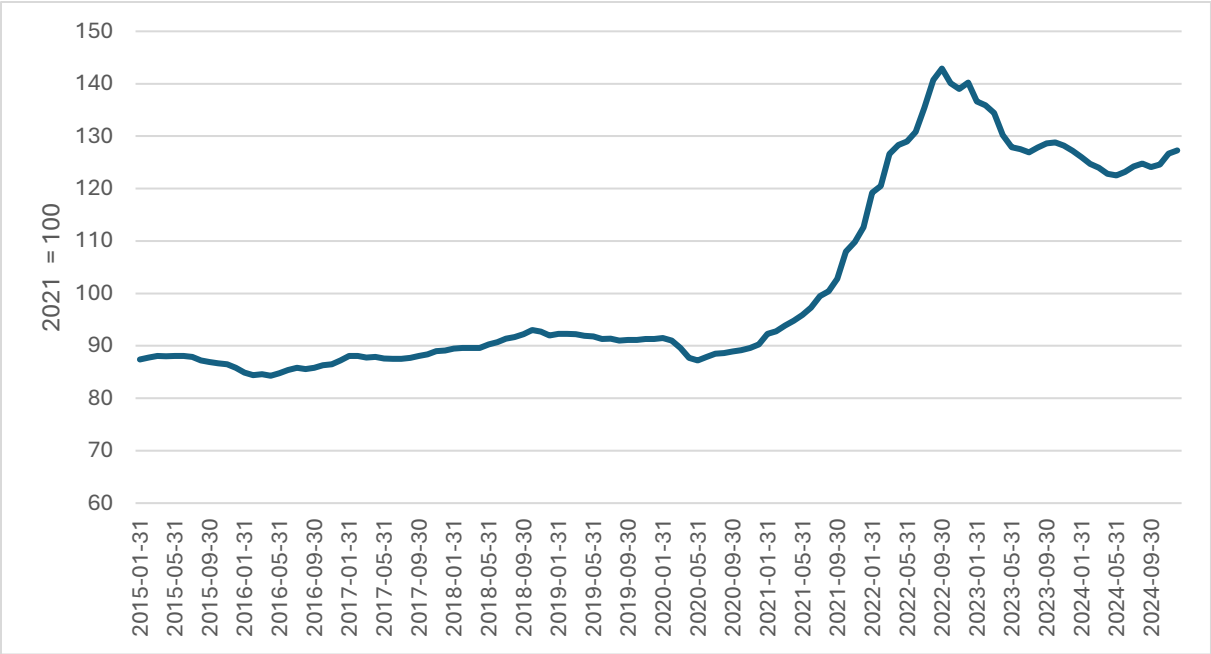


When looking at the graph from figure 13, we can see that the rise in service prices closely followed the one in industrial goods prices, mimicking its fluctuations after a little lag. This can be explained by the mechanism behind both of these shocks. Since the trade ban acted as a negative supply shock in goods used by European producers and a rise in energy prices, their own goods have, in turn, seen their prices increase because of higher production costs. As goods became more costly, service providers were also faced with higher costs for the maintenance or production of their services that relied on industrial goods and used energy.

Given this explanation, the main transmission channel by which the import ban propagated into the economy is primarily the production cost in the EU's industry. To track this more accurately than with global inflation related to this sector, we can use the *Industrial Producer Price Index* (PPI).

The PPI is an index that tracks the selling prices of goods at the factory gate, meaning excluding the VAT and transportation costs. This isolates further the potential fluctuations inside the variable, reducing them to price changes from the producer's perspective. While this does not directly track the increase in the cost of production, it does track the part of this increase that is not absorbed by the producer, and thus the part that affects inflation.

Figure 12: Producer Price Index (PPI) from 2015 to 2024 (monthly)



Looking at this graph of the PPI, we can see a sharp increase during the year 2022, with much higher prices persistent after the shock. Given the timing, this graph seems to support our reasoning, and this variable effectively captures the transmission of the trade bans on imports. The stability of the PPI before the war is also a good sign, since it did not react much to the pandemic, ensuring that it would not be contaminated by other unrelated shocks.

However, there is a significant caveat. Once again, much like energy prices, the shock in the PPI began before the sanctions and the war during the latter half of 2021. Fortunately, these objections can be explained with the same reasoning applied to the gas price that is that the exposure of this variable to trades with Russia is such that it captures the geopolitical tensions between the two. Indeed, we explained before that tension between Russia and the EU started to rise when the probability of a war in Ukraine increased in the second part of 2021.

As we saw earlier, importations were not the only activities impacted by the sanctions. Exportation of technology, goods and services in relation to the manufacturing of oil, or that could be useful to the Russian war effort, was also prohibited. While these export bans were less significant, since the EU imported much more than it exported to Russia, they nonetheless also hurt European firms and thus cannot be overlooked. These exports worked as a negative demand shock on the international market, but only from an EU point of view.

Exports were also impacted by the bans on imports from Russia. These import bans created a negative supply shock for companies within the eurozone, raising production costs. The combination of higher costs and decreased demand for exports led to a decline in total sales, which in turn reduced global exports. This deteriorates the European trade balance, hurting the GDP but also weakening the euro against other currencies. Therefore, the exchange rate could be an additional variable to capture more indirect effects of the trade bans. As for the

choice of the currency against which the euro will be compared, this will come in the next section.

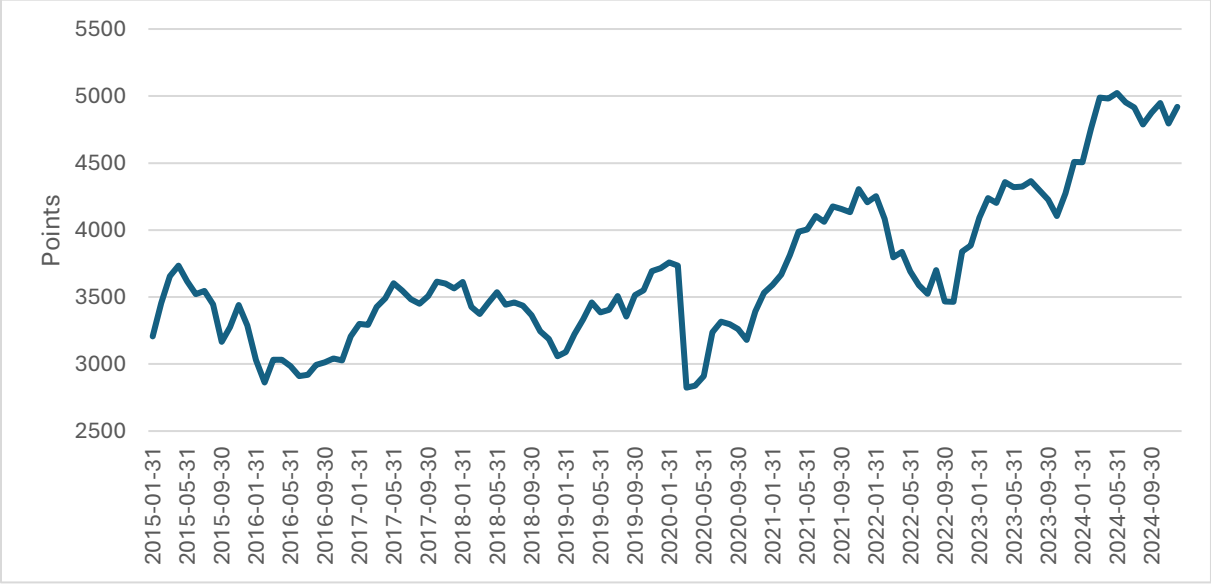
- ### 4.5.3 Finance

Until now, we focused heavily on trade with Russia, since this was the main way through which the sanctions impacted the EU. But Russia's financial system was also targeted, as explained previously in this thesis. This exposed European banks to more risk and a loss of equity while also exposing the European market to more uncertainty. These effects, coupled with the difficulties the EU's industry sector encountered because of the trading bans, led to a decrease in the investments made in the EU, as it was seen as riskier.

The main way the EU suffered from these financial sanctions against Russia was a global increase in volatility in its own financial market, as it reorganized when faced with the sanctions by its exposure to Russia. This higher volatility led to an increase in uncertainty shocks.

Taking a look at the *EURO STOXX 50* index, for example, allows us to track how this uncertainty shock led to a decrease in investor confidence in the EU. This index tracks the performance of fifty of the largest and most liquid companies in the eurozone, across multiple countries and sectors. This broad approach, while not the best to isolate the impact of the sanctions, still gives us a good look at global market sentiment after the beginning of the war.

Figure 13: Euro STOXX 50 Equity Index from 2015 to 2024 (monthly)



The increased perceived risk from investors means a reduction in investments coming into the EU, as we can assume they will prefer less risky investments given their mostly risk-averse nature. If there is a loss of confidence in the European economy because of the sanctions, investors may convert their money and assets into foreign currency. This will weaken the euro, once again being captured by the exchange rate.

The exchange rate could indeed prove to be an interesting variable. It can be used to symbolize the international economic power of the EU, reflecting the problems suffered internally by multiple companies and financial institutions as the sanctions packages were

released. But before using this variable, we need to find an adequate second currency to pit against the euro. The currency chosen needs to be close to the euro to ensure that other variations such as diverging monetary policies do not impact the exchange rate too much, preventing it from capturing the sanctions impact on the EU's economic power.

The classic euro-dollar exchange rate could be a good fit, as it is one of the most traded currency pairs in the world. The main argument toward using this exchange rate is that when the EU is perceived as riskier, the dollar tends to strengthen, while the euro weakens, as capital flow tends to go to the US instead, then seen as safer. The US dollar possesses this safe haven status due to its role as a worldwide reserve currency.

Unfortunately, the US dollar being such a widely used currency worldwide makes this exchange rate a poor tool to isolate EU-specific effects, such as its sanctions against Russia. This problem is magnified by several other factors. First, the EU and the US have vastly different economies and, while their monetary policies both aim to regulate inflation, their monetary instruments, such as the ECB and FED key interest rates, might move very differently, impacting their currencies and thus exchange rate. Second, since the US dollar is a worldwide safe haven, other geopolitical events might create other capital flow toward the dollar, with the same mechanism as previously mentioned for the EU and the euro. A change in the rate could thus be impacted by events other than the EU sanctions. Third, since the US also instigated sanctions on Russia, such as trade bans and extensive financial sanctions, the exchange rate might capture their impact as well. Finally, the US is not exempt from other economic problems that create uncertainty. While the 2025 tariff war is only beginning as of now in the second quarter of 2025, the uncertainty it brought toward the dollar could be captured since their elections, as their current president, Donald Trump, already promised to impose them, among other things, during his electoral campaign. Thus, we cannot exclude that the uncertain political landscape of the US toward the end of 2024 would also be captured.

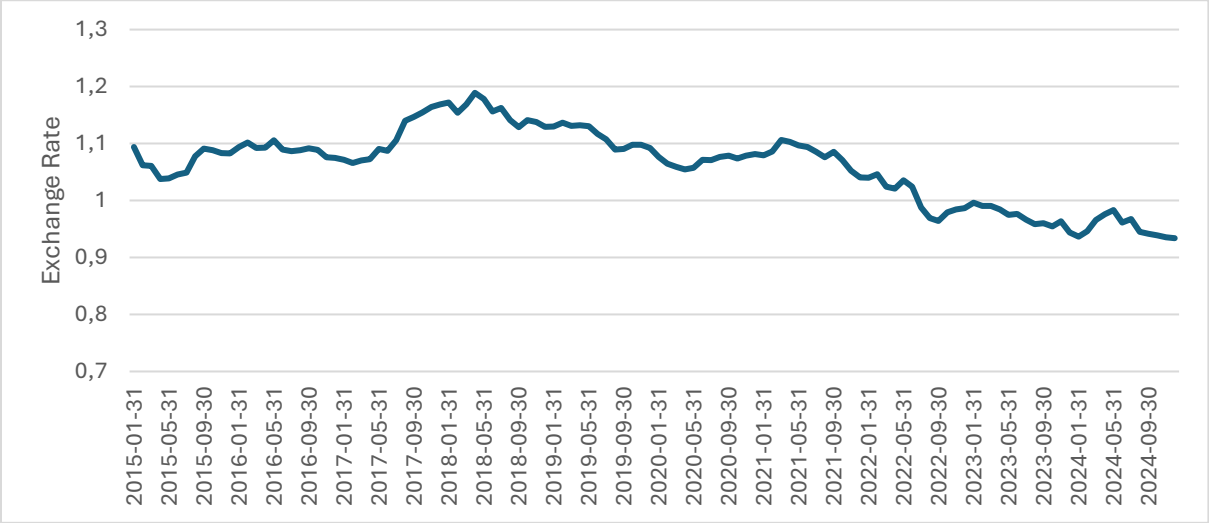
In this case, I suggest using the Euro-Swiss Franc exchange rate as an alternative to better capture the impact of the sanctions.

Switzerland is an historically neutral country. It generally does not take a position in geopolitical conflicts and stays militarily nonaligned. However, this argument takes a hit when looking at the exceptional case of the Russo-Ukrainian war. In 2022, Switzerland was one of the many countries to impose sanctions on Russia for its invasion of Ukraine. Nevertheless, despite the extraordinary nature of this act for Switzerland, the sanctions they imposed are far less severe than the US or EU ones, ensuring minimal distortions. This put the country as an ideal control variable when interpreting the effects of EU conflicts.

While the Swiss franc is also often cited as a safe haven, like the US dollar, it also shares more similarities with the euro. Nonetheless, its status as safe haven would make it a good variable to capture the effect of the sanctions. As explained, when the EU is considered riskier than the rest of the world, investors tend to convert their capital into currencies other than the euro, creating a capital flow out of the EU. This phenomenon is true for all countries and in case of worldwide geopolitical conflicts, where both the EU and the US impose severe sanctions, making them both seen as riskier, we can safely assume that investors will gladly

take refuge in a neutral country. Even though Switzerland put some sanctions, they still remained far less involved than the other two in the war, continuing to be perceived as less risky.

Figure 14: Euro to Swiss franc exchange rate from 2018 to 2024 (monthly)



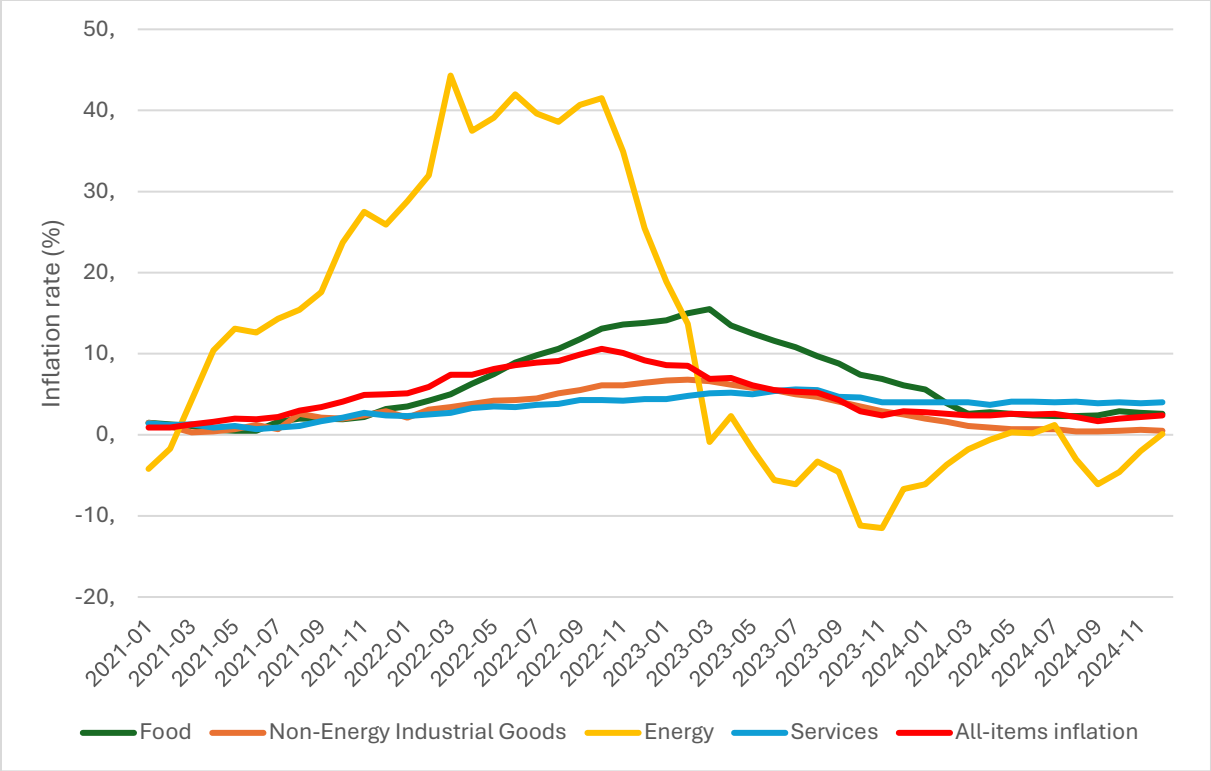
When looking at the graph above, we can see that there are variations in the exchange rate between the two currencies in the months following the war as well as the sanctions. The exchange rate oscillated around the 1,1 mark for most of the years before 2022. The dip started at the end of 2021, like for most variables we have seen, once again because of the rising tension between Russia and the EU and the subsequent disruption it brought. Despite this, the biggest decreases all happened during 2022, when the sanctions were at their highest intensity. The exchange rate then remained at a persistent lower rate in the years 2023 and 2024, as the sanctions are still in place and further sanction packages were announced.

4.6 The sanctions and inflation

We now have a good idea of the different ways by which the sanctions got transmitted into the EU's economy along with variables to measure their impact. All these variables' fluctuations correlate well with the upward pressure inflation encountered during 2022 and 2023. When looking at the graphs below, on figure 17, we see that this shock in inflation transmitted through most of its components and only got back at acceptable levels as 2024 drew near. This shock was not ordinary, impacting on the persistence of inflation and deviating it from its medium-term target of 2% set by the European Central Bank.

NB: the inflation analysis present in this thesis does not focus on food price growth despite its visible increase during the same period as the sanctions. This is because the increased cost of food products can also be attributed to a negative supply shock from the war and not the sanctions, as the products imported from Ukraine as well as the trade route passing through the country were disturbed.

Figure 15: Inflation for All-item HICP & its components from 2021 to 2024 (monthly)



The ECB maintains a public and widely communicated inflation target to anchor expectations. By anchoring expectations, the central bank fosters trust among consumers and businesses, assuring them that inflation will remain near the target. This trust helps align future expectations with the target, making inflation more resilient to shocks. When people set prices and wages, they base them on expected inflation, so stable expectations lead to greater stability in actual inflation.

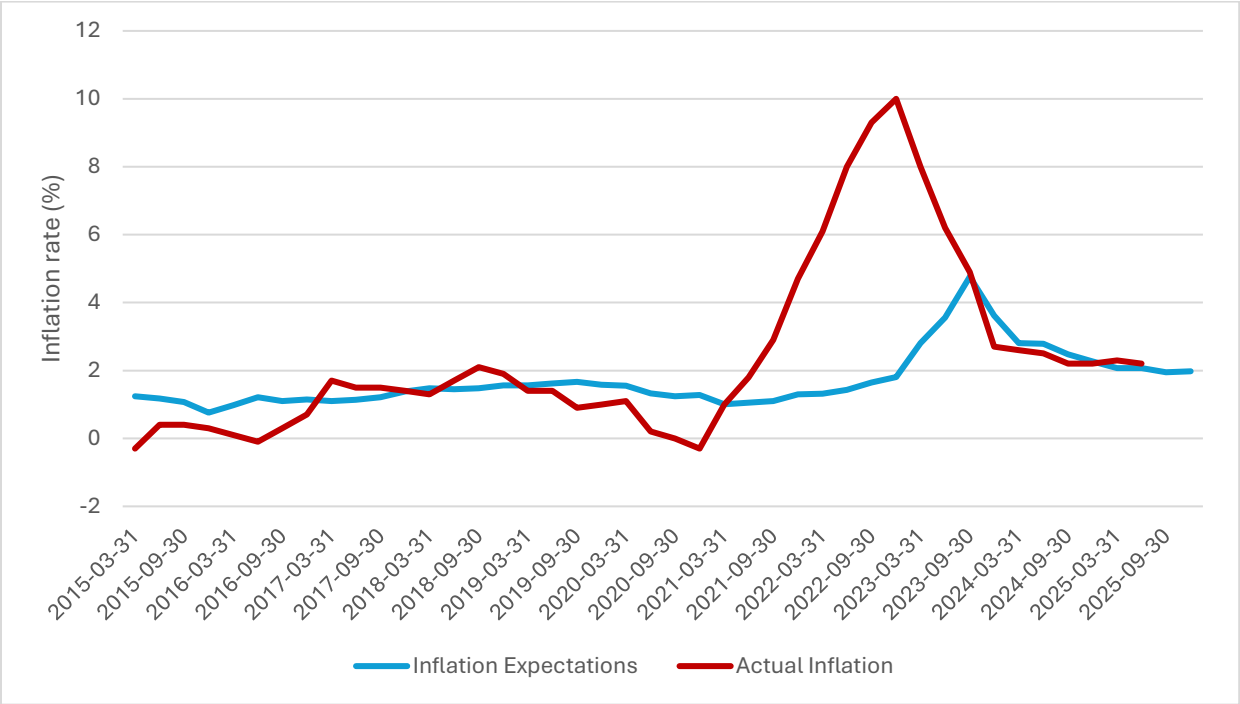
For example, during the 70s, an oil price shock was amplified because of the lack of expectations anchoring. When the price of oil drastically increased, pushing inflation upward, people expected inflation to continue to rise. They thus acted on this expectation, demanding higher wages, creating a wage price upward spiral (prices adjust to wages, which then adjust to prices, etc.) and pushing inflation even higher. This created an even bigger shock, with even more persistent inflation. This phenomenon is often called self-fulfilling expectations.

Finding whether inflation remained anchored or not during the 2022 shock is thus important to understand the mechanism behind the persistence of inflation. But contrary to the other variables used up to now, expectations are not so easily measured. We can identify two types of inflation expectations: forward-looking and backward-looking. Forward-looking expectations are the results of multiple surveys, the subjects of which vary from one to another. Some focus more on consumers' confidence and expectations, while others ask professionals and firms what their forecast for future inflation is. Backward-looking expectations are based on past inflation, using the assumptions people expect future inflation to resemble recent inflation.

In this study, we will focus on forward-looking inflation expectations for several reasons. Backward-looking expectations are more focused on the outcome of previous inflation rather than the actual anticipation the market can have and do not account for external factors other than inflation's inertia. Forward-looking expectations, however, focus on anticipation and are affected by these external factors, such as anchoring by monetary authorities. Using the latter allows us to discern *persistent* inflation, since they are less sensible for contemporaneous noises and the weight of previous inflation. They also reflect the policy's credibility, as they indicate how well expectations are anchored and the degree of trust that economic agents may place in the ECB. As such, they are a good transmission channel for the way the uncertainty created by the sanctions' shock to the economy.

The specific expectations forecast we will be using is the "*Euro area - HICP Inflation - Average of Point forecasts - Target period ends 12 months after survey cycle begins*", which long title contains the main argument for its choice. This variable focuses on short-term expectations, capturing how agents expect inflation to evolve during the next twelve months. As such, it will be extra sensitive to the shocks caused in the different transmission channels we went through earlier, making it a good subject for our analysis.

Figure 16: Inflation expectations and actual inflation in the Euro area from 2015 to 2025 (quarterly)



Comparing the evolution of these expectations to actual inflation, we can see that despite the increase in inflation brought by the rising tensions with Russia, expectations remained relatively anchored. While they increased during 2022, they remained around the 2% target, going above it only in 2023 once the shock's effect started to dissipate and inflation came down, which, in turn, quickly decreased expectations close to its previous level. The anchoring of expectations by the ECB thus seems to have worked, which is supported by the central bank's own observations. Their analysis inside the euro area suggested that longer-term inflation

expectations were still anchored, at around the 2% mark despite an increased rate for short-term expectations[13].

Nonetheless, inflation expectations remained slightly higher than their previous values, showing that agents now integrated into their forecast increased long-term inflation. When looking at actual inflation, while back at acceptable levels by the end of 2024, it indeed remains at a level superior to the one before COVID, when inflation was pushed downward by the sluggish economy of the 2010s, proving that there is still inflation persistence from the 2022 inflation shock.

This shock is therefore unlike previous shocks of such size. While the oil price shock in the seventies was driven even higher by the de-anchoring of expectations, creating an upward spiral, this was not the case this time. The sanctions' pressure on inflation was not amplified by expectations, but by two other factors: the timing of several shocks since the beginning of the decade and the rising geopolitical tensions, especially between the EU and Russia.

As explained when discussing the economic landscape of the years coming up to 2022, different worldwide shocks had already struck before the war and the sanctions. The economy did not have time to heal and carried over some inflation persistence from this period, mostly from 2021's high pressure on inflation created by the post-COVID recovery of the worldwide economy.

Geopolitical tensions worldwide increased, causing ripples in the European economy. We discussed this previously when we looked at the different variables that capture the transmission of sanctions. They all already felt an external shock in the latter parts of 2021 due to geopolitical tensions, such as Russia's rising energy prices. Once again, quantifying the economic risks linked to geopolitical tensions worldwide is not easily done, but we will go over this in their own dedicated sections.

[13] Baptista, P., Bates, C., Kouvavas, O., Meyer, J., & Werkmeister, K. (2025, April 29). *Long-term inflation expectations of consumers: an overview*. European Central Bank.

5. The ECB Policy Response

We have seen up to now how the sanctions on Russia also had an effect on several parts of the EU's economy. This transmission caused an upward pressure in inflation, led mainly by energy prices, but also by an increase in core inflation. Which brings us to the ECB role and its monetary policies since the start of this crisis.

The ECB does watch over a multitude of different parameters to comprehend the flow of the economy, the trends and fluctuations of the economy's cycle. Nonetheless, among those variables, one sticks out. Its main aim is "*to maintain price stability, i.e. to safeguard the value of the euro*". As explained on its website, "*Price stability is essential for economic growth and job creation – two of the European Union's objectives – and it represents the most important contribution monetary policy can make in that area.*"[14]. To ensure price stability, it is essential to monitor its growth – that is, inflation.

Regulating inflation is thus its top priority. And to regulate the economy and make sure that key variables such as inflation stay within acceptable parameters, the ECB has multiple tools and instruments at its disposal. The monetary policy *tools* are the mechanisms and methods used by the central bank to conduct its policies, while its *instruments* are specific variables that are adjusted within these tools. We will first take a look at the tools, before going over the specific instruments, and thus variables, that were used to regulate the economy since the sanctions were voted. For instance, standing marginal facilities are a tool and their deposit facility rate is an instrument within this tool.

When discussing the monetary policy tools, one needs to take into account that there are two broad "categories" within them: the conventional and unconventional tools. As their names imply, the former are used during normal economic conditions, while the latter are designed to act when the conventional tools are ineffective.

5.1 ECB monetary policy tools

- **Conventional tools:**

  To implement its monetary policy, the ECB uses the following tools:

  - ***Open Market Operations (OMO):*** OMO are used to inject or absorb liquidity into the EU's financial system. This allows the ECB to influence the different interest rates present on the market to align them with the monetary decision of the ECB. The OMOs are initiated and under total control of the ECB, as the central bank decides on the terms and conditions as well as the date of the different OMOs. Different open market operations exist, with each their own aim and procedure. The focus of this work will be on the Main Refinancing Operations (MROs).

[14] European Central Bank. (2024, April 30). *Tasks*.

- ***Standing Facilities:*** This instrument comprises marginal lending facilities and deposit facilities. These allow banks to borrow or deposit overnight from the ECB at a set interest rate. These interest rates provide anchors for short-term money market rates, once again steering them into the direction chosen by the monetary policy of the ECB.
- ***Minimum Reserve Requirement:*** The ECB requires credit institutions such as banks inside the euro area to hold a certain percentage of their funds in accounts within the national bank of the concerned country. The reserve requirement is there to ensure stability in the money market interest rate and control potential liquidity shortages or bank runs.

- **Unconventional tools:**

When the conventional tools fail to achieve the ECB's objectives, generally in periods of crisis, these additional tools are used:

- ***Asset Purchase Programmes (APP):*** APPs are a way for the ECB to increase liquidity in the economy by buying financial assets from both the private and the public sector. Doing so, more money circulates, creating inflationary pressures. The ECB and national central banks buy a wide range of assets during the APP to inject liquidity into the economy and decrease long-term interest rates. The assets include government and corporate bonds, securities and asset-backed securities.
- ***Negative Interest Rates:*** the ECB sets one or multiples of its key interest rates below zero to encourage lending and spending. By setting a negative deposit facility interest rate, banks would need to pay to deposit excess money to the central bank. Doing so, the ECB pushes banks to lend more to businesses and consumers instead of storing cash away.
- ***Targeted Longer-Term Refinancing Operations (TLTROs):*** these refinancing operations differ from regular OMO in three ways. They are specifically targeted at maintaining or increasing banks' lending to businesses and consumers, are conditional and offer longer-term loans than OMOs. They are used to sustain the economy, incentivizing lending to the real economy by providing banks with funding certainty at a favorable cost as long as they support lending to firms and households. These TLTROs were a key measure during the COVID crisis.
- ***Forward Guidance:*** the ECB uses its influence and trust to communicate the stance of its monetary policy. Doing so, it lets the markets, firms and consumers know what its future policy intentions are. This allows the ECB to influence the financial sector by managing expectations.

5.2 Response to the sanctions

As stated before, the objective of the ECB is to maintain inflation at the 2% medium-term target. The impact of the sanctions and the war on the EU's economy go against that goal, which means the ECB needed to monitor the transmission of the sanctions into the euro-area to ensure they do not cause too much damage to the EU, or at least that this damage is limited. However, it is important to specify that, despite being an essential organ of the EU, the central bank is not responsible for the creation and enforcement of the sanctions. Indeed, while it monitors banks, the ECB's only goal is to ensure the well-being of the banking system inside the euro area and is thus not responsible for the compliance of banks or their punishment if they disobey.

Figure 17: ECB's role in the sanctions

Source: ECB Banking Supervision[15]

Since the start of the war, several monetary policies have been adopted by the European central bank. These were made to react to and control the shocks that the economy would suffer in the following months. As for the packages of sanctions from the EU, we will once again not go over the whole monetary policy decisions announced since the sanctions to avoid bloating but will instead see the main points around which those articulate themselves.

5.2.1 Key interest rates

The primary instrument for the ECB to set up a monetary policy stance is through variation in its key interest rates. These three rates are the *deposit facility rate*, the *main refinancing operations rate* (MRO rate) and the *marginal lending facility rate*.

- The **deposit facility rate** is the interest rate that banks earn when depositing excess reserves at the ECB. The higher the rate is, the more likely it is that banks will stock their money at the ECB instead of lending it, which reduces liquidity in the economy and creates deflationary pressure. Since 2014, this rate has been

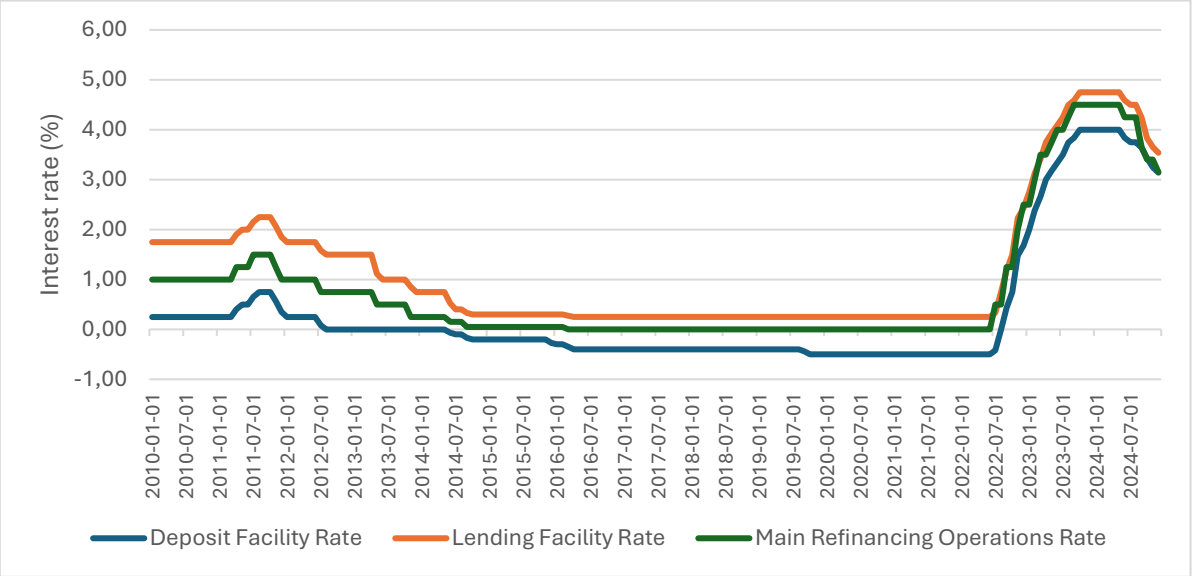
[15]European Central Bank. (2022, April 26). *FAQs on Russia's war against Ukraine and ECB Banking Supervision*. European Central Bank - Banking Supervision

negative, meaning that it costs money to hold funds at the ECB. This stance was taken to increase lending and consumption to sustain economic growth.

- **The marginal lending facility rate** is the interest rate paid by banks when they borrow from the ECB overnight, namely in case of an unexpected need for liquidity. Its role is to help relieve stress from financial markets in dire times by providing liquidity in an emergency. Before 2022, this was the only key interest rate from the ECB to be positive, with a rate of 0,25%.

- The **MRO rate** is used for short-term borrowing from the ECB. Commercial banks can, when giving credible collateral, borrow liquidity from the ECB for a one-week period. The process of these MROs is a weekly bid for liquidity. Variation in the MRO rate allows for variation in the lending capabilities of banks. Since 2016, the MRO rate was fixed at zero, meaning that banks could borrow from the ECB without worrying about paying any interest to motivate lending to consumers.

Figure 18: ECB key interest rates from 2010 to 2024 (monthly)



When the ECB published its new monetary policy decisions following the Russian invasion of Ukraine and the subsequent European sanctions, the interest rates did not change at first. It was only the following quarter that they raised their key interest rates, making them all positive. The exit from negative interest rates allowed a transition to a more flexible approach, where the Governing Council at the ECB could take a meeting-by-meeting approach to interest rate decisions. As they correctly announced at the time, this was only the beginning, as these three rates would continue to increase consistently over the next two years.

The ECB projections of inflation oriented its decision to maintain high interest rates for an extended period of time. It had to make several upward revisions since the beginning of the conflict and, despite the new measures, still predicted a significant rise in interest rates at a steady pace. The Governing Council announced it would only stop these restrictive measures once it is confident inflation returns to the 2% medium-term target. By aggressively increasing

its key interest rate, the most intense hike in the ECB's history, it hoped for a timely return to such inflation levels.

The escalating rates reached their peak by October 2023, where they were announced to remain constant. Inflation was still high, but the monetary policy measures allowed for inflation easing. Furthermore, if no new increase was announced, the effects of the previous ones were still propagating through the European economy, continuing to push down inflation. Thus, the ECB judged the current level of its key interest rates to be sufficient for the time being.

Nine months later, in June 2024, the ECB finally decided to lower its interest rates, thanks to the updated assessment of the inflation outlook. All three rates were lowered by 25 basis points. Monetary policy transmission and the dynamics of inflation showed that the disinflationary process was working. Even though the effects of the crisis were still being felt, the policies enacted by the ECB worked and it was judged appropriate to moderate the restrictions imposed on the economy.

5.2.2 Asset purchase programme (APP)

The uncertainty created by the invasion of Ukraine and the subsequent sanctions put on Russia forced the ECB to revise its schedule for its asset purchase programme. In March 2022, it announced a plan to gradually reduce its net asset purchases. During the first quarter following the war, the ECB decreased the APP by €90 billion. The goal was to decrease inflation toward the 2% medium-term target by reducing monthly purchases. The ECB then stopped its net asset purchases under the APP in July 2022.

The central bank also reinvested the full maturities from the assets bought. The ECB vowed to do so even once its key interest rates increased and for as long as necessary to maintain appropriate liquidity conditions. It did indeed maintain a full reinvestment from July 2022 to February 2023. Doing so, it kept the size of its APP portfolio to a constant number of assets.

This full reinvestment might seem counterproductive, as it would support the hike in inflation. It would reduce the effectiveness of the aggressive increase in the ECB's key interest rates. By continuously buying bonds through this reinvestment, it would sustain the demand for bonds, increasing its prices and reducing borrowing costs from banks, both effects backing the inflationary pressure already affecting the economy. This was, however, planned. Doing so helps the ECB avoid further shocks, as pushing too hard in the other direction might destabilize the economy more, again creating uncertainty and volatility, hindering long-term recovery.

When reinvesting the full maturity of its bonds while stopping their APP, the ECB provides much needed stability in the financial market. It mitigates the impact of its withdrawal; it prevents its tightening policy, spearheaded by its interest rates, from working too quickly. This creates a smoother policy transition, from the loose post-pandemic recovery to the new restrictive measures, by anchoring expectations and providing stability. The gradual adjustment created by the smooth transition prevented the shift from adding even more volatility than there already was in the economy in 2022.

The ECB transitioned to a partial reinvestment phase by progressively declining its APP portfolio by an average of €15 billion per month, from March to June 2023. Following this first

period of decline, the subsequent reductions were to be determined over time. By the end of 2024, the portfolio was still declining at a measured and predictable pace. This is part of the discontinuation of the APP announced to combat inflation brought by the war.

5.2.3 Pandemic Emergency Purchase Programme (PEPP)

When the pandemic hit, in March 2020, the ECB decided to enact the PEPP. This temporary purchase program was a monetary policy measure created to counter the risks posed by the virus outbreak that shook the world. It combined private and public sector securities and all asset categories covered by the APP were also eligible for the PEPP. The main differences between the APP and the PEPP were in their objectives and flexibility.

The PEPP objective was to counter the shocks caused by COVID-19 to the economy. Namely, it aimed at mitigating risks to monetary policy transmission and financial stability. Additionally, whereas the APP had rigid rules for purchases, the PEPP was more flexible. Its purchases were based on the basis of the market condition and could be made both over time and asset classes. This helped smooth the economic transition during the pandemic.

Once the pandemic was over and its crisis relatively managed, the governing council of the ECB decided to discontinue net asset purchases under the PEPP. The announcement was made in December 2021, and it took effect as planned in March 2022. However, much like the APP, the maturities would be fully reinvested until the end of 2024, at least. This first deadline would be then extended for half a year. Finally, the PEPP portfolio would be decreased by €7.5 billion per month on average during the second half of 2024. The goals of these changes were the same as for the changes in APP policy.

5.2.4 Liquidity Measures & Targeted Longer-Term Refinancing Operations (TLTROs)

Three TLTROs have been launched multiple times in the ECB's history, the last being the TLTRO III in March 2019. These latest TLTROs linked the interest rate at which banks could borrow from the ECB to their lending pattern. The more loans the banks issued to non-financial corporations and households, the more attractive the interest rate on their TLTRO III borrowings was.

Once the war and the sanctions happened, the ECB announced it would continue its TLTRO III but would closely monitor them to ensure these operations would not hamper the smooth transmission of its new monetary policies. The ECB would also assess at regular intervals how the TLTRO III lending conditions would contribute to the new, more restrictive, stance. This monitoring led to a recalibration of the interest rate of the TLTRO III, in the last quarter of 2022. As stated in the October 2022 press release of the ECB monetary policy decisions: "*…from 23 November 2022 until the maturity date or early repayment date of each respective outstanding TLTRO III operation, the interest rate on TLTRO III operations will be indexed to the average applicable key ECB interest rates over this period."*[16]

[16]European Central Bank. (2022b, October 27). *Monetary policy decisions*.

6. Geopolitical Risk

We now have a better grasp on the way the sanctions have impacted the European economy and how the ECB dealt with this new crisis they brought about jointly with the war. While we explored the different channels by which they propagated, we saw that all the variables started to receive upward pressures during the second half of 2021. While global inflation was already rising at the start of the year during the renewed economic activity that came with the end of the worldwide lockdown due to the pandemic, its growth accelerated during the second half of the year. This is proof that something other than the war and the sanctions was already pressuring the EU's economy.

Therefore, we can assume that the beginning of the shock started before the sanctions, but was transmitted by the same channels, as proven by the correlation between these variables and European inflation. For example, the gas price already began to rise sharply by the seventh month of 2021. The root of all of these elevated levels comes, as explained before, from tension with Russia. Thus, there seems to be a link between geopolitical tensions across the globe and the economy, at least when it comes to Russia and the EU. This link is never more evident than with the sanctions: the tensions between these two geopolitical entities came to such a level that the EU imposed economic restrictions on Russia to punish it.

This link between the economy and geopolitical tensions was already approached by economists recently. Their aim was to better understand whether or not increased geopolitical risks impacted inflation and how (Iacoviello, Caldara, Conlisk, Penn; 2024)[17]. Their finding was that "*geopolitical risks foreshadow high inflation"*. The mechanism behind this assumption is that a higher geopolitical risk leads to higher uncertainty and volatility as well as potential supply disruptions and decreased economic activity, all leading in turn to an increase in inflation. While we cannot take one study as an absolute truth, their reasoning seems in line with the mechanism of the sanctions' impact analyzed in this thesis. This supports the idea that the main cause of inflation was, at its core, the rising geopolitical risk associated with the EU, which propagated through the same ways we discussed earlier while talking about the sanctions specifically.

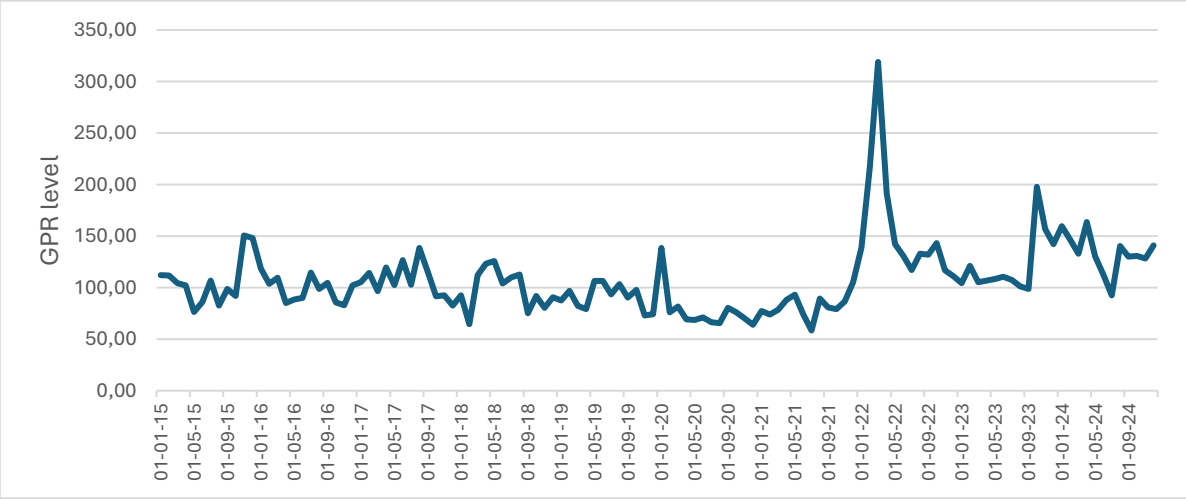
A caveat to this theory is that geopolitical tensions are not an easy thing to measure. Much like inflation expectations, there is not one objective measure approved by all. Thus, the way it is measured might greatly impact its perceived effect on inflation and the economy. However, in 2022, a study by Dario Caldara and Matteo Iacoviello[18] aimed to create an index to measure geopolitical tension, an index they called the *Geopolitical Risk Index* (GPR index).

When looking at this GPR index, plotted in the graph below, we can see that it rises during the end of 2021 and goes to levels unseen during the last decade when the war and the sanctions happened. While this geopolitical risk decreased drastically in the second half of 2022, it

[17] Caldara, D., Conlisk, S., Iacoviello, M., & Penn, M. (2024). Do Geopolitical Risks Raise or Lower Inflation?
[18] Caldara, D., & Iacoviello, M. (2022). Measuring Geopolitical Risk. *American Economic Review*, *112*(4), 1194–1225.

nonetheless remained at an elevated level compared to before the tensions with Russia. As such, its correlation with inflation in the EU and the timing of the sanctions seem to match.

Figure 19: Geopolitical Risk Index (GPR) level from 2015 to 2024 (monthly)



However, there are several caveats to the utilization of this GPR index. It is a newspaper-based index and, as such, was constructed using text from 25 million news articles, from 1900 to today, and searching for key words inside of those. The geopolitical risk that it represents is thus severely dependent on the newspaper, and key words used to build it as well as the definition of geopolitical risk made by the creator of this index.

First off, the definition of geopolitical risk for the GPR index is as follows: "…*the threat, realization, and escalation of adverse events associated with wars, terrorism, and any tensions among states and political actors that affect the peaceful course of international relations."*[19] This definition is appropriate, as it would capture the economic sanctions taken by the EU.

The sample used for this index is where the main problem is. The news articles are all written in English. This comes down to the fact that this index primary is used for the US and not the EU. As such, while it will capture most global conflicts, their intensity and impact will be proportionate to their relevance to English journals. Country-specific components were separated from this index, but they were once again only in relation to the risk represented to the US and not other parts of the world. The GPR index is thus mainly relevant from the North American and British perspective.

Furthermore, this index captures all tensions across the globe, not only those related to the sanctions. We can see this on the graph by looking at the sharp rise of the GPR level in October 2023. This date corresponds to the beginning of a war in Israel and Gaza. Thus, tensions other than the one due to the EU's sanctions on Russia will be captured by the index, making it a poor fit as is. Despite this, the link between geopolitical tensions and inflation cannot be simply overlooked, which is why we will find a way to include this GPR index in our econometric analysis, as will be explained in the next section of this thesis.

[19] Caldara, D., & Iacoviello, M. (2022). Measuring Geopolitical Risk. *American Economic Review*, *112*(4), 1194–1225.

7. Econometric Analysis

This section will be dedicated to an econometric analysis, made to have a better idea of the dynamics going into the way the sanctions impacted inflation in the euro area. The goal is to better understand how they propagated as well as their role in inflation persistence.

7.1 Phillips Curve Model

As we focus on the way inflation behaved, one of the most well-known models to do so comes to mind, the *Phillips Curve*. The Phillips Curve (PC) is an economic concept, named after the economist Bill Phillips, which illustrates the inverse relationship between inflation and unemployment. It suggests that when unemployment is on the rise, inflation tends to decrease, while when it is lowering, inflation tends to increase.

However, this method has recently made the object of discussions in economic literature, as there are different opinions on whether or not the PC is still a valid way to make inflation forecasts in our modern economy. Indeed, most advanced economies seem to have experienced a breakdown of the model, as the link between the rate of price growth and the level of economic activity seems less clear than before. Multiple studies have discussed this breakdown of the model. Despite the "missing disinflation" experienced by advanced economies, some papers still suggest that the Phillips Curve remains a valid model if tweaked properly (Coibon and Gorodnichenko, 2013)[20]. While this thesis is not here to end this debate nor prove one of these diverging opinions, this context is still useful when looking at the potential shortcomings of the model.

• 7.1.1 Classic PC model

Here we will use the *Expectations-Augmented Phillips Curve* (EAPC) model:

$$\pi_t = \beta_0 + \beta_1 \pi_t^e + \beta_2 (U_t - U^n)$$

With

- π_t= Current inflation
- π_t^e = Expected inflation
- U_t = Current unemployment
- U^n = Natural rate of unemployment
- β = Sensitivity of inflation to the variable

[20]Coibion, O., & Gorodnichenko, Y. (2013). Is the Phillips Curve Alive and Well after All? Inflation Expectations and the Missing Disinflation. *SSRN Electronic Journal*.

The part of the equation $(U_t - U^n)$ is called the *unemployment gap* and is the difference between the unemployment rate and its natural rate. It represents the short-term fluctuations in the unemployment rate and thus the part of unemployment that impacts inflation.

Using the ECB website and Eurostat, we can easily find adequate time series for each of these variables. The HICP index and unemployment rate for the euro-area are given and the expected inflation used is the one discussed earlier in this work (*section 4.6*), which is the "*Euro area - HICP Inflation - Average of Point forecasts - Target period ends 12 months after survey cycle begins*". As for the natural unemployment rate, it is constructed using the Hodrick-Prescott filter.

The time frame used will be from 2000 to 2024. A Phillips Curve model needs a long horizon of data, generally over multiple business cycles, to accurately analyze the structural relationship of the variables inside the model. Despite the focus of this thesis on the 2022 shock, it is best not to interpret the model only from the perspective of the period covered by the sanctions. To give the model reasonable fundamental coefficients of the drivers of inflation, it needs some sort of historical anchoring, not only created around the shock we want to analyze. Furthermore, the frequency of the data is quarterly, as inflation expectations are only available in such a format. This reinforces the need for a broader time frame to get a sufficient sample of data.

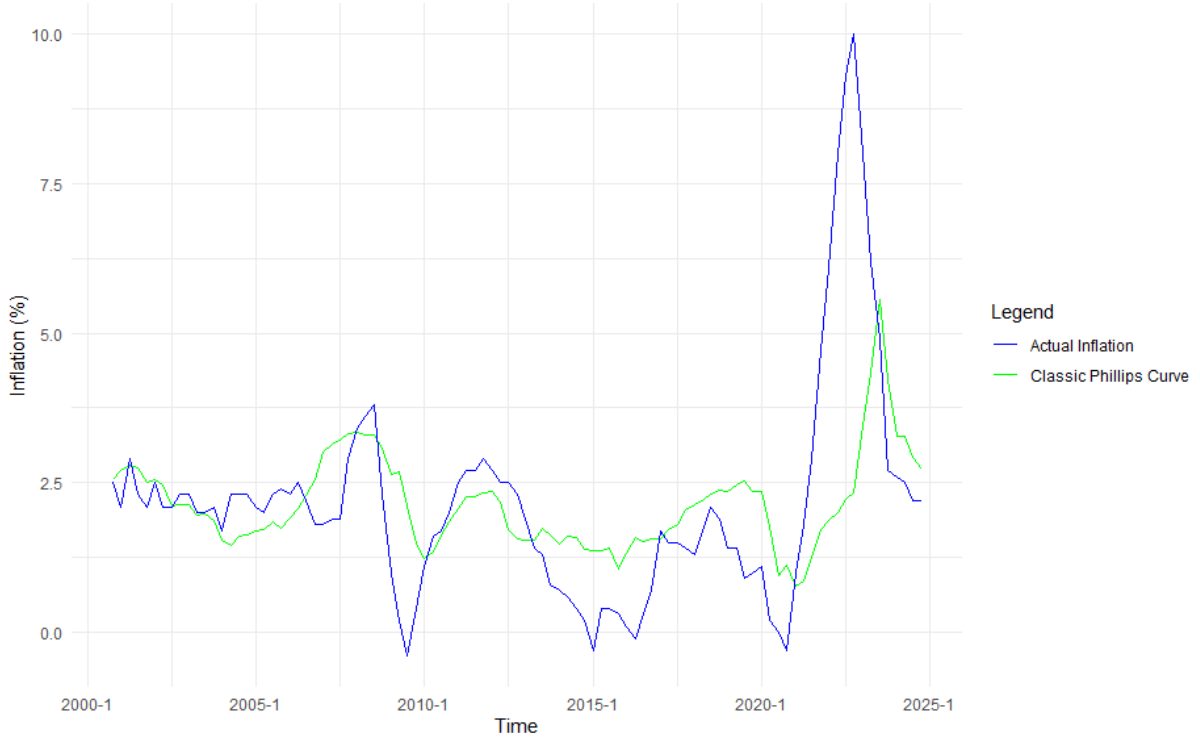
Inputting all of the variables chosen into an OLS regression gives us the following results, allowing us to get an estimate of the betas for the Phillips Curve:

		Adjusted $R^2 = 0.1634$
Coefficients	**Estimate**	**P-value**
β_0 (Intercept)	0.2226	0.685454
β_1 (Inflation Expectations)	1.1176	0.000396 ***
β_2 (Unemployment Gap)	-0.7463	0.027637 *

Statistical Significance Codes: $p \leq 0.001$ = "***"; $p \leq 0.01$ = "**", $p \leq 0.05$ "*", $p \leq 0.1$ "."

Once those are put into the classic EAPC model, we get the following inflation forecast:

Figure 20: Classic PC versus actual inflation



As we can see, a lot of the inflation after the shock caused by the rising tensions between the EU and Russia is missing. The rise of our Phillips Curve only begins after actual inflation begins to rise and does not predict levels of inflation similar to what happened during the shock. This supports our explanation of the transmission of the impact of the sanctions onto the EU's economy. Since this classic model of the PC evaluates the internal drivers of inflation, such as economic activity and monetary policy, through the unemployment gap and inflation expectations, the missing inflation should be proof that the main drivers were external to the EU's economy.

This is further supported by the adjusted R^2 of the OLS regression, which represents the explanatory power of the variables over the fluctuations in inflation. In other words, it is the quantification of how well the model explains inflation. This adjusted R^2 value was 0.1634, which means that 16.34% of the variance in inflation is explained by the current model. This percentage exhibits that inflation expectations and the unemployment gap are not enough and that we need to input additional variables that better capture these fluctuations in inflation.

Fortunately, we already know two candidates that should be a good fit. When we discussed the transmission of the sanctions on inflation, we separated the sanctions' impacts into different categories: energy, trade and finance.

- **Gas price growth** accurately represented the degradation of the relationship between the EU and Russia as well as the energy side of the impact.
- The **Producer Price Index** (PPI) **growth** accurately depicted the increase in price for goods and services caused by the trade bans.

NB: The growth rates are constructed by using the log difference.

The financial side of the sanctions is not easily captured by a PC model, at least not directly, and will be noticed by indirect effects on other variables. As such, no variables are used to attempt to capture it specifically in this current model. As for the decrease in economic activity's impact, it would be captured by the unemployment gap.

• 7.1.2 Robustness checks and model adjustments

After several robustness checks, it was decided not to use the growth rates of PPI and gas price contemporaneously with inflation but rather use their lagged values. Not only does this provide us with a better model, as its adjusted R^2 almost doubles, it also corrects some strange behavior inside the coefficients. Gas price growth was shown to have a negative contemporaneous relationship with inflation, which goes against what was not only assumed previously but what was observed when looking at the data and graphs. The standard errors are also smaller when using the lagged values.

This choice is not only better because of its results, it is also theoretically more acceptable. Economic shocks do not propagate to inflation instantly, especially those like the one we study, which originate from negative supply shocks, creating cost-push inflation. Its consequences take time to propagate, as firms will not adjust their prices and expectations instantly in response to these changes. The existence of this pass-through of both energy prices and production cost shocks creates a lagged effect on inflation, which is why the model responds better when using the lagged values of both variables.

Furthermore, our robustness checks showed that the best fit was with a lagged value of one quarter for gas price growth and of two quarters for PPI growth. Different optimal lag values make sense, since both variables have different passthrough effects on inflation, each of which will have different transmission speeds.

However, a problem remains inside the model: to avoid too much clutter, the OLS regression we get in by simply adding both lagged variables is in the appendix (*Appendix 10.2.2, Table 2*). The results showed that the constant had a negative value of -1.35 and was significative, with a p-value under 0.001. This negative and significative constant suggests that the model is mis-specified. After some testing, it is found that this unusual result is the consequence of a structural break happening in 2023.

The sharp disinflation that happened during the years 2023 and 2024 is not adequately captured through our current model. It seems that these years deviate from the historical patterns of our Phillips Curve. This is the result of a change in the relationship between variables specifically during this period because the constant act normally inside the model if we stop our analysis at the year 2022 (*Appendix 10.2.3, Table 3*). Such breaks in the structure of the economic relationship can reflect multiple causes, such as the impact of a drastic monetary policy change or supply chain adjustments.

This is in line with the EU's plan to limit its dependence on gas and imports from Russia, which was shown in the evolution of its trade balance with Russia and imported volume of gas

earlier in this thesis (*section 4.3*). The change in monetary policy of the ECB was also non-negligible, and its lagged effect would have hit the economy starting in 2023. The structural break observed would then be explained by these events.

To account for this regime shift without distorting structural coefficients, a dummy variable for the 2023–2024 disinflationary period was introduced. This dummy variable is equal to 1 for all quarters previous to the beginning of 2023. Using it, we can mitigate the impact of the structural break by isolating the residual dynamics not captured by our other variables.

• 7.1.3 Augmented PC model

Once added to the previous equation, these new variables give us our new *Augmented Phillips Curve*:

$$\pi_t = \beta_0 + \beta_1 \pi_t^e + \beta_2 (U_t - U^n)_t + \beta_3 \Delta P_{gas,t-1} + \beta_4 \Delta PPI_{t-2} + \beta_5 Dummy23$$

With

- $\Delta P_{gas,t-1}$ = Growth rate of gas price with a lag of 1 quarter
- ΔPPI_{t-2} = Growth rate of the Producer Price Index with a lag of 2 quarters
- $Dummy23$ = Dummy variable for quarters after the beginning of 2023

Once again, using an OLS regression gives us the estimate of the betas for the augmented Phillips Curve:

		Adjusted R^2 = 0.8115
Coefficients	**Estimate**	**P-value**
β_0 (Intercept)	-0.889558	0.01926 *
β_1 (Inflation Expectations)	1.475278	3.89e-09 ***
β_2 (Unemployment Gap)	-0.123739	0.45450
β_3 (Gas Price growth (L=1))	0.011827	0.00263 **
β_4 (PPI growth (L=2))	0.672131	< 2e-16 ***
β_5 (Dummy23)	0.856746	0.06411 .

Statistical Significance Codes: p ≤ 0.001 = "***"; p ≤ 0.01 = "**", p ≤ 0.05 "*", p ≤ 0.1 "."

Using only these estimates, we can get a good idea of the dynamics inside of the model. These betas represent the percentage of variation inflation undergoes when the associated variable increases by 1%. Using this, we see that the way each variable impacted inflation during this period of time is conform to what was suggested previously in this thesis.

The intercept is the constant; it represents long-run inflation drift unaffected by the other parameters. It is still negative and significant, but less so than without the dummy, proving that it is indeed absorbing part of the unexplained disinflation present within the model. The parts

still present in this estimate nonetheless prove that this solution is not perfect. Yet, the intercept is now within more acceptable levels and will be addressed in more detail at the end of the Phillips Curve section.

Inflation expectations behave as expected with a typical Phillips Curve model. Highly significant, its impact on inflation is positive, showing that when expectations rose, they created an upward spiral of inflation, such as during the 1970's oil price shock, where inflation expectations and inflation amplified one another. However, as we discussed previously, they remained mostly anchored, playing a role in mitigating the transmission of the shock in the economy by creating downward pressure on inflation during 2022, when inflation was at its highest.

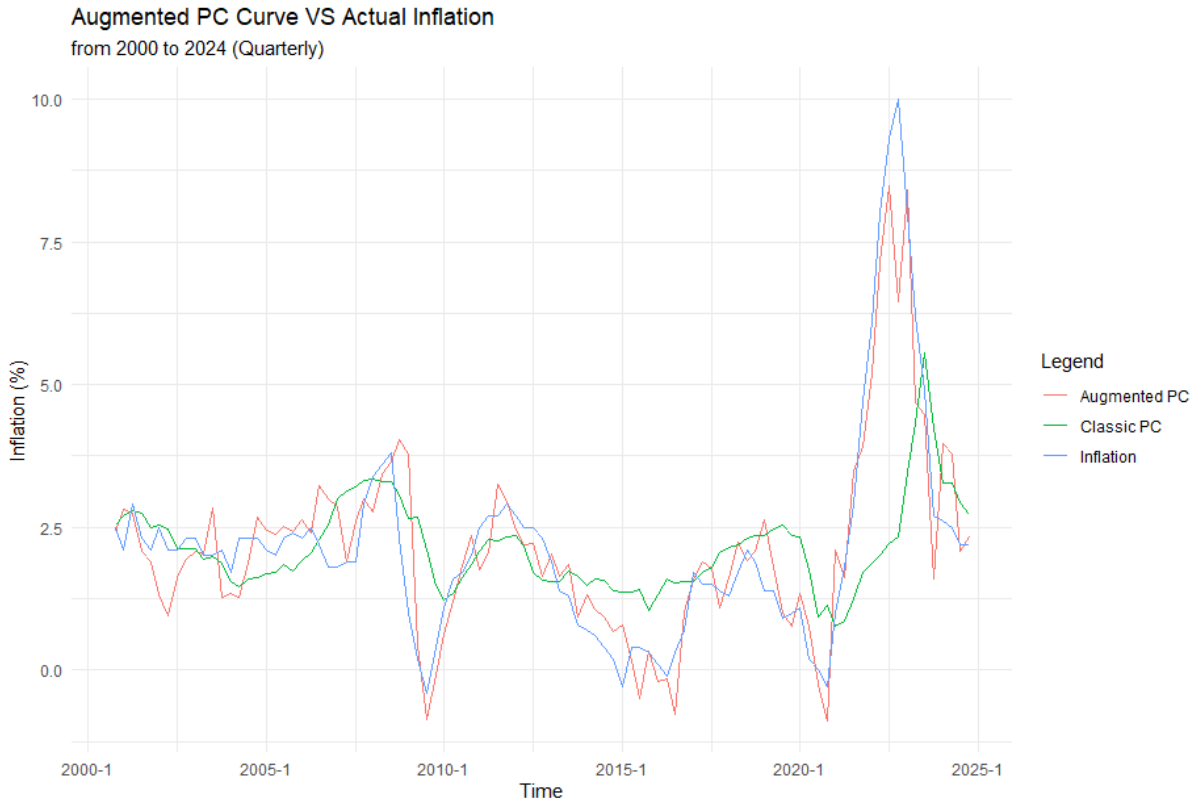
The unemployment gap's effect also shows that it behaved as expected for a PC model. Its increase is linked to a decrease in inflation, as when unemployment is high, there is slack in the labor market and thus less pressure on wages and a slowdown in economic activity, which in turn lowers inflation. However, its lack of impact on the model now that we have introduced our additional variables, representing external supply shocks, is unusual. It means that inflation was mainly supply-driven in our model, which consistent with what we assumed when discussing the causes of the rise in recent inflation. The fall in its significance compared to the classic PC can be explained: by lacking the information these additional variables brought, the classic EAPC model attributed, by default, these changes to both inflation expectations and the unemployment gap.

As for the gas price and PPI effects, they both are in line with what was explained during the "*sanctions transmission channels*" section of this thesis. They both were important drivers of inflation, reflecting the impact the sanctions had on the economy. We can note that while both variables had a significant effect, the beta for PPI has a much greater coefficient and a smaller p-value. This model thus shows that PPI was a bigger driver of inflation than the gas price.

This provides further insight into the mechanisms through which the sanctions influenced inflation, primarily not via the energy channel, but rather through the increase in production costs induced by the trade bans and reduced energy component supply brought about by the sanctions.

With the results of this regression, we can add the beta estimates to the equation and get our Augmented Phillips Curve, represented along the actual inflation in the following graph.

Figure 21: Augmented PC versus actual inflation



While the classic PC containing only the two variables of inflation expectations and the unemployment gap fails to account for the full magnitude of the shock, the PPI and gas price allow for a better degree of fidelity to actual inflation. This is especially true during the period of the shock we are trying to analyze. According to this model, they are the main drivers of the recent period of high inflation encountered in the EU. Furthermore, since those channels are the ones we identified as the specific pass trough of the sanctions back into the euro zone, this augmented Phillips Curve supports the idea that the sanctions on Russia did bring upward pressure on inflation in the EU. This pressure was partially brought with the energy channel, but even more so because of the trade bans that acted as a negative supply shock for producers.

- ### 7.1.4 PC model with the GPR index

As previously said, the geopolitical tensions between the EU and Russia seem to be correlated with the rise in inflation. The sanctions being an expression of these rising tensions, finding a way to capture them would complement our current analysis. To this effect, we will use the GPR index discussed in a previous section.

To remedy its shortcomings, a dummy variable is created for the GPR index. Inside this dummy variable, the GPR index's level is only taken into account during the quarters where sanctions were announced. This is not a perfect solution, as it is still using the perceived risk by English papers and is thus focused on the impact felt by North America and the United Kingdom more than by the EU. However, creating a brand-new index tailored for the EU is outside the scope of this thesis and not including any measure of geopolitical risk would mean missing a crucial part of our analysis.

Hence, we turn to the classic *Expectations-Augmented Phillips Curve* (EAPC) model adding our dummy variable for the GPR index:

$$\pi_t = \beta_0 + \beta_1 \pi_t^e + \beta_2 (U_t - U^n) + \beta_3 GPR_{dum,t-2}$$

With

- $GPR_{dum,t-2}$ = GPR dummy level with a lag of 2 quarters

The model gave the best results when using a lag of 2 periods for the GPR dummy, indicating that the geopolitical tensions took some time to propagate through the economy into inflation. This is in line with our thinking that while these geopolitical tensions are the root cause of the inflation shock the EU went through, it only affects the economy indirectly, passing by other channels, much like the sanctions did.

Using this equation for an OLS regression, we get the following estimates for the betas:

		Adjusted R^2 = 0.3042
Coefficients	**Estimate**	**P-value**
β_0 (Intercept)	0.07377	0.8832
β_1 (Inflation Expectations)	0.95095	0.0010 **
β_2 (Unemployment Gap)	-0.71090	0.0216 *
β_3 (GPR dummy (L=2)))	0.01857	2.17e-05 ***

Statistical Significance Codes: p ≤ 0.001 = "***"; p ≤ 0.01 = "**", p ≤ 0.05 "*", p ≤ 0.1 "."

Adding the GPR dummy to our classic EAPC model resulted in a high increase in its explanatory power. The adjusted R^2 almost doubled, going from 16.34% to 30.42%. These results support the hypothesis that geopolitical risk contributed significantly to the observed increase in inflation. As our dummy represents the sanctions, the culmination of the ever-rising tensions between the EU and Russia, we conclude that this geopolitical dimension is a critical factor to consider when analyzing the recent inflation shock.

Using a smaller time frame, since the beginning of 2014, gives even greater weight to the GPR dummy, reinforcing our theory (*Appendix 10.2.6, Table 6*). Since the GPR dummy is only active when sanctions are released, it makes sense that its effect decreases, as we include more years from before the sanctions, where the dummy would be zero.

The intercept also behaves normally, without the need for our dummy capturing the structural break of the years 2023 and 2024 (Dummy23). This indicates that the inflation dynamics with geopolitical risks do hold even when the mechanism by which it might pass through changes.

• 7.1.5 Final augmented PC model

To add to this theory and to put it in relation to what we learned about the way the sanctions impacted the economy, we did one final Phillips Curve model. This time we included

not only the gas price and the PPI growth rates, but also their interaction with the GPR dummy. Giving us this final PC model:

$$\pi_t = \beta_1 \pi_t^e + \beta_2 (U_t - U^n)_t + \beta_3 \Delta P_{gas,t-1} + \beta_4 \Delta PPI_{t-2} +$$

$$\beta_5 GPR_{dum,t-2} + \beta_6 \Delta P_{gas,t-1} * GPR_{dum,t-2} + \beta_7 \Delta PPI_{t-2} * GPR_{dum,t-2}$$

Inputting these parameters inside of an OLS regression, and including the dummy quarters after the beginning of 2023 (Dummy23), we get the following beta estimates:

		Adjusted R^2 =0.8664
Coefficients	**Estimate**	**P-value**
β_0 (Intercept)	-0.2369	0.54518
β_1 (Inflation Expectations)	1.154	1.39e-06 ***
β_2 (Unemployment Gap)	-0.2749	0.05718 .
β_3 (Gas Price growth (L=1))	0.007952	0.12205
β_4 (PPI growth (L=2))	0.4389	1.38e-08 ***
β_5 (GPR dummy (L=2))	-0.007750	0.02266 *
β_6 (Gas Price growth (L=1) GPR Interaction)	1953e-04	0.00751 **
β_7 (PPI growth (L=2) GPR Interaction)	3.340e-03	2.21e-05 ***
β_8 (Dummy23)	1.861	0.00177 **

Statistical Significance Codes: $p \leq 0.001$ = "***"; $p \leq 0.01$ = "**", $p \leq 0.05$ "*", $p \leq 0.1$ "."

This final PC model is the most complete and has the best ability to accurately explain the fluctuations of inflation, as proven by its higher adjusted R^2, at 86.64%. Furthermore, the intercept is non-significant, with a low value, as should be the case in a normal model. While most interactions within the model follow the same logic as explained before, we will focus particularly on the interactions between the growth rates and the GPR dummy.

Gas price growth is now non-significant, while its interaction with the GPR dummy, and thus its effect on inflation when there are geopolitical tensions, is significant with a positive impact. This highlights the strong link between the two variables, as the gas price during the period we analyzed seemed to be mainly driven by the geopolitical tensions between Russia and the EU, as proven earlier in this thesis (*section 4.5.1*).

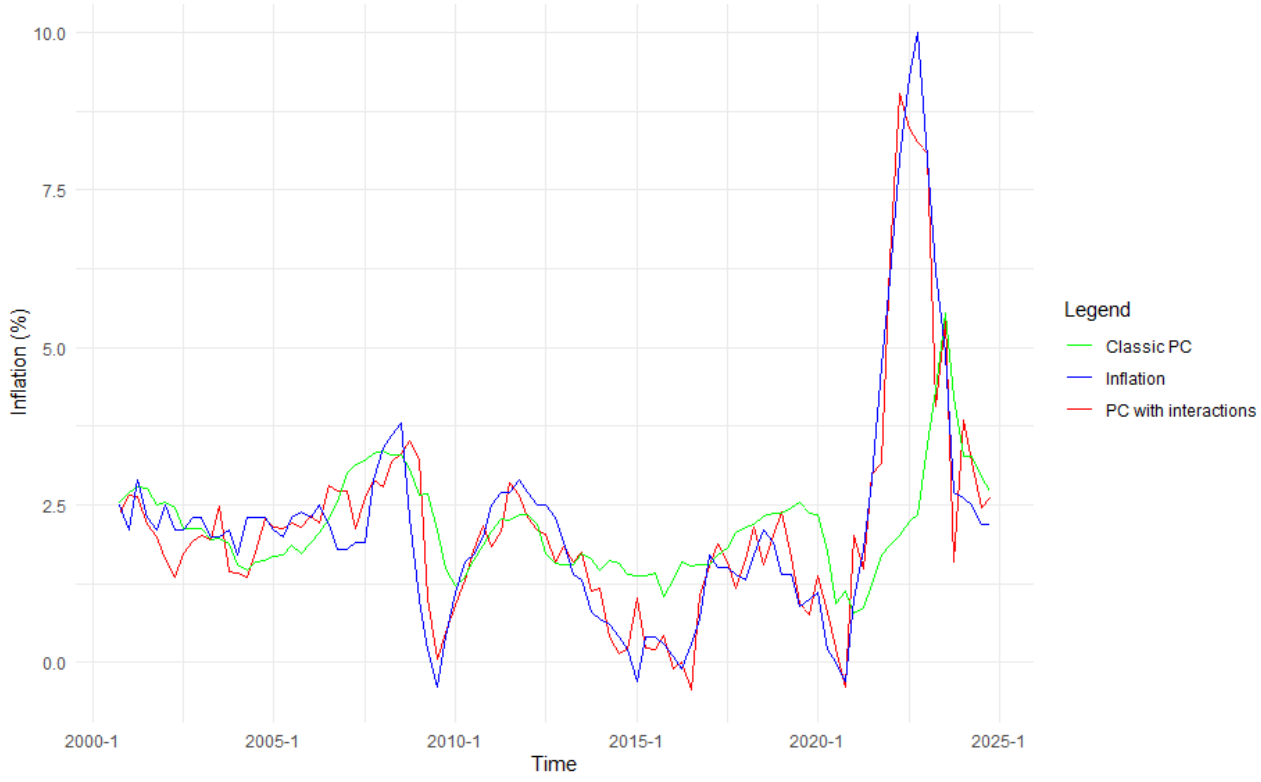
As for PPI growth, both its beta and the beta of its interaction with the GPR dummy are significant with a positive relationship with inflation. The PPI index is our stand in for production costs, which can impact the economy for other reasons than geopolitical tensions. As such it will always remain an important variable. Nonetheless, these results are in line with

our assumption that they are a passthrough for geopolitical tensions, namely the sanctions, as the effect of the PPI growth on inflation is amplified by the GPR index.

Finally, when looking at the GPR dummy in itself, interestingly, we can see that its effect is now deflationary. Once the cost-push interaction of the increased geopolitical risk, the way in which it pushed inflation upward, is accounted for by the gas price and PPI growths and their interactions with the GPR, we observe a negative coefficient for the latter. It likely reflects the second-order deflationary effects of geopolitical risk.

The impact of an increase in geopolitical tensions on inflation is linked to a multitude of impacts, both on supply, demand and policy forces. These could, from a theoretical perspective, move the inflation in either direction (Iacoviello, Caldara, Conlisk, Penn; 2024)[21]. However, as the shock of 2022 has shown, this assumption seems to be false, as the effects brought about the GPR show a predominance of upward pressures on inflation. The model captured the primary inflationary pressure of the geopolitical tensions with PPI and the gas price. Thus, what is left for the GPR dummy to represent is the deflationary pressure, hence the negative coefficient.

Figure 22: Augmented PC with GPR interaction versus actual inflation



The results from these Phillips Curve models support our hypothesis that the Geopolitical Risk (GPR) index can indirectly capture broader economic dynamics that contribute to higher inflation. While it is preferable to identify specific transmission channels, such as gas price or the Producer Price Index (PPI), this approach can be challenging in real time. This limitation underscores the value of a broader indicator like the GPR. Moreover, our findings show that

[21] Caldara, D., Conlisk, S., Iacoviello, M., & Penn, M. (2024). Do Geopolitical Risks Raise or Lower Inflation?

even when specific variables are included, the GPR remains a valuable complementary addition, as demonstrated in the final model.

• 7.1.6 Structural Break and Dynamism

As we explained earlier, we found a structural break within the dynamics of our model during the years 2023 and 2024, as the EU encountered a sharp deflationary period. We tackled this by using a dummy variable. However, this solution is purely theoretical and highlights the limitations of our current model.

A Phillips Curve model is static in its approach, and thus limited in its ability to capture the dynamic interactions and evolving macroeconomic transmission mechanism presents inside the economy. To remedy this flaw, we will use another type of model to complement our current analysis, as we will now move onto a more complex model that can account for such dynamism: a *vector autoregression* (VAR) model.

7.2 Vector autoregression (VAR) model

A VAR model is a statistical model that is able to capture the joint evolution of multiple macroeconomic variables. Contrary to the Phillips Curve, it includes an element of dynamism, each time series being able to interact with the others, not only contemporaneously but also with their lagged values.

This model was created at the beginning of the eighties. At that time, macro-econometric models were failing and subjected to a lot of criticism and some even started to question their usefulness. In response, Christopher Sims brought the vector autoregression model into economics. Its flexibility and ability to capture complex dynamic relationships among time series made it a staple in macro-econometric analysis. Unlike traditional structural models that impose strong theoretical constraints, the VAR model treats all variables as potentially endogenous, allowing for pure data driven results regarding their interactions over time.

Inside a VAR model, the variables are explained by their own past values and the past values of all other variables. To do this, the variables are all put inside a vector, which is then used to construct the following model, called the *reduced-form VAR model*:

$$\mathrm{Y_t} = C + A_1\mathrm{Y_{t-1}} + A_2\mathrm{Y_{t-2}} + \ldots + A_p\mathrm{Y_{t-p}} + \varepsilon_t$$

With:

- C = vector of constants
- $\mathrm{Y_t}$ = vector of variables
- A_i = coefficient matrices
- ε_t = vector of innovations (shocks)

The most valuable tools from a VAR model analysis are the *impulse response function* (IRF) and *forecast error variance decomposition* (FEVD). The IRF is a graph tracing the effect

of a one-time, unit-sized shock (such as a positive shock on the PPI) on another time series' current and future values (such as inflation). IRFs measure the impact of shocks from one time series on the others, showing not only the magnitude and direction of the effect but also its duration. The FEVD is a complementary analysis, delving into how much of the variability in each time series is attributable to the shocks inside the other series. Both of these tools grant us a better and deeper understanding of the transmission mechanisms and causal dynamics at play in the economy.

• 7.2.1 Model Specifications

To construct the vector Y_t, much like for the Phillips Curve, we need to find a group of variables that would capture the different effects of the shocks created by the sanctions. Once again, we refer to earlier in this thesis to find adequate candidates.

This time, the model flexibility allows us to include a higher number of variables, ensuring we can reflect many of the specific channels by which this shock propagated into the economy and inflation. Thus, the vector's seven variables are:

- **The GPR index dummy**: as stated in its own section, the GPR index seems to correlate to inflation fluctuations. This assumption was further supported by our experiments with the Phillips Curve. Once again, the dummy variable is used to focus on the sanctions' impact.
- **Gas price growth**: the gas price accurately represented the degradation of the relationship between the EU and Russia as well as the impact. On the energy sector. This assumption was further reinforced by the results of our augmented PC model.
- **Producer Price Index growth**: the PPI captured well the increase in prices for goods and services caused by the trade bans and has proven its link to inflation in the augmented PC model.
- **Exchange rate (euro-Swiss franc) growth:** when we discussed the transmission of the sanctions impact, we assumed that this exchange rate recent fluctuations would capture the financial toll of the sanctions on the EU.
- **Interest rate (MRO):** including one of the key interest rates of the ECB let us capture the impact of its monetary policy on recent inflation and see how the ECB's measures played a role in the dynamics of the shock. The MRO has been chosen, since it is the main reference among the three key rates for the ECB's policy.
- **Unemployment gap**: this variable is used to capture the decrease in economic activity caused by the sanctions.
- **Inflation:** the variable studied, which mechanisms and dynamics we want to analyze.

The time frame used for this model will be from 2014 to 2024. 2014 was deliberately chosen, since it was the year of Russia's annexation of Ukraine, an event that led to the first European sanctions on Russia according to the official timeline by the European Council[22] and thus the first year where a link between those and inflation dynamics could be observed. Contrary to a Phillips Curve, VAR models do not need a baseline of data, as such models are more sensitive to short-term variation and structural breaks. They need a focused sample to accurately determine the dynamics at play during the shocks.

The frequency is monthly instead of the previously used quarterly period. While the previous model incorporated inflation expectations, which were only recorded in quarterly and were difficult to work around in a Phillips Curve model, our VAR model possesses variables that can all be found in a monthly format. Besides the added benefit of having more precise time series by using this higher frequency, having a large sample of data is crucial in a VAR. Since VAR models are made of matrices that interact with one another, they are highly parameter intensive. They estimate a complex system of equations that includes many parameters per variable and thus requires a larger number of observations to produce reliable results.

When creating a VAR, a strong assumption is the stationarity of the model. The stationarity assumption in a VAR model is that we assume that the time series vector Y_t is at least weakly stationary: the time series chosen to create this vector, our variables, must have a constant variance and mean overtime to ensure that the model only captures the short-term fluctuation due to shocks and to decrease the risk of spurious regression, where coefficients may appear significant even though they are not. In other words, a stationary time series has a consistent behavior over time.

Using the Phillips-Perron test and the Augmented Dickey-Fuller test, we can verify whether this assumption holds for each variable. If not, there are several ways to make a time series stationary, such as taking its growth rate instead of its value in level. During testing, we found out that all series, except the unemployment gap, were indeed not stationary during the period selected. However, we need to follow a case-by-case approach when treating them, as while this stationarity assumption is important, it should not be followed to the detriment of the analysis we are trying to perform. We should not aim solely to have only stationary time series but instead be sure that the model is able to capture the effects of the shocks accurately.

The inflation rate is not stationary in our sample because of the shock we are trying to study. Furthermore, it is already a growth rate of the price level. As such, using its growth rate would distort the significance and persistence of the inflation created during that time, thus losing the very thing we want to study. The same logic applies to the GPR dummy. Since we have previously shown that its higher level during the sanctions is a cause of inflation during that period, we do not want to distort this effect by using its growth rate. As for the MRO rate, since its level directly reflects the monetary policy stance of the ECB, taking its growth rate

[22]European Council. *Timeline – EU sanctions against Russia*

would make it lose most of its interpretability; the ECB's key interest rate's role as monetary policy instruments prevents them from having a natural growth rate interpretation. Given this reasoning, these variables were kept in levels despite their lack of stationarity.

Since neither the gas price nor the PPI's non-stationarity were backed by any strong premise, we used their growth rate, ensuring they are stationary inside the model. Lastly, the exchange rate was also taken in growth rate. This choice is not only to ensure its stationarity but because its growth better reflects what we want to capture: the appreciation and depreciation dynamics happening between the two currencies in the short term.

The choice of having multiple time series that are not stationary is strongly supported but comes with an increased risk, as previously explained. In our specific case, this lack of stationarity, while justified, still introduces some risk when using a standard VAR model. Furthermore, the number of variables we incorporate relative to our sample size can also create problems inside the model, such as increased risks of overfitting and multicollinearity. This is because their high parameterizations can lead to unstable inference and inaccurate forecasts, a liability of the model which only increases with the number of variables.

To resolve these issues, we will use the *Bayesian VAR* (BVAR) model, with Minnesota priors. The Bayesian VARs impose some economic reasoning inside the model, the priors, and by doing so, they shrink the parameter estimates. This allows us to reduce the variance and instability that the problems listed in the paragraph above risk introducing, without losing interpretability. The advantage of using a Bayesian VAR model thus comes from its potentially improved forecasting capabilities. Bayesian VARs can outperform the standard VAR model in some cases: when faced with many variables, with a relatively short data sample or with an unstable system. All three of those cases are characteristics of the model we have created, hence its use.

• 7.2.2 Structural Restrictions

To analyze the shocks, we need to add structural restrictions to our model. While able to estimate the correlations between the variables through time, a base VAR model is not able to draw any conclusions on the causality among them. Without causality, we cannot understand which variables created which part of the shocks to other variables, which means the structural shocks are not defined. Since the IRFs and FEVDs need this causality, we impose structural restrictions onto our model, creating a *Structural VAR* (SVAR) model.

The chosen method of restrictions is the *Cholesky decomposition*: we include another matrix inside our reduced-form VAR model from earlier to impose restrictions on the shocks. This B matrix creates a new assumption inside of the model, allowing us to identify structural shocks.

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + \boldsymbol{B}\varepsilon_t$$

The SVAR model will assume that the first variable in the system is contemporaneously exogenous to all other variables, which means that it is not affected by any other variables within the same period *t*. The second variable of the vector Y_t is only contemporaneously

affected by the first one, the third only by the second and first and so on. The last one is the most endogenous variables, since it is affected by all other variables contemporaneously.

Hence, the ordering of the variables inside of the vector matters. The way we class them will affect the analysis, since the Cholesky decomposition creates the assumption that they ordered from the most to the least exogenous. We must base our choice on both theoretical and empirical knowledge to ensure this assumption is respected. This order is the same one as when the vector's seven variables were first explained, as they were preemptively placed that way to avoid any confusion. The vector of variables Y_t is thus as follows:

$$Y_t = \begin{pmatrix} GPR\_dum_t \\ Gas\_Pgrwth_t \\ PPI\_grwth_t \\ Ex\_grwth_t \\ Int\_rate_t \\ Un\_Gap_t \\ Infl_t \end{pmatrix}$$

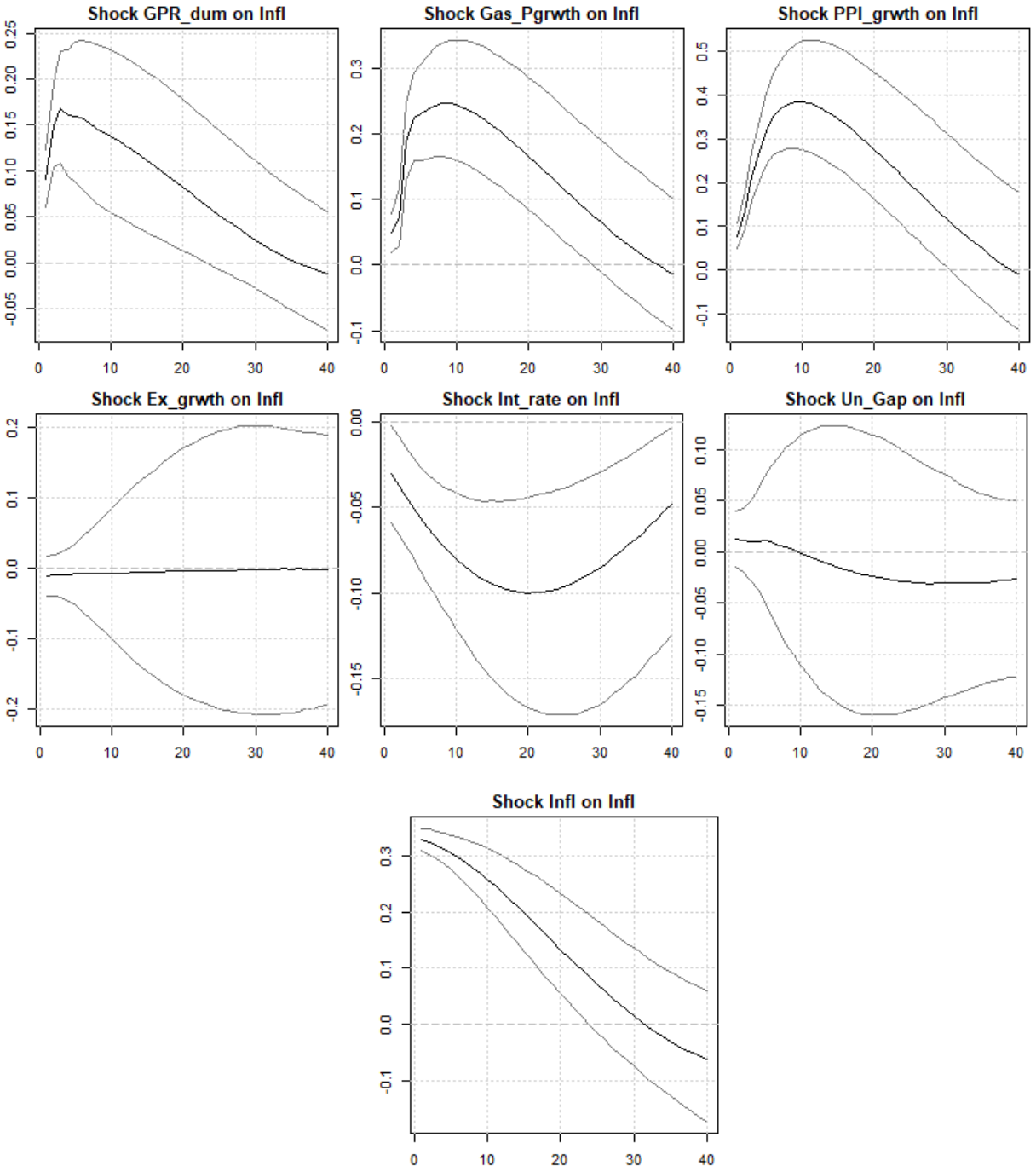
Combining both the structural restrictions and the Bayesian VAR model then gives us our final model, from which we can derive both the IRFs and FEVDs needed for our analysis.

• 7.2.3 Impulse response functions

The Bayesian SVAR model gives us the IRFs below. Note that these are not the full IRFs, which can be found in the appendix of this thesis (*Appendix 10.3.1, figure 25*), but only those that relate to inflation. We focus on the IRFs that represent the effect of a shock to each variable on the fluctuations of inflation over time, since the goal of our analysis is to determine how the sanctions affected price stability inside the EU. These are all the same: a positive one-unit shock. Each has a horizon set to "*n=40*" as it corresponds to the time it took most variable to stabilize back toward zero. Since the frequency of the data is monthly, each *n* corresponds to one month.

In the graphs below, the solid black line in the middle represents the point estimate of the impulse response. As for the gray lines above and below it, they denote the confidence bands, capturing the uncertainty around the estimate.

Figure 23: IRFs of inflation



Looking at these IRFs in order, we make several observations that relate to the assumptions we made previously as well as several others that come to complete them.

First, the inflation response to a GPR dummy shock is instantaneous, beginning around 0.08, and sharply increases until around the 0.17 mark before declining gradually as time passes. This is in line with what we assumed: the geopolitical risk linked to the sanctions significantly increased inflation in the short to medium term. This mostly reflects the climate of uncertainty generated by the tensions between Russia and the EU when the sanctions were released and how it created inflationary pressure on the economy.

The shock on gas price growth is stronger, peaking at around 0.25 before the 10-month mark. This once again is in line with what was supposed and supported by our Phillips Curve analysis. Inflation was significantly driven by the negative supply disruption in the energy market that raised its prices inside the EU.

In line with the previous observation, the PPI growth shock severely impacted inflation. Peaking at around 0.38 at the 10-month mark before gradually declining, this value represents the biggest impact of all variables. This model shows that the supply shock created by the trade bans increased the production price, which was then passed downstream to consumers, as reflected by the PPI increase during 2022.

The relationship of the interest rate (in this case the MRO) with inflation behaves as expected. When the MRO is increased by the ECB, inflation responds negatively and gradually, reaching its bottom of -0.10 percentage points after 20 months, before its effect slowly fades away. This is in line with the economic theory: when the ECB tightens its monetary policy by increasing its key interest rates, it creates deflationary pressure on the economy. However this response takes time, which aligns with the conventional idea of monetary policy having a lagged effect on the economy.

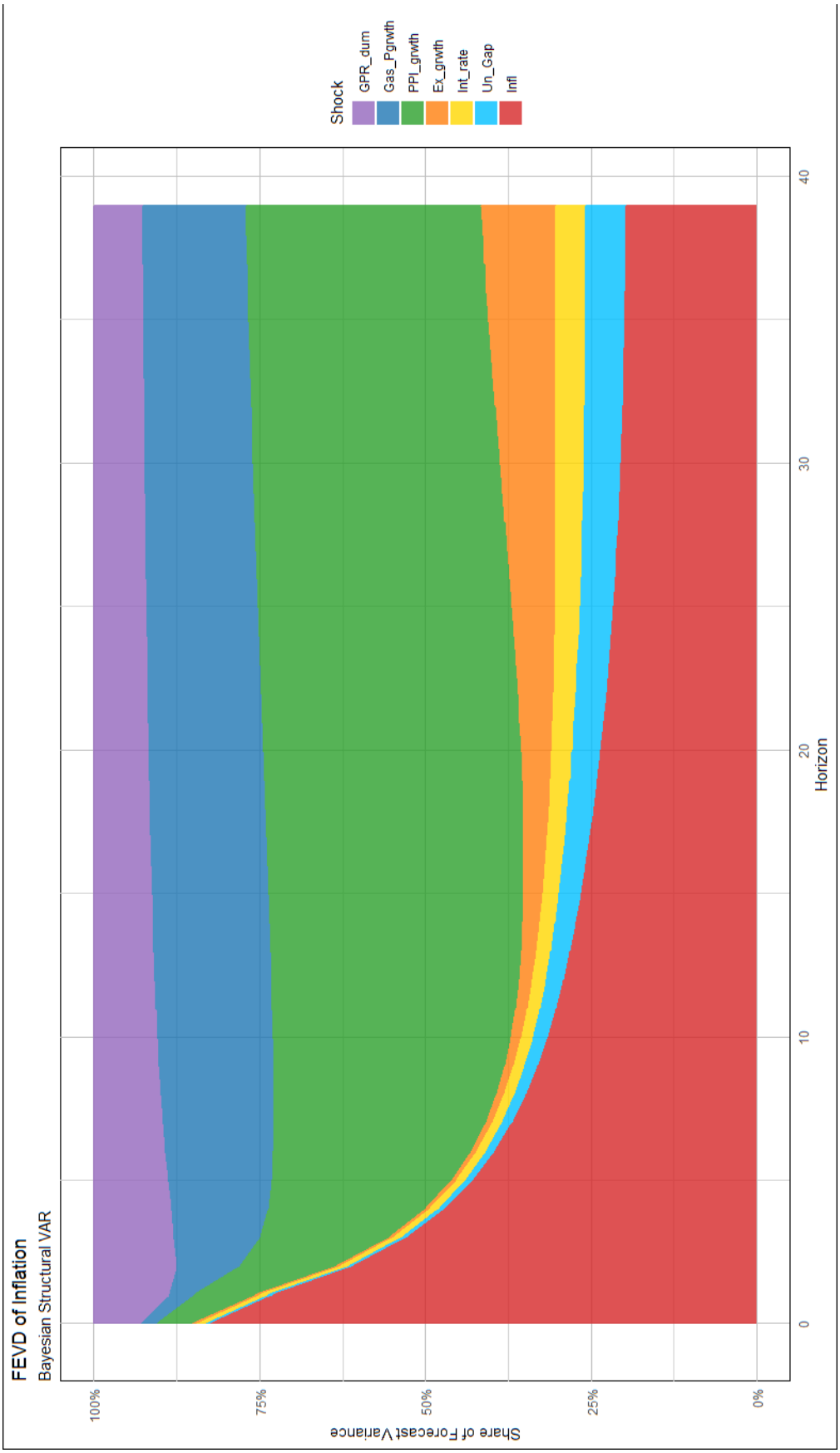
Both the exchange rate and unemployment gap shocks proved to be non-significant drivers of inflation during this period. The unemployment gap's lack of effect can be explained by the breakdown of classic models, such as the *Expectation-Augmented Phillips Curve* during unusual shocks, like the one studied here, proving that inflation is generated by other channels than the internal economic activity of the EU. However, the insignificant results of the exchange rate in this model are unexpected and show either the lack of significant impact the sanctions had on the financial side of the economy or that this effect was offset due to other factors, such as monetary policy or the global rise in price.

Finally, inflation's response to its own shocks is the second largest. There is a strong autocorrelation, as the shock pushes inflation up to 0.3 percentage points instantly, followed by a gradual decay over time. This indicates a high degree of inflation persistence in the economy, as an initial increase in inflation leads to elevated inflation rates in subsequent months. This can be explained by a self-reinforcing price-wage spiral: as prices rise, workers demand higher wages to maintain their purchasing power. In response, firms raise prices further to cover increased labor costs, perpetuating the inflationary cycle.

• 7.2.4 Forecast error variance decomposition

Much like the IRFs, the following FEVD given by our Bayesian SVAR model is only the one representing the impact of the other variables on inflation's variance over time. The full table of the FEVDs is also available in the appendix at the end of this thesis (*Appendix 10.3.2, figure 26*). The FEVD below shows how much of the forecast error variance in inflation is attributable to each of the other variables' structural shocks. The horizon is once again set to "*n=40*" for the same reason as for the IRFs.

Figure 24: FEVD of inflation



Over the short term, the first 6 months, we can see that inflation is mainly driven by itself, with around 80% of its forecast error variance determined by inflation shocks. This once again reinforces the importance of inflation persistence. Both the PPI growth and GPR dummy are the two main factors influencing inflation during this period, once again mirroring the observations of our IRFs.

Moving onto the medium term, from 7 to 24 months, inflation persistence falls quickly but remains the second most important factor, explaining still above 25% of its own forecast error variance. The GPR dummy explanatory power degrades slowly over time, but remains above 10%, highlighting the far-reaching effects of geopolitical uncertainty on inflation. In the meantime, gas price growth's impact became significant in this period, increasing its share of the FEVD quickly to reach around 20%. Finally, over the medium term, the last three variables, i.e., the unemployment gap, interest rate and exchange rate, all gradually increase. While they remain minor contributors, by the 24th month, they managed to explain around 15% of the inflation's FEVD.

As for the long term, from months 25 to 40, the PPI growth share continues to impose itself as the biggest factor in inflation, while slightly fading. Gas price growth and the GPR dummy both stabilized at around 15% and 7% respectively. Inflation persistence also stabilizes itself, still explaining a significant part of the FEVD at around 20%. The interest rate's delayed effect is here and, along with the unemployment gap and exchange rate, they contribute to about 25% of the FEVD.

7.3 Interpretation

With these results in mind, we are able to draw several conclusions regarding the dynamics that were at play during the inflation shock of 2022. The combined analysis of the IRFs and FEVD provides us with a better understanding of the structural drivers of inflation during that period. Furthermore, given that our variables were specifically chosen to reflect the impact of the sanctions on Russia, we can assume that the fluctuations showed in our model are their direct or indirect results. We will go over each variable and what their effect on inflation was, from most to least impacting.

- **PPI growth:** As shown by our Phillips Curve and VAR models, the main structural driver of inflation was the producer price index (PPI) growth. PPI growth shocks quickly emerged as the main source of total forecast variance in our FEVD and its IRF shows that its impact was greater than the other, even bigger than inflation's effect on itself.
- **Inflation:** Short-term fluctuations within inflation were mainly driven by itself, reinforcing that inflation persistence was high during the time period studied. The inertia of inflation shows the presence of structural shocks, even impacting core inflation, such as the increase in producer prices.

- **Gas price growth:** Gas price growth follows a similar pattern to PPI growth, reflecting a persistent impact on inflation, while its effect is only around half the size of the PPI growth inside the FEVD.
- **GPR index dummy:** Used to reflect the geopolitical risk correlated to the sanctions announcement, the GPR index dummy's relatively constant significance throughout the FEVD and its significant IRF prove that geopolitical tensions did indeed play a role in the upward pressure inflation encountered. The results from the Phillips Curve models also support this, as not only did the dummy allow us to create a better forecast of inflation than using the base EAPC model, but interacting it with PPI and Gas price growths showed that it amplified their effect on inflation.
- **Exchange rate (euro-Swiss franc) growth:** The exchange rate, despite its insignificant impact on the IRF, still accounts for a growing share of inflation variance over time in the FEVD. These clashing outcomes are the results of the diverging utilities of both tools. While the IRFs' focus is on capturing a direct and immediate response to a single one-unit shock, the FEVD is reflecting the cumulative contribution of the exchange rate to the variance of inflation. Following this logic, their contradictions lead to the assumption that the exchange rate possesses an indirect or at least cumulative effect on inflation. Several robustness checks support that hypothesis, since removing or replacing the exchange rate between the euro and the Swiss franc led to models of lesser quality, as shown by their worse log-likelihoods and AIC-BIC test results.
- **Unemployment Gap:** The unemployment gap's lack of significance the IRFs shows that during this period the traditional relationship between inflation and unemployment was not an influential part of the dynamics at play in the inflation shock. This reinforces our assumption that the shock was external to the EU's economy due to the geopolitical nature of the sanctions, whereas the unemployment gap is a measure of the internal state of the economy. The breakdown of the classic EAPC model made at the beginning of our econometric analysis also supports this, since it was not able to forecast the sharp rise in inflation.
- **Interest Rate:** the MRO's effect, while significant, is far from the cumulative effects of the other shocks and is only felt in the long term. This is in line with the lag monetary policy operates on, which forces the ECB to think in advance, as any tools they use will need time to propagate through the economy. While it might take some time for the interest rate to apply deflationary pressure to our model, this pressure is nonetheless shown to be persistent in the long term, as shown by our FEVD.

Together, these results suggest that the rise in inflation observed during 2022 was mainly driven by the shock to PPI growth in the EU. As for production price increase, it was itself caused by the numerous trade bans that were enacted by the sanctions. Many materials needed

in the manufacture of industrial goods could not be imported from Russia anymore, creating a negative supply shock. In the meantime, energy prices also rose, as reflected by the gas price, not only because of sanctions but also because of the added geopolitical tensions they created between the EU and Russia, which is captured by the GPR dummy. Both supply shocks, in the imports of raw materials and in energy, led to higher production prices, increasing the price of goods on the market. In turn, service providers and other goods manufacturers were faced with higher costs for their services, despite not being directly reliant on the supply coming from Russia. This cascading effect, coupled with the added uncertainty and volatility created by geopolitical tensions as well as the already unstable economy due to its previous recent shocks, created the sharp rise in inflation inside the Euro-zone during 2022.

The persistence of geopolitical risks, as shown in the FEVD, also feeds into inflation persistence, diminishing the effect of potential deflationary efforts, such as the rise in the ECB's interest rate that develops in the long term. Furthermore, the influence of monetary policy is also hampered in the medium term by dominant supply-side pressures, furthering the already high inflation persistence.

8. Conclusion

In this thesis we analyzed how the EU's sanctions on Russia impacted inflation in the euro-area. We first described what the sanctions entailed for Russia as well as the means by which it potentially could have come back into the EU's economy. By doing so, we were able to find three main ways by which they propagated in the euro-zone, which are the energy sector, international trade and the financial market. Inside these, several variables, such as the gas price and producer price index, showed a correlation with the increased inflation that the EU experienced in 2022 and 2023.

Using a base expectation-augmented Phillips Curve model, we identified that the shock to the EU's inflation was not explained by these classic drivers, meaning the added pressure came from somewhere else. Using both the PPI and gas price growth rates to augment this base model, we were able to show that these specific channels were important causes of the inflation shock that happened inside the euro-area. An additional more in-depth analysis was then performed with a Bayesian Structural VAR model, in which this causality was further proven.

Our results suggest that the surge in inflation observed in the euro-area during 2022 was mainly caused not by the war specifically, but the geopolitical sanctions enacted against Russia, namely the trade ban that acted as a negative supply shock for industrial goods producers. The energy sources that were banned from being imported or whose supply were cut by Russia because of the sanctions furthered this shock to inflation, adding another upward pressure. Additionally, the energy shock raised the cost of production further, cost that was passed onto consumers, increasing prices inside the EU.

The financial sanctions captured inside our models suggested a weaker impact on the EU's economy. While its cumulative effect on inflation is still significant, it was overshadowed by the effect of the other channels by which the sanctions were transmitted into the economy. Nonetheless, inflation still showed a correlation with the significant depreciation of the euro during 2022, indicating both a loss in international competitiveness, investor confidence and a capital flight from the EU because of the geopolitical tensions' repercussions on the economy. The FEVD of our model also proves that the exchange rate supported inflation persistence in the long term, likely because of a pass-through effect on import prices that worsened the negative supply shock.

Our IRFs and FEVD proved the existence of high inflation persistence inside the economy. While mainly due to its intrinsic persistence, we showed that it was also due to the external shocks created by the sanctions, namely PPI growth. Like inflation, its persistence was largely structurally driven by external supply shocks and geopolitical tensions. The long-term effects of both of these limited the ability of the monetary policy to efficiently lower inflation.

The findings of this thesis support the idea that, in our modern world, geopolitical tensions across the globe can affect the economy significantly. Geopolitical risk, represented in this study by the GPR index, is correlated with higher inflation. This increase passes principally by supply disruptions, an increase in the cost of goods and an increased uncertainty. If geopolitical

tensions persist, they increase the persistence of shocks and damper the effectiveness of the central bank's deflationary measures.

The crisis brought about by the war is proof that geopolitics can influence the monetary policies of a central bank. When the tensions rose and resulted in the sanctions that, in turn, added inflation into the economy, the ECB had to adapt its policy by tightening it. As such, effectively tracking geopolitical risks and considering their multifaceted effects on inflation and the economy of the EU might prove important to policymakers. A higher geopolitical risk might lead to not only an increase in inflation but also an increase in its persistence. Incorporating a measure of this risk in forecasting models could give some beneficial insights.

However, as discussed previously, we must acknowledge the shortcomings of the GPR index used in this thesis. It is tailored not for the EU but for English-speaking countries, mainly the US. Its focus on the English language and its intrinsic non-European view prevent it from accurately perceiving the risks specifically associated with the euro-area. While the use of a dummy was an acceptable solution in the context of this study, the creation of a geopolitical risk index tailored to the EU would certainly increase its forecasting capabilities for the Euro-zone.

9. Annexes

9.1 Bibliography

9.1.1 Research Articles:

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9.2 Data Sources

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- Exchange rate (Euro/Swiss franc): https://data.ecb.europa.eu/data/datasets/EXR/EXR.D.CHF.EUR.SP00.A
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- HICP – Overall index: https://data.ecb.europa.eu/data/datasets/ICP/ICP.M.U2.Y.000000.3.INX
- Euro area - HICP Inflation forecast: https://data.ecb.europa.eu/data/datasets/SPF/SPF.M.U2.HICP.POINT.P12M.Q.AVG
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- Crude Oil Prices (Brent – Europe): https://fred.stlouisfed.org/series/MCOILBRENTEU
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- ECB Deposit Facility Rate: https://fred.stlouisfed.org/series/ECBDFR
- ECB: Marginal Lending Facility Rate: https://fred.stlouisfed.org/series/ECBMLFR

9.3 Additional data and graphs:

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10. Appendixes

10.1

Figure 1: Inflation for All-item HICP from 2018 to 2024 (monthly)

Figure 2: GDP volume growth in the euro-area from 2010 to 2024 (quarterly)

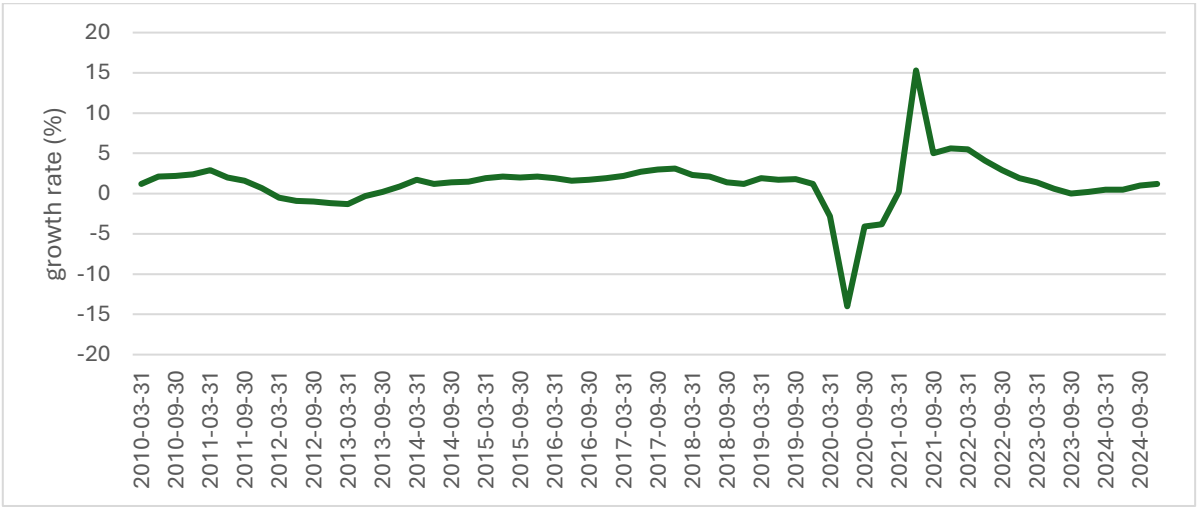


Figure 3: EURO STOXX Banks Index, 2015 to 2025

Figure 8: Energy related inflation from 2018 to 2024 (monthly)

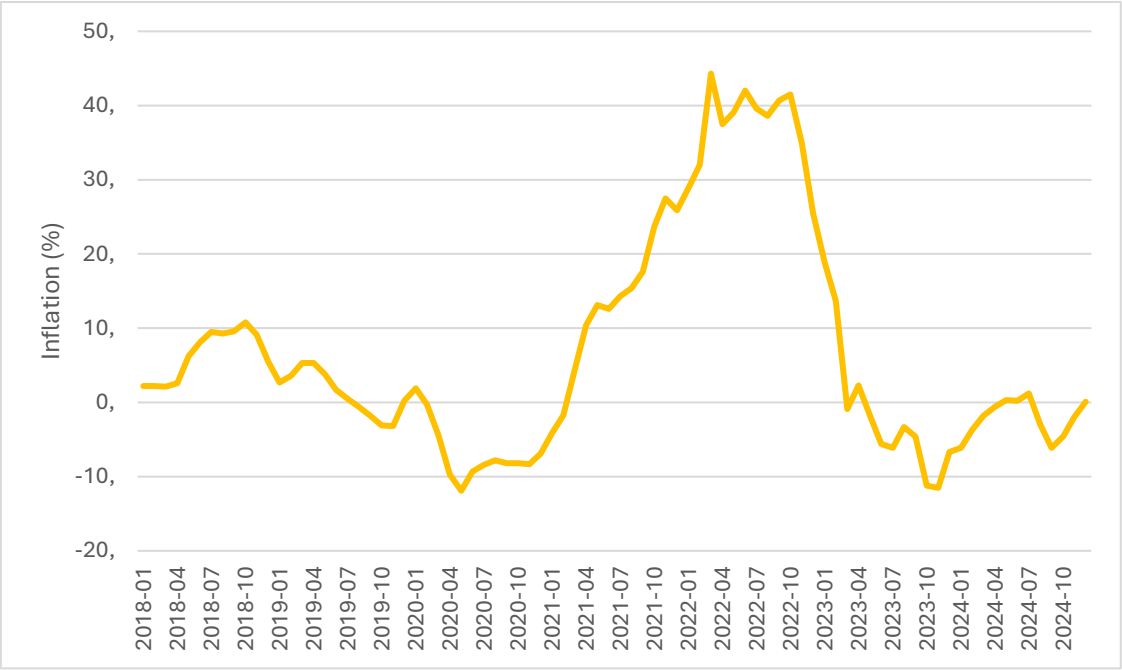


Figure 9: Oil price in the EU from 2018 to 2024

Figure 10: Gas price in the EU from 2018 to 2024 (monthly)

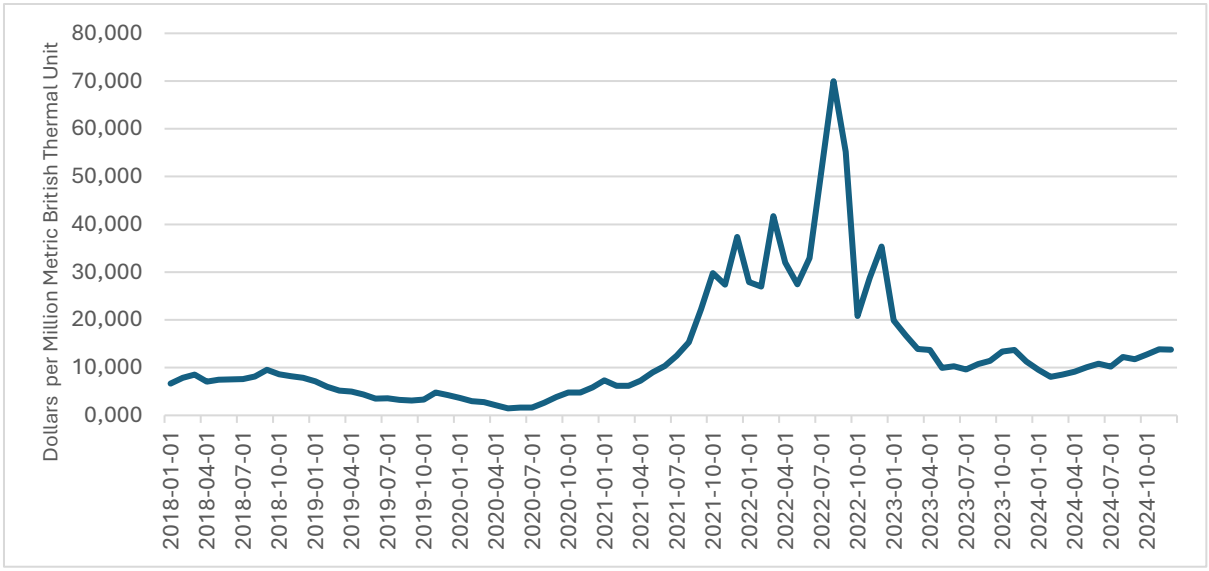


Figure 11: Goods and services inflation components from 2010 to 2024 (monthly)

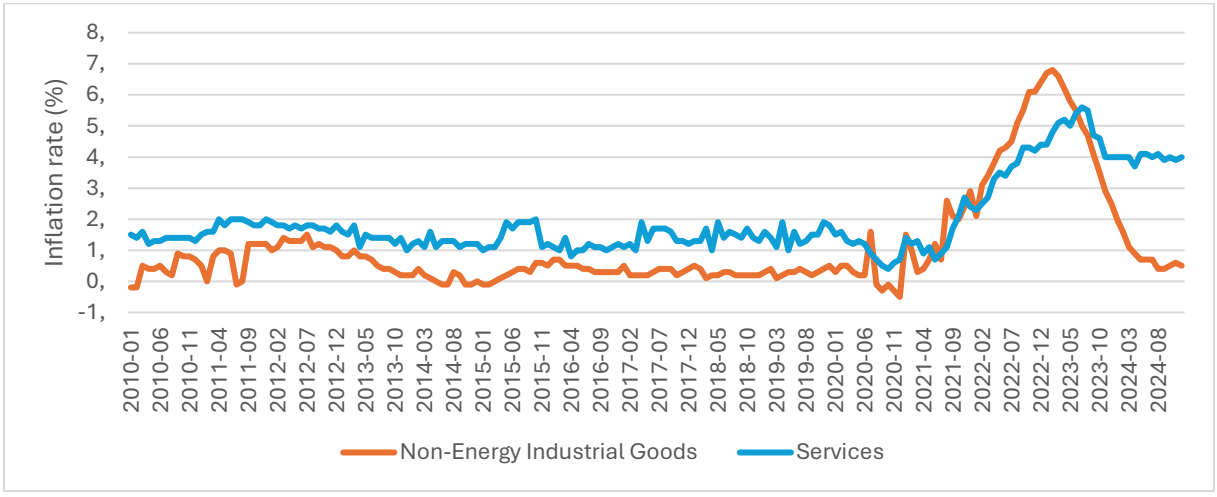


Figure 12: Producer Price Index (PPI) from 2015 to 2024 (monthly)

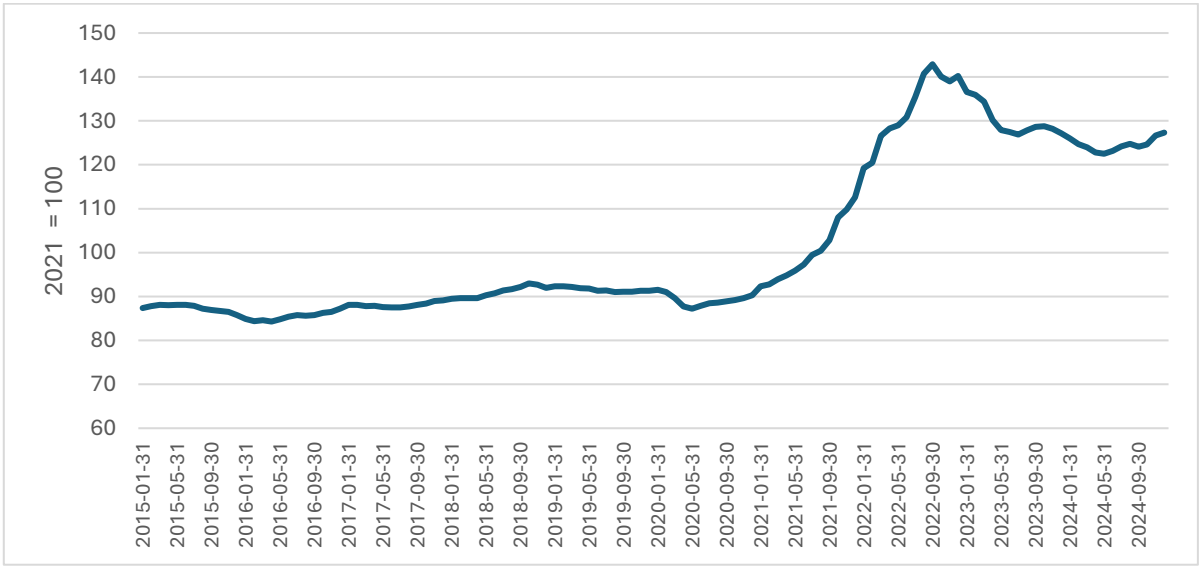


Figure 13: Euro STOXX 50 Equity Index from 2015 to 2024 (monthly)

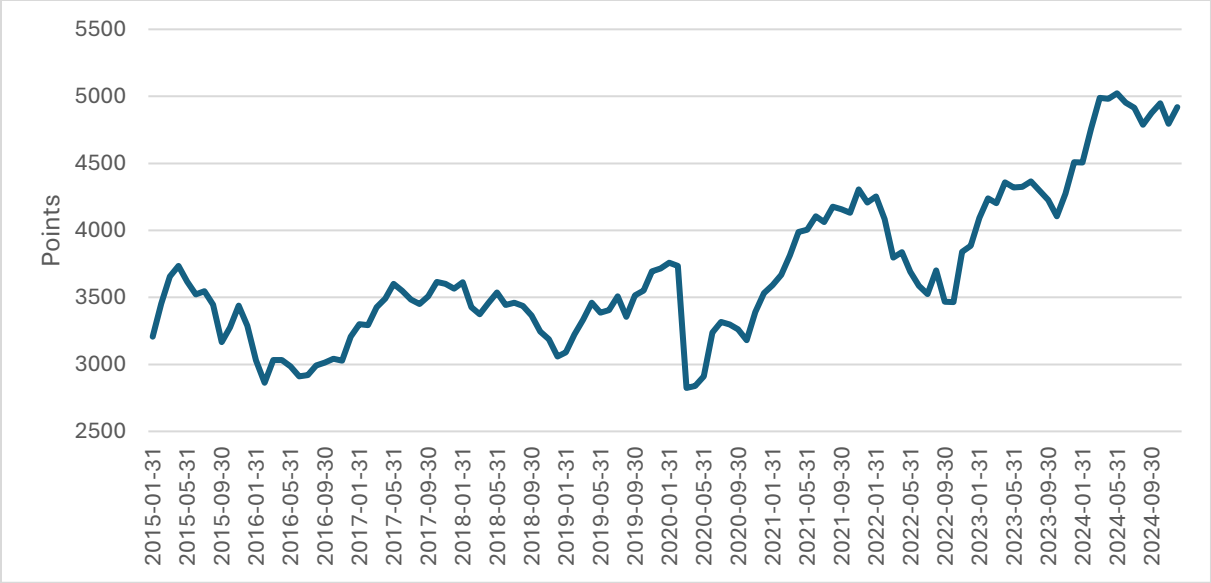


Figure 14: Euro to Swiss franc exchange rate from 2018 to 2024 (monthly)

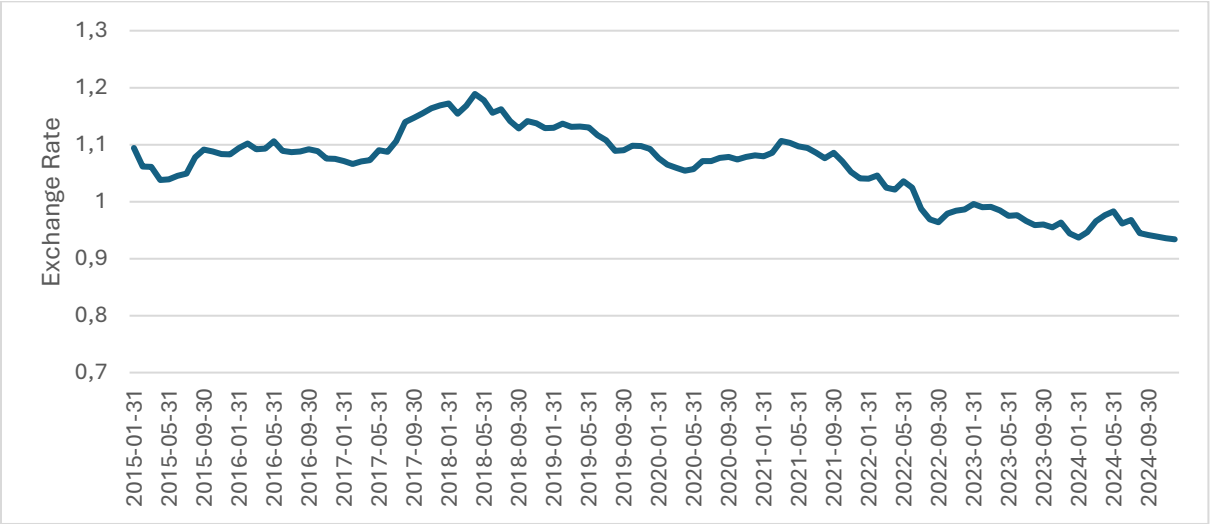


Figure 15: Inflation for All-item HICP & its components from 2021 to 2024 (monthly)

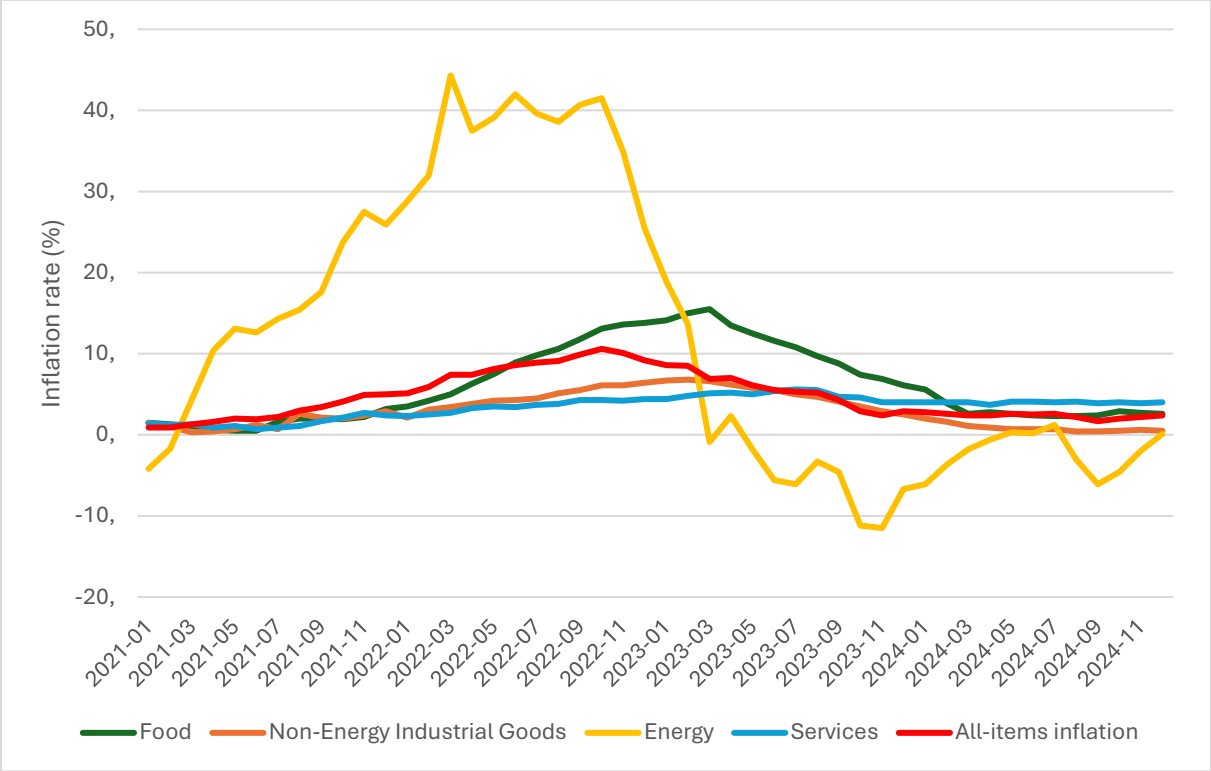


Figure 16: Inflation expectations and actual inflation in the Euro area from 2015 to 2025 (quarterly)

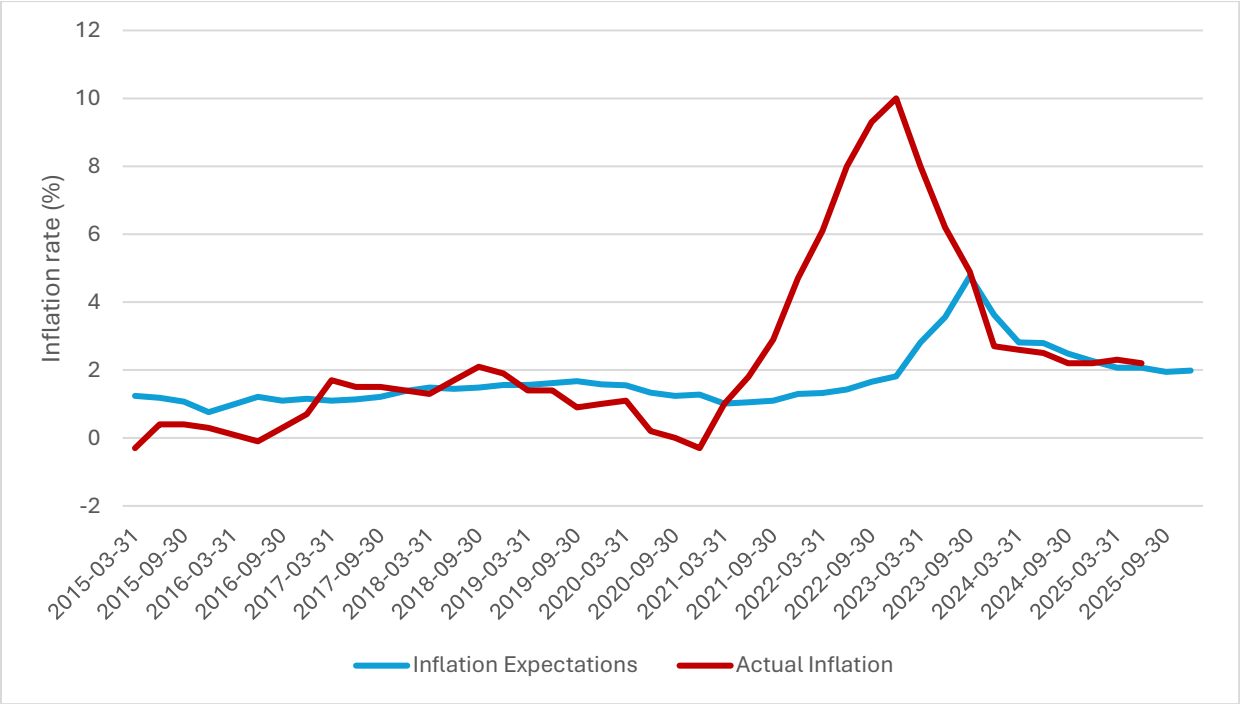


Figure 18: ECB key interest rates from 2010 to 2024 (monthly)

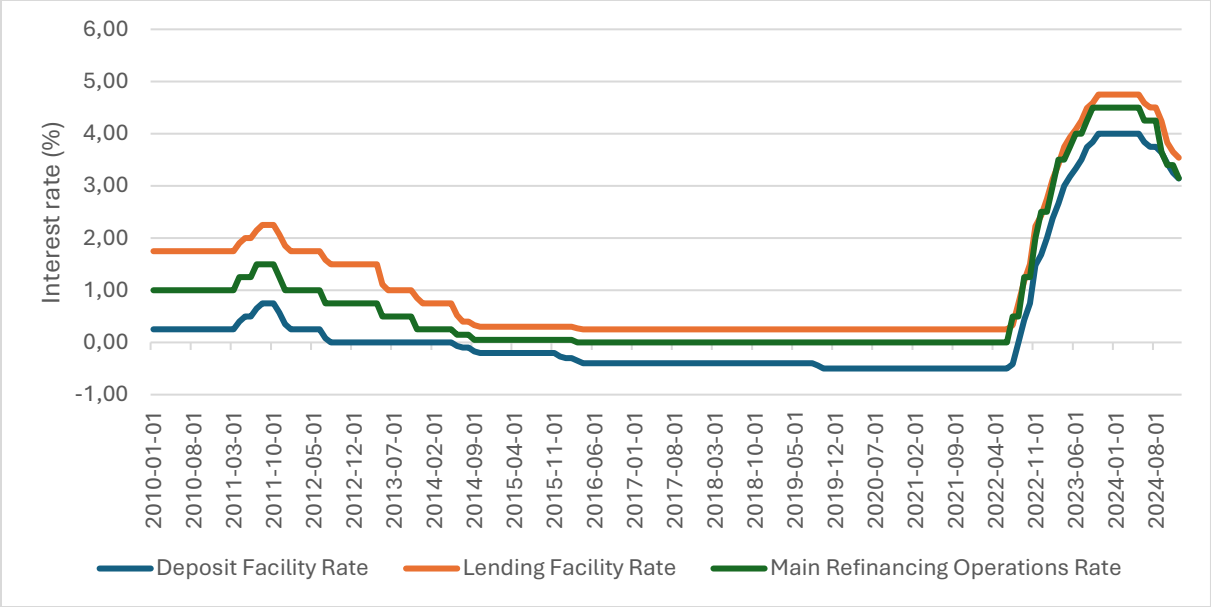
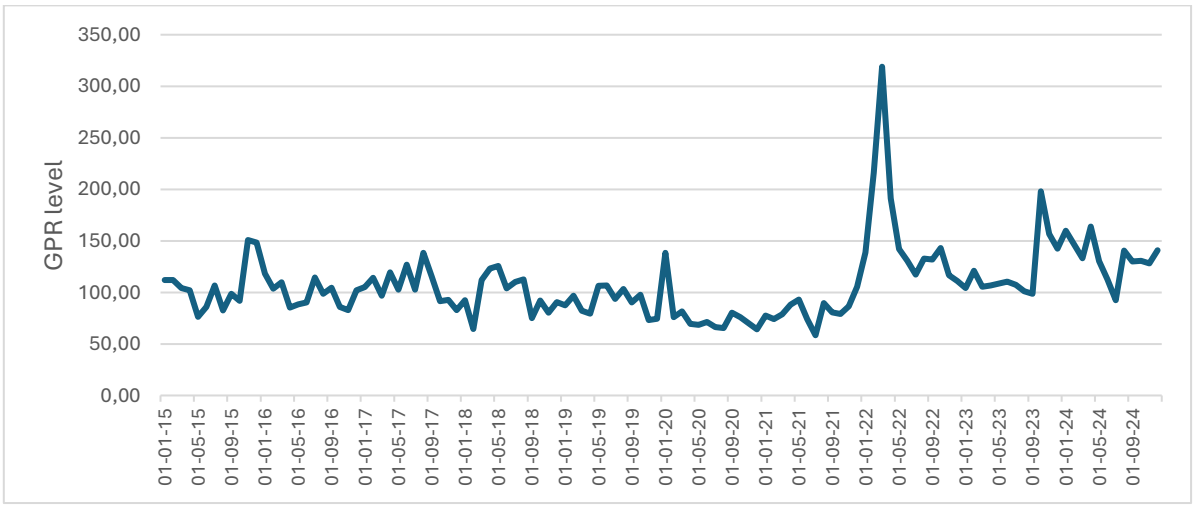


Figure 19: Geopolitical Risk Index (GPR) level from 2015 to 2024 (monthly)



10.2 Trade with Russia – Eurostat

Figure 4: Volume of gas imported by the EU in billion cubic meters:

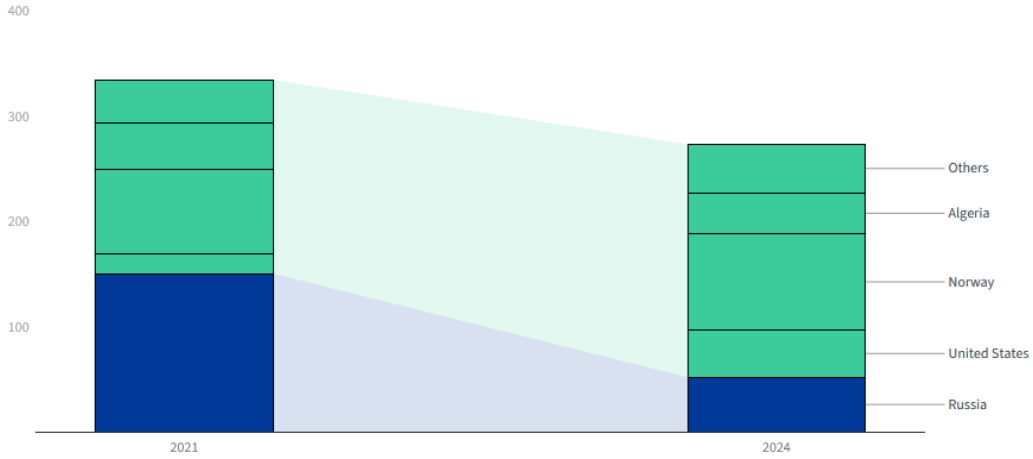
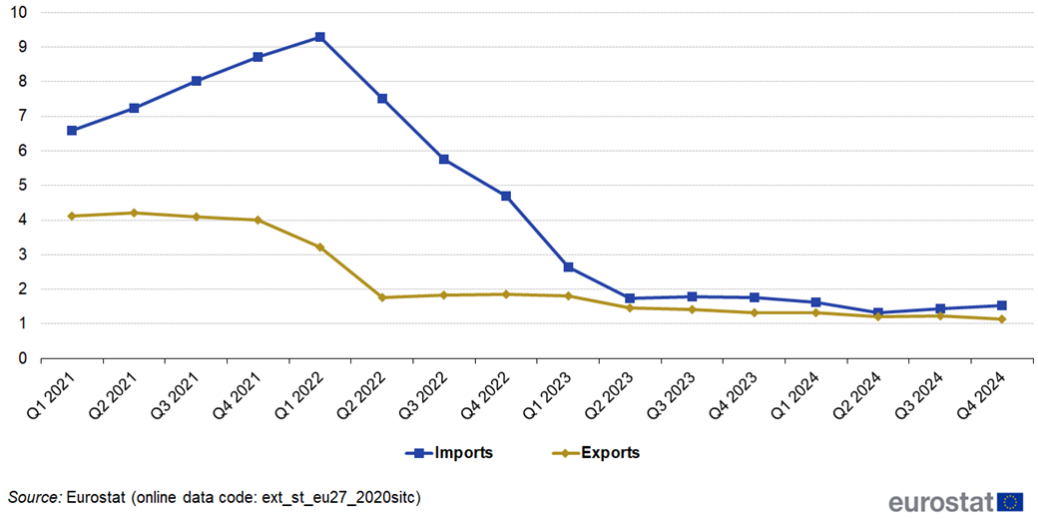


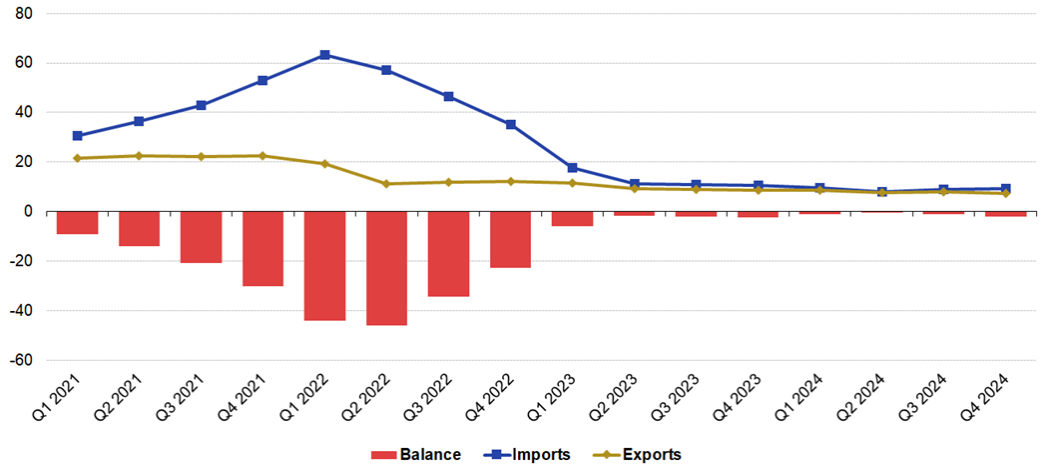
Figure 5: EU trade in goods with Russia, Q1 2021 to Q4 2024 (% share in extra-EU trade, seasonally adjusted)



Source: Eurostat (online data code: ext_st_eu27_2020sitc)

eurostat

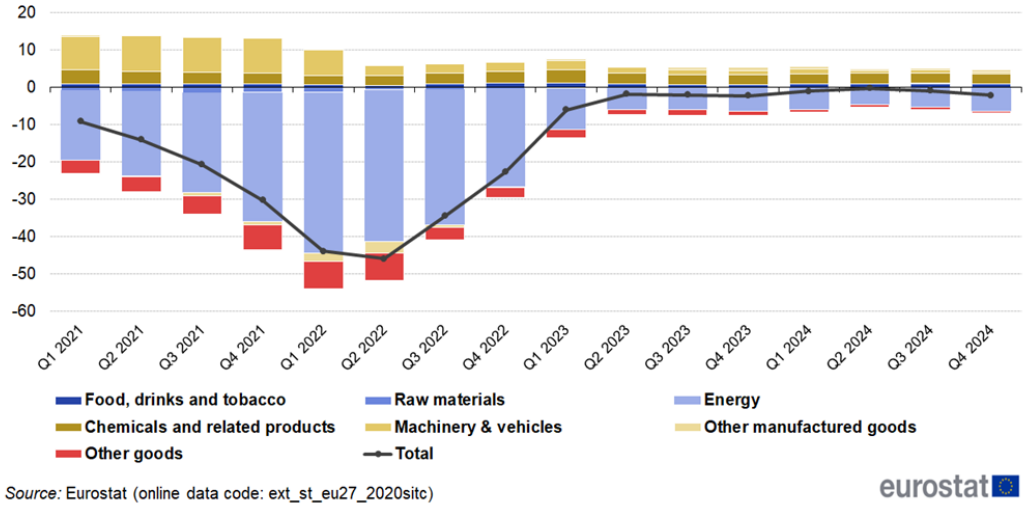
Figure 6: EU trade in goods with Russia, Q1 2021 to Q4 2024 (€ billion, seasonally adjusted)



Source: Eurostat (online data code: ext_st_eu27_2020sitc)

eurostat

Figure 7: EU-Russia trade balance by product group, Q1 2021 to Q4 2024 (€ billion)



Source: Eurostat (online data code: ext_st_eu27_2020sitc)

10.2 Phillips Curve models

10.2.1 Classic PC model

Table 1: OLS regression results for the classic EAPC model

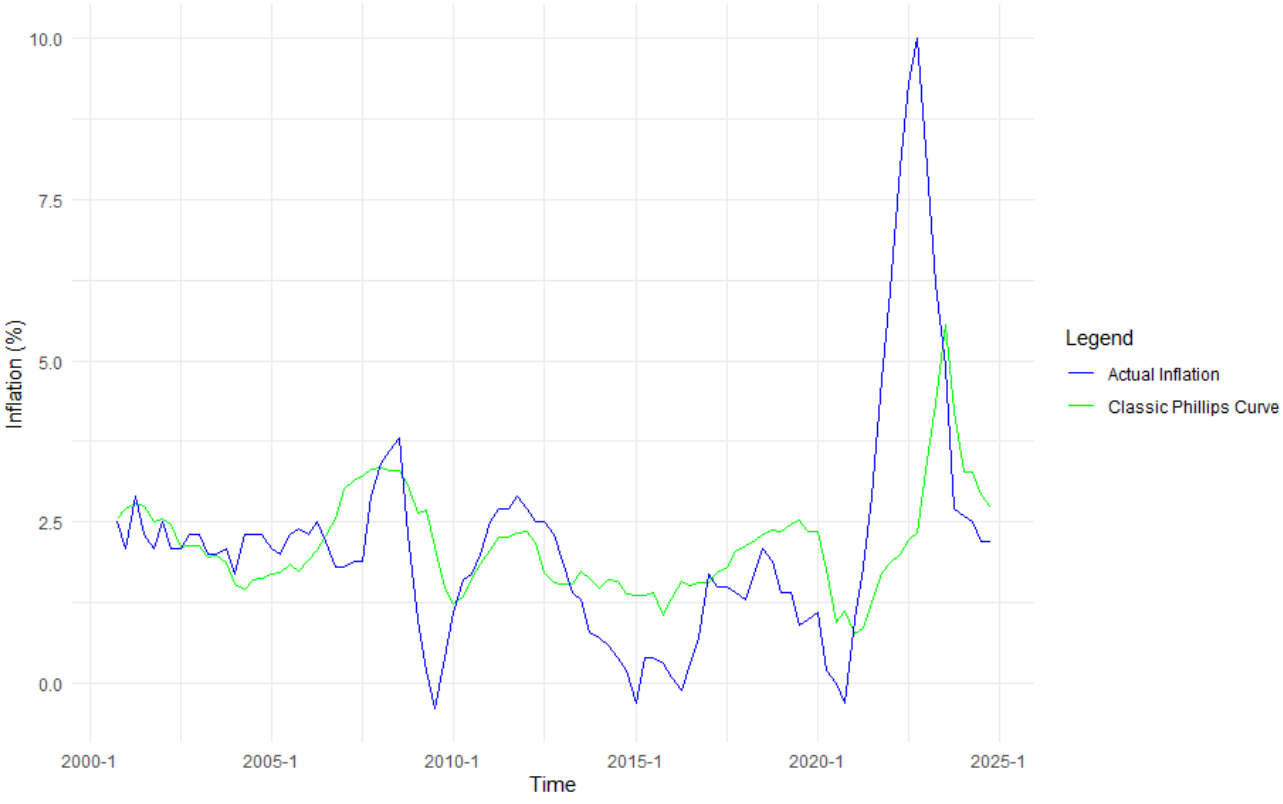
```
Call:
lm(formula = Inflation ~ Infl_Expect + Un_Gap, data = Data)

Residuals:
    Min      1Q  Median      3Q     Max
-2.5046 -0.9385 -0.2112  0.3522  7.6575

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.2226     0.5478   0.406 0.685454
Infl_Expect   1.1176     0.3041   3.675 0.000396 ***
Un_Gap       -0.7463     0.3336  -2.237 0.027637 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.68 on 94 degrees of freedom
Multiple R-squared:  0.1808,    Adjusted R-squared:  0.1634
F-statistic: 10.37 on 2 and 94 DF,  p-value: 8.49e-05
```

Figure 20: Classic PC versus actual inflation



10.2.2 Augmented PC model suffering from a structural break

Table 2: OLS regression results for the augmented PC model suffering from a structural break

```
Call:
lm(formula = Inflation ~ Infl_Expect + Un_Gap + PGas_grwthL1 +
    PPI_grwthL2, data = Data)

Residuals:
    Min      1Q  Median      3Q     Max
-2.9683 -0.4557  0.0530  0.4318  3.4837

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -1.351833   0.284041  -4.759 7.19e-06 ***
Infl_Expect   1.787496   0.155329  11.508  < 2e-16 ***
Un_Gap       -0.077584   0.165089  -0.470  0.63950
PGas_grwthL1  0.011222   0.003861   2.906  0.00458 **
PPI_grwthL2   0.671152   0.040493  16.574  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8084 on 92 degrees of freedom
Multiple R-squared:  0.8144,    Adjusted R-squared:  0.8063
F-statistic: 100.9 on 4 and 92 DF,  p-value: < 2.2e-16
```

10.2.3 Augmented PC model from 2000 to 2022 — no structural break

Table 3: OLS regression results for the augmented PC model from 2000 to 2022

```
Call:
lm(formula = Inflation ~ Infl_Expect + Un_Gap + PGas_grwthL1 +
    PPI_grwthL2, data = Data)

Residuals:
    Min      1Q  Median      3Q     Max
-2.6308 -0.4294  0.0354  0.3901  3.4634

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.368825   0.432270  -0.853  0.39596
Infl_Expect   1.132407   0.266948   4.242 5.67e-05 ***
Un_Gap       -0.128370   0.159801  -0.803  0.42406
PGas_grwthL1  0.011652   0.004372   2.665  0.00923 **
PPI_grwthL2   0.703630   0.047417  14.839  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7654 on 84 degrees of freedom
Multiple R-squared:  0.8128,    Adjusted R-squared:  0.8038
F-statistic: 91.16 on 4 and 84 DF,  p-value: < 2.2e-16
```

10.2.4 Augmented PC model — Dummy23

Table 4: OLS regression results for the augmented PC model

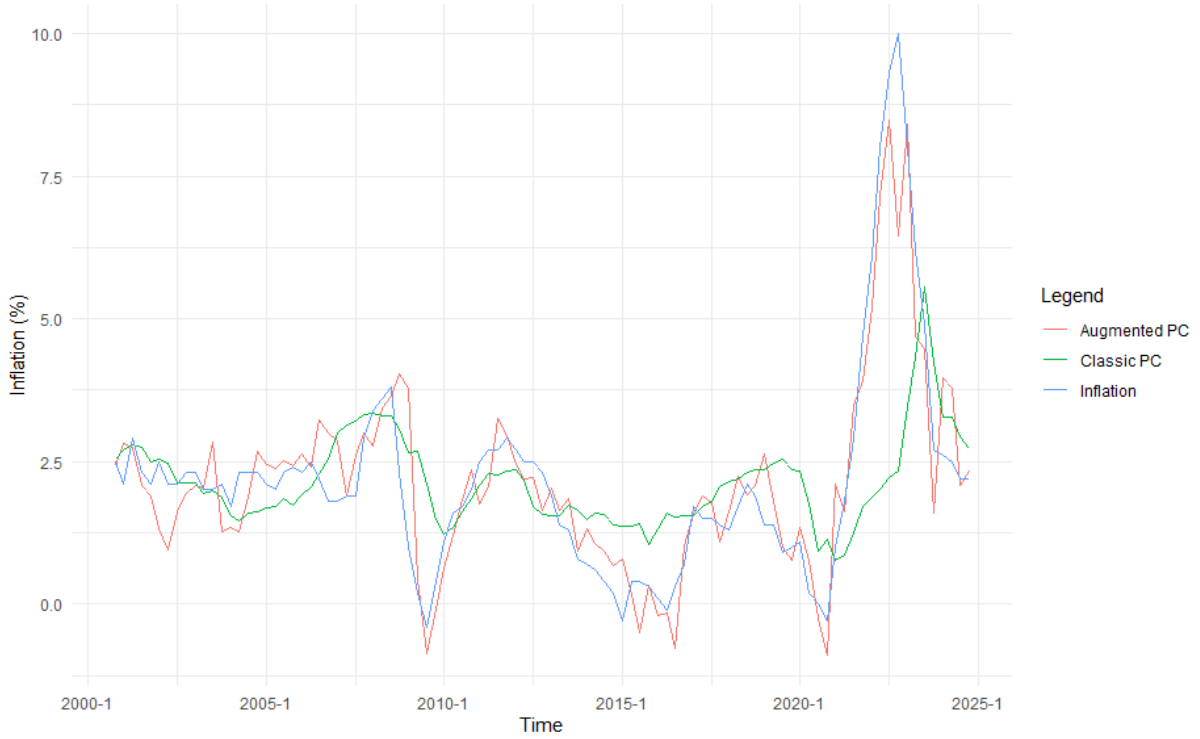
```
Call:
lm(formula = Inflation ~ Infl_Expect + Un_Gap + PGas_grwthL1 +
    PPI_grwthL2 + Dummy23, data = Data)

Residuals:
    Min      1Q  Median      3Q     Max
-2.7769 -0.3872  0.0092  0.3857  3.5358

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.889558   0.373322  -2.383  0.01926 *
Infl_Expect   1.475278   0.226354   6.518 3.89e-09 ***
Un_Gap       -0.123739   0.164731  -0.751  0.45450
PGas_grwthL1  0.011827   0.003823   3.093  0.00263 **
PPI_grwthL2   0.672131   0.039955  16.822  < 2e-16 ***
Dummy23       0.856746   0.457118   1.874  0.06411 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.7976 on 91 degrees of freedom
Multiple R-squared:  0.8213,    Adjusted R-squared:  0.8115
F-statistic: 83.64 on 5 and 91 DF,  p-value: < 2.2e-16
```

Figure 21: Augmented PC versus actual inflation



10.2.5 EAPC model with GPR index

Table 5: OLS regression results for the EAPC model with GPR index dummy

```
Call:
lm(formula = Inflation ~ Infl_Expect + Un_Gap + GPR_dum_QoQ,
    data = Data)

Residuals:
    Min      1Q  Median      3Q     Max
-2.9076 -1.0445  0.0989  0.8153  5.8984

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.07377    0.50073   0.147   0.8832
Infl_Expect  0.95095    0.27985   3.398   0.0010 **
Un_Gap      -0.71090    0.30432  -2.336   0.0216 *
GPR_dum_QoQ  0.01857    0.00415   4.474 2.17e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.532 on 93 degrees of freedom
Multiple R-squared:  0.3259,    Adjusted R-squared:  0.3042
F-statistic: 14.99 on 3 and 93 DF,  p-value: 4.9e-08
```

10.2.6 EAPC model with GPR index from 2021 to 2024

Table 6: OLS regression results for the EAPC model with GPR index dummy from 2021 to 2024

```
Call:
lm(formula = Inflation ~ Infl_Expect + Un_Gap + GPR_dum_QoQ,
    data = Data)

Residuals:
    Min      1Q  Median      3Q     Max
-3.5781 -1.2329 -0.4823  0.8803  5.7749

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.793934   0.738826  -1.075 0.288998
Infl_Expect  0.828222   0.400766   2.067 0.045288 *
Un_Gap      -1.175294   0.787075  -1.493 0.143220
GPR_dum_QoQ  0.031219   0.007733   4.037 0.000238 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.025 on 40 degrees of freedom
Multiple R-squared:  0.4412,    Adjusted R-squared:  0.3993
F-statistic: 10.53 on 3 and 40 DF,  p-value: 3.092e-05
```

10.2.7 Final augmented PC model — GPR interactions

Table 7: OLS regression results for the Final augmented PC model

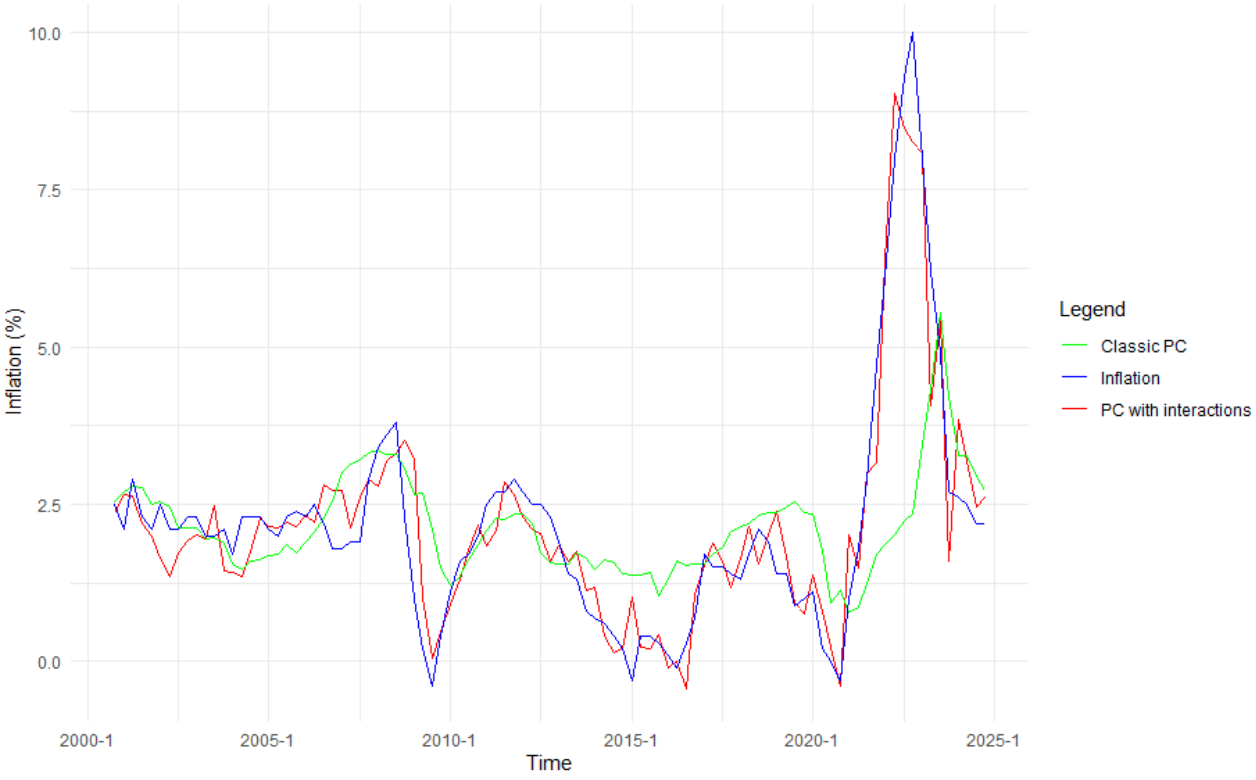
```
Call:
lm(formula = Inflation ~ Infl_Expect + Un_Gap + PGas_grwthL1 +
    PPI_grwthL2 + GPR_dum_QoQ + PGas_grwthL1:GPR_dum_QoQ + PPI_grwthL2:GPR_dum_QoQ +
    Dummy23, data = Data)

Residuals:
     Min       1Q   Median       3Q      Max
-2.23075 -0.34148  0.00492  0.28906  2.14422

Coefficients:
                           Estimate Std. Error t value Pr(>|t|)
(Intercept)              -2.369e-01  3.901e-01  -0.607  0.54518
Infl_Expect               1.154e+00  2.228e-01   5.180 1.39e-06 ***
Un_Gap                   -2.749e-01  1.427e-01  -1.927  0.05718 .
PGas_grwthL1              7.952e-03  5.093e-03   1.561  0.12205
PPI_grwthL2               4.389e-01  7.014e-02   6.257 1.38e-08 ***
GPR_dum_QoQ              -7.750e-03  3.341e-03  -2.320  0.02266 *
Dummy23                   1.861e+00  5.770e-01   3.225  0.00177 **
PGas_grwthL1:GPR_dum_QoQ  1.953e-04  7.137e-05   2.737  0.00751 **
PPI_grwthL2:GPR_dum_QoQ   3.340e-03  7.451e-04   4.483 2.21e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6713 on 88 degrees of freedom
Multiple R-squared:  0.8776,    Adjusted R-squared:  0.8664
F-statistic: 78.84 on 8 and 88 DF,  p-value: < 2.2e-16
```

Figure 22: Augmented PC with GPR interaction versus actual inflation



10.3 Bayesian SVAR model results

10.3.1 IRFs

Figure 23: IRFs of inflation

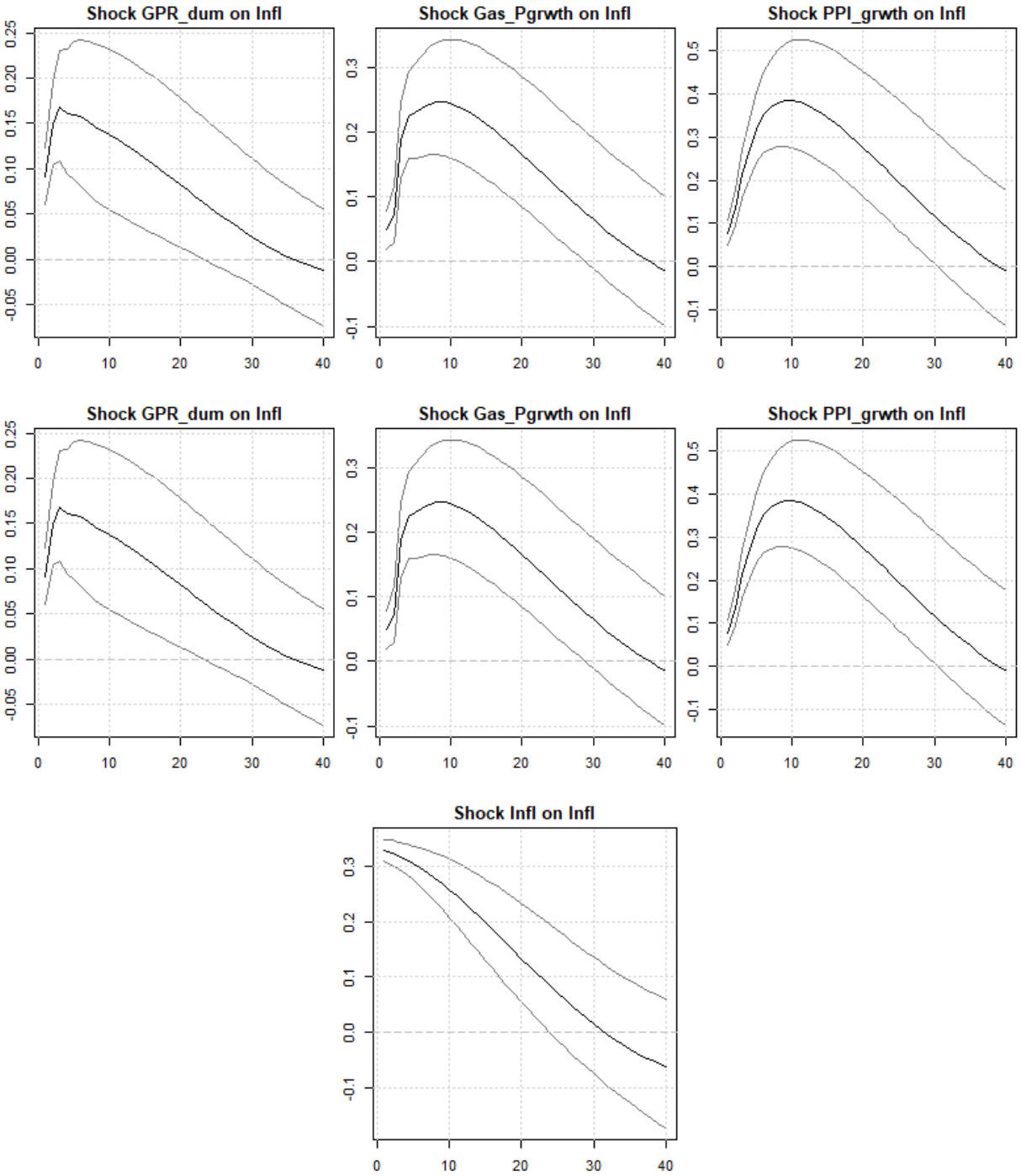
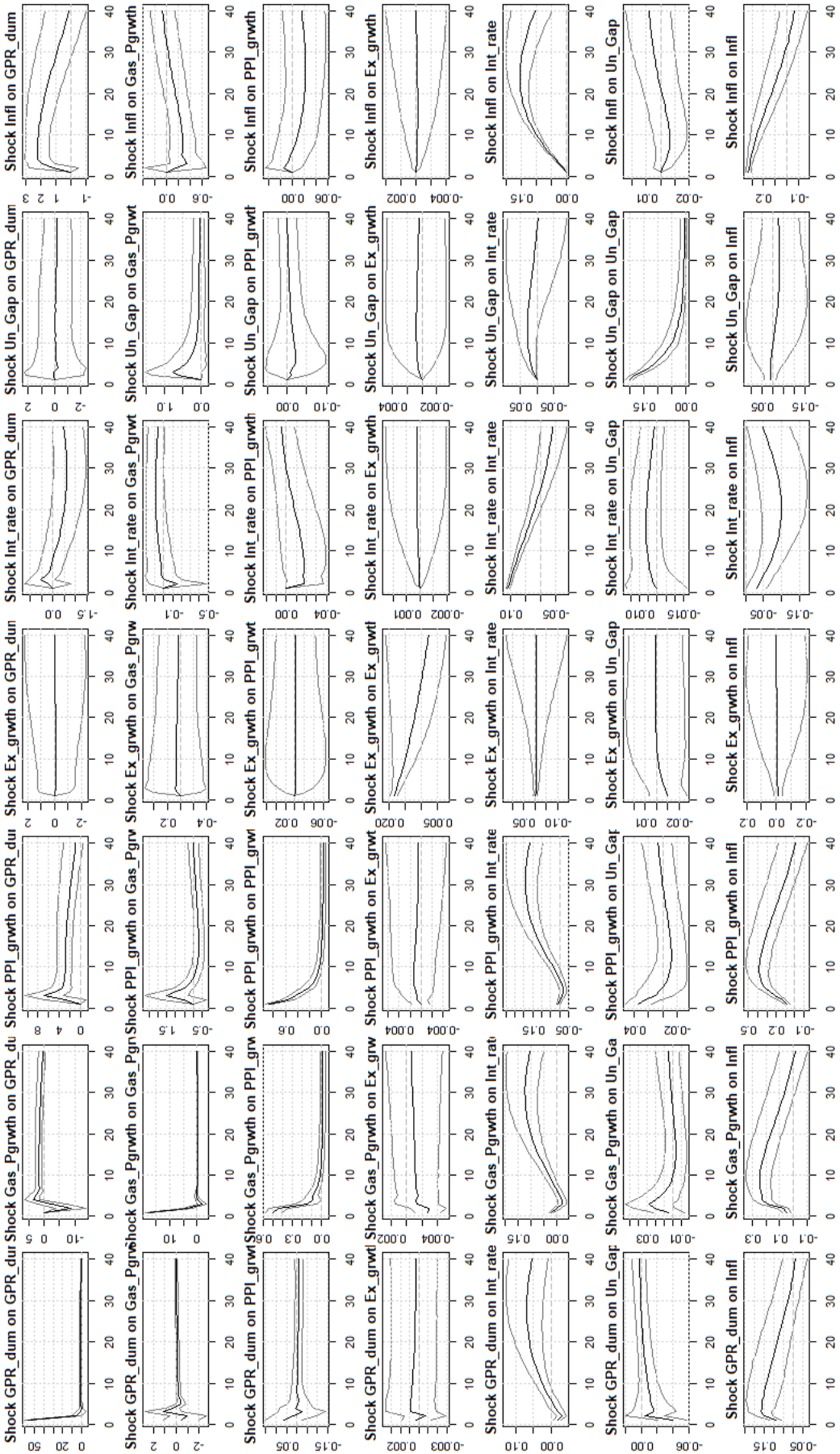


Figure 25: Full IRFs of the Bayesian SVAR



10.3.2 FEVDs

Figure 24: FEVD of inflation

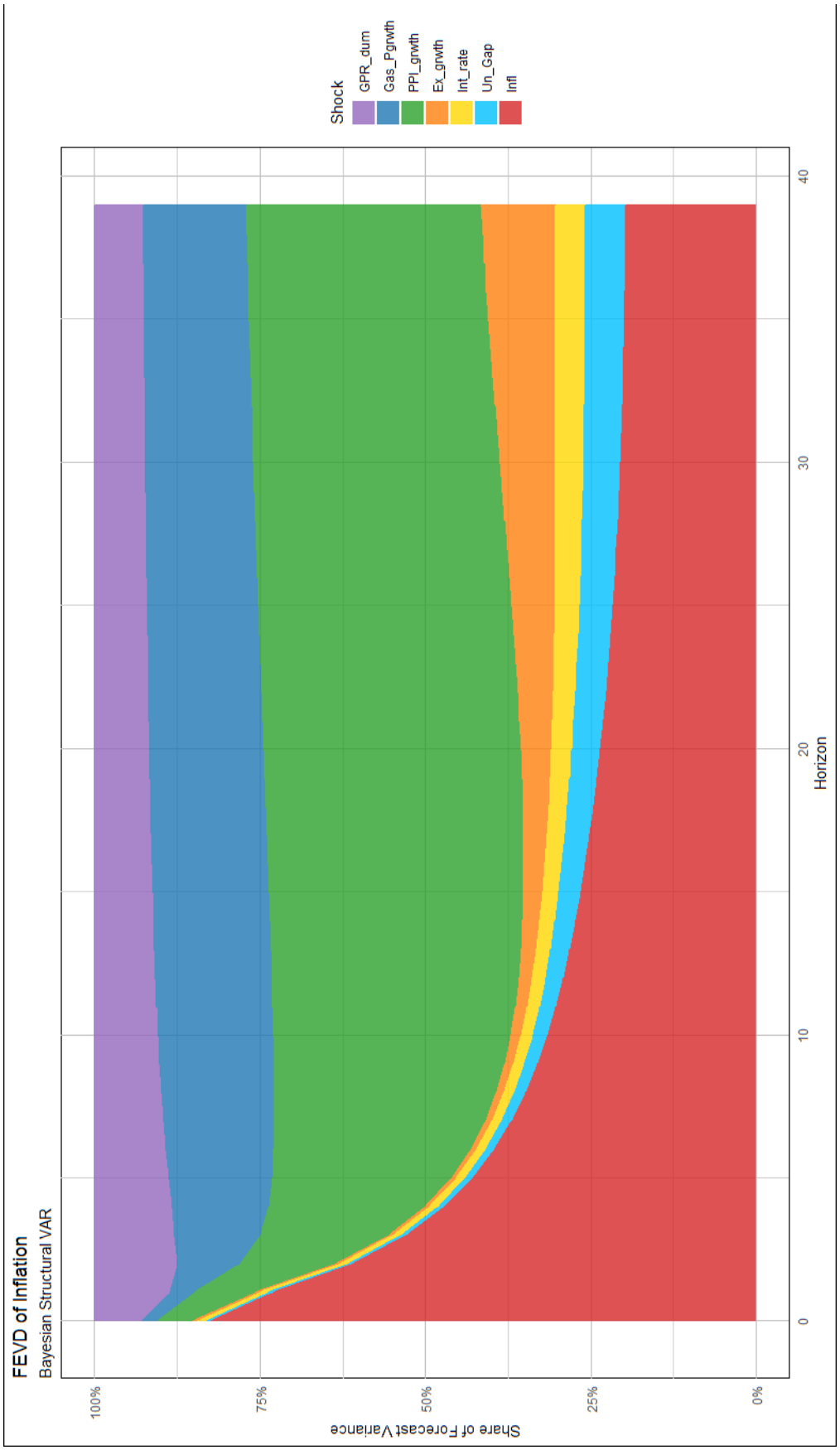
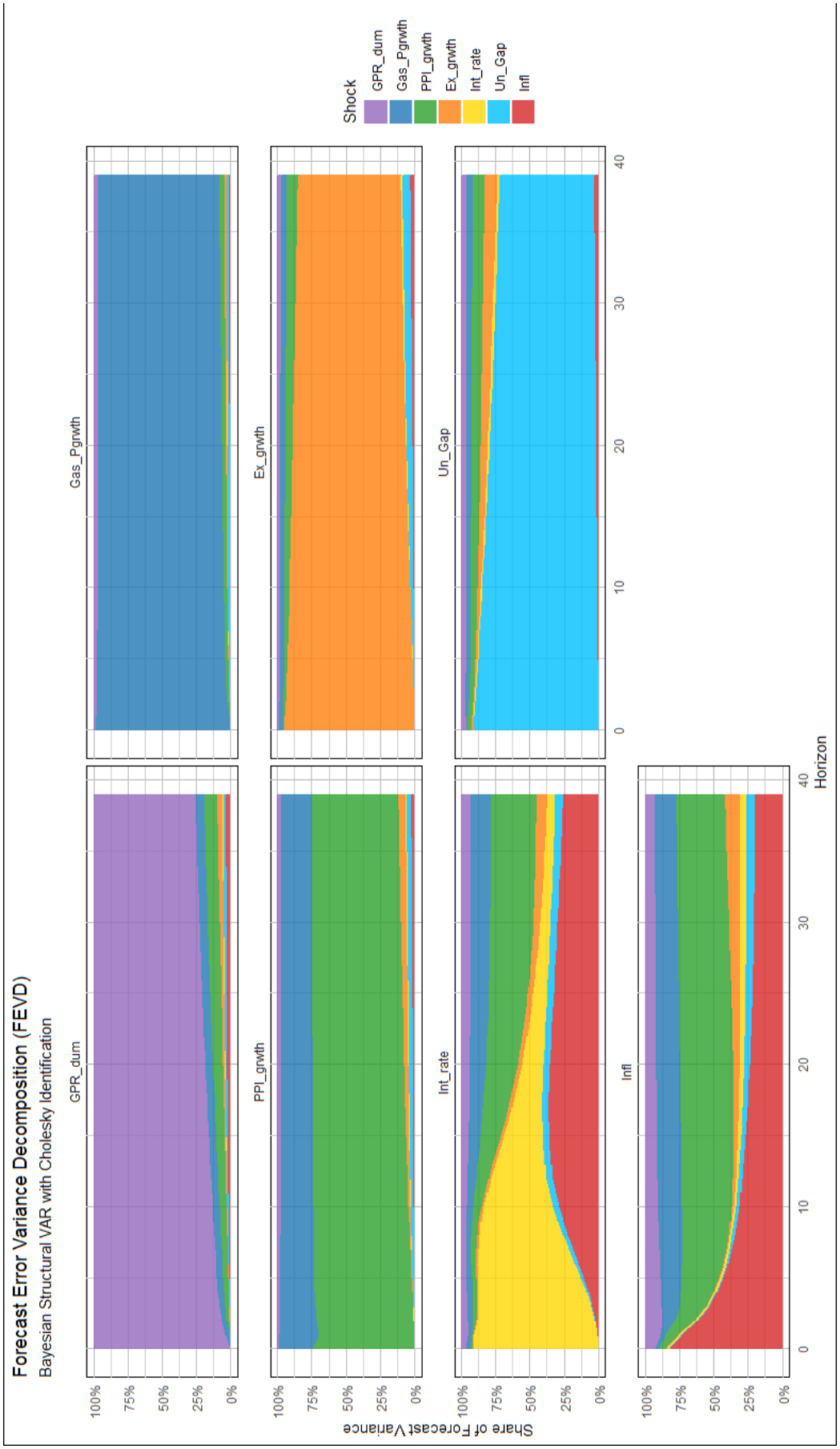


Figure 26: Full FEVD



10.4 Additional illustrations

Figure 17: ECB's role in the sanctions