Resources Policy 107 (2025) 105667

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Oil price swings and inflationary echoes: The impact of oil market shocks on consumer and producer prices in Europe and the U.S.

Joana Gago, Sofia Vale *

Iscte-Instituto Universitário de Lisboa, Edifício Iscte, Av das Forças Armadas, 40, 1649-026, Lisbon, Portugal

ARTICLE INFO

JEL classification:
E31
Q41
Q43

Keywords:
Inflation
Oil price volatility
Supply shocks
Demand shocks
SVAR

ABSTRACT

This paper empirically investigates the impact of oil price fluctuations on inflation in France, Germany, Portugal, and the United States. Employing a Structural Vector Autoregression (SVAR) model, we analyze the effects of oil supply shocks, global aggregate demand shocks, and oil-specific demand shocks on headline and core inflation as well as the Producer Price Index. Our findings indicate that oil market shocks have non-persistent inflationary effects, with producer prices showing greater volatility compared to consumer prices. The most significant effects stem from oil-specific demand shocks. The study highlights the need for central banks to consider various inflation metrics and the adoption of renewable energies to mitigate the instability caused by oil price swings. The response of each economy to the shocks differs from consumer price and producer price perspectives, revealing the importance of analyzing distinct economic realities and using different inflation measures for more robust conclusions.

1. Introduction

In the aftermath of the global pandemic, the world witnessed a dramatic surge in oil prices, a result of complex factors including supply chain disruptions and rebounding demand. From 2022 onwards, the geopolitical context from the Russia-Ukraine conflict exacerbated the rise in oil prices from disruptions in energy supply, sending prices even higher. To avoid economic instability caused by escalating inflation, the Federal Reserve System (FRED) and the European Central Bank (ECB) opted for successive increases in interest rates.

The role that energy prices have played in increasing inflation is one contentious issue. If there are phases in which the oil price is a strong driver of the price level, there are others in which this relationship becomes weak (Castillo et al., 2020). Since 2002, oil prices have had little impact on inflation due to monetary policy's strong reaction to expected inflation.

Another controversial issue in recent literature is the relative importance of demand and supply effects on inflation. Kilian (2008a, 2008b, 2009), focusing on the United States, identified different sources of oil price shocks – supply shocks, demand shocks due to global business cycles, and precautionary demand shocks driven by future supply constraints, – concluding that demand-driven oil price increases, mainly pushed by growth in emerging markets, have more pronounced effects than those caused by supply disruptions. In the same line, Baumeister and Peersman (2013) and Caldara et al. (2019) concluded that demand shocks were more influential in driving oil prices and inflation than supply shocks. Nevertheless, Kilian's emphasis on demand shocks has been challenged by Hamilton (2021), who argued that energy price increases contribute to inflation more predictably and directly through supply-side disruptions and cost-push effects, rather than solely through global demand shifts. Also, Herrera and Pesavento (2009) questioned Kilian's decomposition approach, suggesting that it might understate the role of supply-side shocks in inflation, challenging Kilian's emphasis on demand as the primary driver.

The purpose of the present paper is to empirically analyze whether oil price fluctuations can significantly influence the general level of prices in the U.S. and three Eurozone countries – France, Germany, and Portugal. This impact is investigated in terms of the magnitude and persistence of headline and core inflation, how these two indices may be correlated, and the effects on the Producer Price Index (PPI). Furthermore, following Kilian (2009), we consider three types of oil price shocks, namely, oil supply shocks from exogenous changes in oil production, global aggregate demand shocks that impact oil demand, and oil-specific demand shocks. The paper tests the dynamic impacts of these shocks on inflation by employing a Structural Vector Autoregressive (SVAR) model and reporting its impulse response functions.

* Corresponding author.
E-mail addresses: Joana_Gago@iscte-iul.pt (J. Gago), sofia.vale@iscte-iul.pt (S. Vale).

https://doi.org/10.1016/j.resourpol.2025.105667
Received 16 December 2024; Received in revised form 12 May 2025; Accepted 24 June 2025
Available online 4 July 2025
0301-4207/

On the one hand, an examination of these issues will enable conclusions to be drawn about the factors that effectively contribute to the fluctuation of oil prices, which, in turn, affects the price of other goods, and all economic activity. On the other hand, a thorough understanding of these explanatory factors can help central banks implement more efficient monetary policies to control and maintain inflation at the expected level.

This paper adds to the literature by making significant contributions to understand how oil prices drive inflation. Firstly, despite the strategy of identifying shocks by Kilian (2009) being common in the analysis of the oil market and inflation, there are not many studies that analyze more recent data in Europe, whose countries are not oil producers, including the economic consequences from the pandemic and the war between Russia and Ukraine, and especially using both inflation indexes, CPI (Consumer Price Index) and PPI. In addition, typically, in these studies the aggregate demand shock is represented by the Index of Global Real Economic Activity (GEA) developed by Kilian (2009). The current analysis initially follows Baumeister and Hamilton (2019, 2021), relying on the World Industrial Production (WIP) index to proxy global real economic activity. This index may be particularly relevant when the objective is to assess the immediate impact of oil price shocks on inflation, as emphasized by Huntington (2018). According to Hamilton (2021) and Kim and Vera (2022), the WIP index tends to produce a stronger positive response of real GDP, supporting its use as a suitable measure of global aggregate demand. However, to assess the robustness of the results, the analysis also incorporates Kilian's (2009) index, which is based on dry cargo shipping rates and reflects global demand for industrial commodities. Thirdly, the producer price perspective is still little explored and valued, and this project serves to clarify the importance that this indicator assumes and how it stands out from the best-known inflation measure, CPI. Since there are some limitations of consumer prices in determining the real price level of an economy, it is important that central banks understand the behavior of different inflation metrics to adopt more effective monetary policies.

The main findings indicate that shocks to the oil market have non-persistent inflationary effects. The stronger stimulus is felt on producer prices, which are demonstrated to be more volatile than consumer prices. In all countries, the stronger effects are those from oil-specific demand shocks, i.e., increases in oil prices. The estimated responses of inflation to oil demand shocks vary across countries depending on the index used. In particular, Baumeister's index yields more intuitive results for Germany, while Kilian's index provides more consistent results for Portugal, highlighting how the choice of global demand proxy can significantly affect the interpretation of oil price shock transmission across different economic contexts.

This work is organized as follows. Section 2 presents the literature review. Next, we describe the empirical strategy, introducing the data and presenting the structural VAR model. Section 4 reports and discusses the model results, distinguishing CPI, and core CPI inflation from PPI inflation. Section 5 presents models estimations based on the Kilian's index, comparing them to the previous ones. The conclusion is presented in Section 6.

2. Literature review

Crude oil prices are critical for the production and transportation of many goods and services (LeBlanc and Chinn, 2004), affecting the cyclical variations of inflation (Garzon and Hierro, 2022). In addition, oil price variability affects inflation indirectly, due to its influence on inflation expectations or when wages are indexed to past inflation (Álvarez et al., 2011). Nevertheless, changes in oil prices seem to have a decreasing impact on inflation over time. Choi et al. (2018) contend that global oil price shocks have a short-run effect on individual domestic inflation, a fact explained by the credibility of monetary policy. Kilian and Zhou (2022), studying U.S. inflation, find that there is no persistent inflationary effect following oil and gasoline price shocks, although there are considerable short-run effects.

Some scholars argue that the positive relationship between oil prices and inflation is not strong. Bachmeier and Cha (2011) show that, from 1973 to 2006, the most significant oil price increase did not cause significant variability in inflation, which remained between 1.2 % and 2.6 %. Castillo et al. (2020) find a positive relationship between oil price changes and inflation just up to 2002. Since then, oil price hikes are no longer driving increases in overall price levels.

Another strand of the literature sustains that oil price fluctuations have a significant impact on headline inflation but no effect on core inflation in the short term. However, there is no evidence that oil prices have a long-term impact on either (Kilian and Zhou, 2022; Hijazine and Al-Assaf, 2022; Choi et al., 2018; Ciner, 2011; Chen and Wen, 2011). According to Kilian and Zhou (2022), gasoline price shocks account for 65 % of changes in headline CPI but only 10 % of fluctuations in core inflation and 51 % of PCE variability, while Kilian and Zhou (2023a) show that gasoline prices do not reflect all the pressures on inflation that originate in the energy sector. Van den Noord and André (2007) emphasize the existence of a significant core inflation response following oil price shocks in the U.S. and the Eurozone. For the European economy, Brief (2022) shows that oil price shocks have a more persistent impact, whereas gas price fluctuations provide more uncertainty and less substitutability, both shocks instantaneously increasing core inflation and input costs. Chen and Wen (2011) argue that, besides energy prices, there is no pass-through of oil prices to the prices of other goods, while Ball et al. (2021) state that the large price changes caused by the COVID-19 pandemic shock induced fluctuations in both headline and core inflation. For Conflitti and Luciani (2019) fluctuations in oil prices are only transmitted to core inflation via their impact on economic activity and the transmission is not significant but persistent. Even though core inflation fluctuates less than headline inflation because it excludes food and energy prices (Hijazine and Al-Assaf, 2022; Bodenstein et al., 2008), there is a correlation between these two indicators (Gamber et al., 2015).

Even if there is consensus that it adds to the literature, less research has focused on the effects of oil prices on inflation captured by PPI, and even less centered on European countries. Husaini and Lean (2021) use PPI and CPI to examine the asymmetric impact of oil prices and exchange rates on price levels, emphasizing how oil prices have a direct impact on the production sectors. This viewpoint is supported by Sek (2023), who notes that, in Malaysia, direct effects on producer costs explain why PPI is more affected than CPI by changes in oil prices.

Other authors have examined how oil demand and supply shocks are potential explanations for oil price fluctuations and, by extension, inflation. For Valcarcel and Wohar (2013), prices were primarily influenced by supply shocks prior to the Great Moderation Period (1980–2007) and demand thereafter. Wen et al. (2021) conclude that, among the G7, oil supply shocks have a greater impact on inflation in the US, France, and Italy. Demand shocks had greater explanatory power during the financial crisis, and supply shocks became more significant before and after that period. In contrast, Kim and Vera (2022) state that oil-specific and aggregate demand shocks have a positive and longer-lasting effect on the US CPI. Garzon and Hierro (2021) contend that oil supply and oil-specific demand shocks have a larger impact on headline inflation than aggregate demand shocks. Oil prices are driven more by demand than supply. Similarly, Baba and Lee (2022) believe that aggregate demand and oil-specific shocks are more important in oil price fluctuations, though these effects vary over time. Hong et al. (2022) claim that oil-specific demand shocks have a greater impact on oil prices than others.

Finally, there is debate over the sensitivity of inflation to oil price shocks across countries. LeBlanc and Chinn (2004) state that, owing to Europe's powerful labor unions and less market competition, European inflation responds more to oil price increases than the US, while Barrell and Pomerantz (2008) show that inflation in the US is more sensitive to changes in oil prices than in the U.K. and Europe given the importance of fuel and its widespread use in the former. Renou-Maissant (2019) agrees that oil has a significant impact on US inflation than in European countries due to higher taxes and less reliance on oil. For Cuñado and de Gracia (2003), given the weakness of the euro, an increase in oil prices in 1999 was expected to have a greater impact in Europe than in the United States, while Brief (2022) argue that the volatility of oil and natural gas prices have a significant impact on European inflation, particularly given its geopolitical situation. Inflation in the U.S. is more sensitive to energy price shocks than in other countries, indicating greater variability and energy intensity (LeBlanc and Chinn, 2004; Van den Noord and André, 2007; Barrell and Pomerantz, 2008; Renou-Maissant, 2019; Wen et al., 2021).

Despite the extensive literature on the subject, there are still gaps to be filled that the current analysis tries to address, as confronting the response of core and headline inflation with that of producer inflation following different type of oil market shocks, namely, oil supply, aggregate demand and oil-specific demand shocks, in the U.S. and Eurozone countries.

3. Empirical strategy

3.1. Data

This study compares three European countries – Germany, France, and Portugal – to the United States. The first two countries are among the world's largest economies and the top crude oil importers in 2019 (Wang et al., 2022), while Portugal has lower economic expression, but is highly dependent on oil imports, experiencing significant price growth during periods of oil inflation. Portugal offers a crucial contrast to the other three, which represent sizable G7 economies with comparatively varied energy strategies. As a small, open, and energy-importing economy within the Euro Area, Portugal has historically shown greater vulnerability to external price shocks while, like Germany and France, it lacks autonomous monetary policy tools. In 2020, Portugal's dependence on energy imports stood at 65.3 percent, close to Germany's (63.7 percent) but much higher than France's (44.5 percent). [1]The U.S., a big economy, differs from the others in that it is an oil producer, and one of the largest. [2] The empirical analysis spans the period 1990M1 to 2025M01 for CPI and core CPI and to 2022M12 for PPI.

The model variables comprise the Global Price of Brent Crude (GBC) in U.S. dollars per barrel to represent oil prices following Álvarez et al. (2011), Baumeister (2023), Bilgin and Ellwanger (2024) and Clerides et al. (2022). An alternative would be to use the refiner's acquisition cost of imported crude oil, which according to, *e.g.*, Herrera et al. (2015) is more appropriate than the price of Brent oil. Our choice is validated by both Kilian and Zhou (2023a), who although using the refiner's acquisition cost of imported crude oil claimed that the Brent price of crude oil could be a suitable substitute (if it did not have the disadvantage of having been in place only since the mid-1980s), and Bilgin and Ellwanger (2024), who found robust results when estimating models using different measures of oil prices. For European countries, this variable is deflated by each country CPI and converted to euros via US dollars to the Natural Currency Spot Exchange Rate. CPI and PPI both measure inflation, with the former analyzed in aggregated and disaggregated forms, i.e., headline inflation and core inflation, or inflation minus food and energy. CPI is the most widely used measure of the general price level, although it only reflects the total amount paid by the consumer, including labor costs and taxes (Donovan, 2015). Producer prices reflect changes in the prices paid by producers for their output, excluding any additional costs included in the final price. Given the limitations of the two indicators, combined analyses produce more robust results. U.S. CPI, GBC, and the exchange rate are obtained from FRED. PPI and CPI data for 2015 are retrieved from the OECD for European countries and FRED for the US.

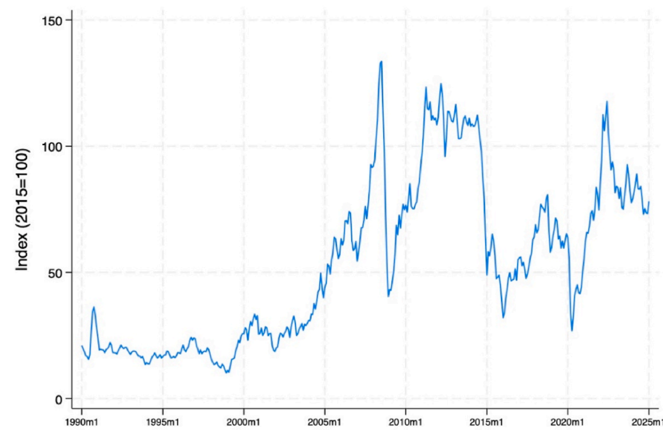


Fig. 1. Global price of brent crude index.
Source: FRED.

Following previous studies (*e.g.,* Kilian, 2009; Garzon and Hierro, 2021; Clerides et al., 2022; Kim and Vera, 2022), three types of oil price shocks are identified, namely oil supply shocks, aggregate demand shocks and oil-specific demand shocks. The variables used to identify these shocks are Crude Oil Production (COP) in the U.S. in thousands of barrels, World Industrial Production Index (WIP) for the OECD and six non-member countries (Brazil, China, India, Indonesia, the Russian Federation, and South Africa), and Global Price of Brent Crude, respectively. COP reflects oil supply bottlenecks and is obtained from the U.S. Energy Information Administration, WIP represents global economic activity and is taken from Baumeister's website.[3] The literature has presented arguments for and against using Baumeister's World Industrial Production Index or Kilian's (2009) Index of Global Real Economic Activity to represent demand shocks, without converging to an agreement on which is more appropriate (Jiménez-Rodríguez, 2022). WIP provides a measure of the physical output of the industrial sector, reflecting tangible changes in production. Its primary drawback, though, is that it only considers industrial production, ignoring services and agriculture, both of which fuel demand shocks. Nevertheless, it has the benefit of covering both emerging and industrialized economies' economic activity (Jiménez-Rodríguez, 2022; Cai, 2025). One benefit of the GEA is that it covers a wider variety of economic activities. Its construction methodology has been identified as a limitation due to the use of proxies, which may introduce normalization issues (Hamilton, 2021). Furthermore, GEA is predicated on shipping freight rates, which are susceptible to influences unrelated to economic activity, such as shifts in the geopolitical environment and interruptions in international supply chains (Cai, 2025). Kim and Vera (2022) demonstrated that demand shocks have a positive impact on the US CPI, regardless of each of these indexes is used in the analysis. Taking this into account, WIP was adopted in the current empirical study, and GEA was used to test the models' robustness. When analyzing European countries, variables expressed in US dollars were converted to euros. All variables were converted into their first differences after having been converted into natural logs.

Figs. 1–5 show the GBC, and the two inflation measures, CPI, and PPI, for the four countries considered in this analysis.

The price of crude oil fluctuated significantly throughout the period, with strong growth beginning in 2005 and lasting until 2008, when it

[1] https://www.statista.com/statistics/1301609/european-union-eu-27-energy-import-dependency-by-country/.

[2] https://www.eia.gov/energyexplained/oil-and-petroleum-products/imports-and-exports.phpUS.

[3] https://sites.google.com/site/cjsbaumeister/datasets.

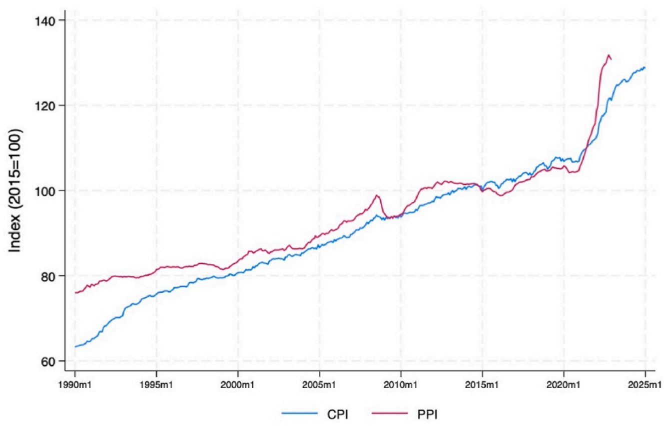


Fig. 2. CPI and PPI, Germany.
Source: OECD.

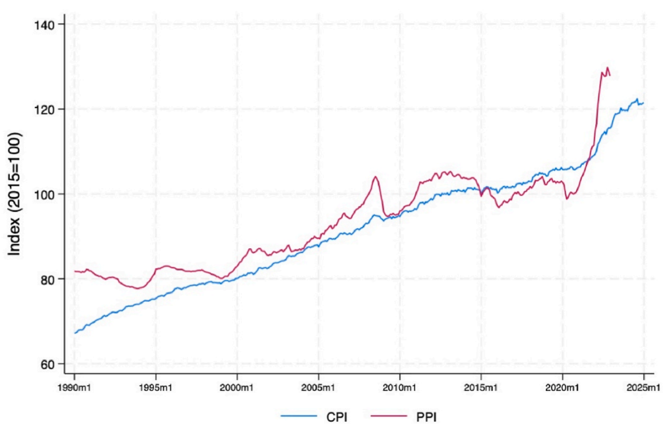


Fig. 3. CPI and PPI, France.
Source: OECD.

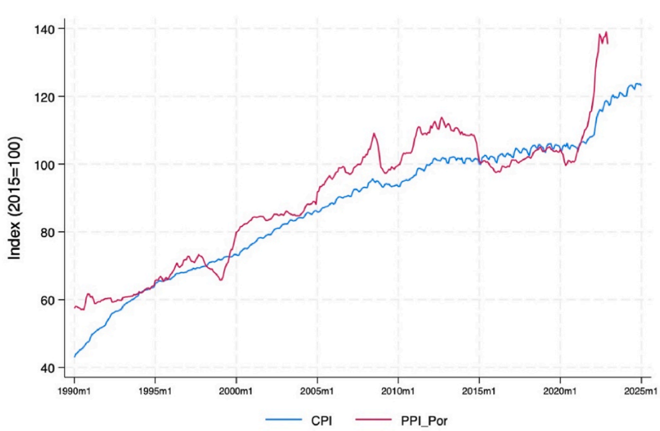


Fig. 4. CPI and PPI, Portugal.
Source: OECD.

reached its peak, followed by a sharp drop caused by the Great Recession of 2008 (see Fig. 1). The same pattern can be seen in inflation indicators in Germany, France and Portugal (Figs. 2–4). CPI and PPI show strong growth in 2008, followed by a sharp decline until 2009. After the crisis,

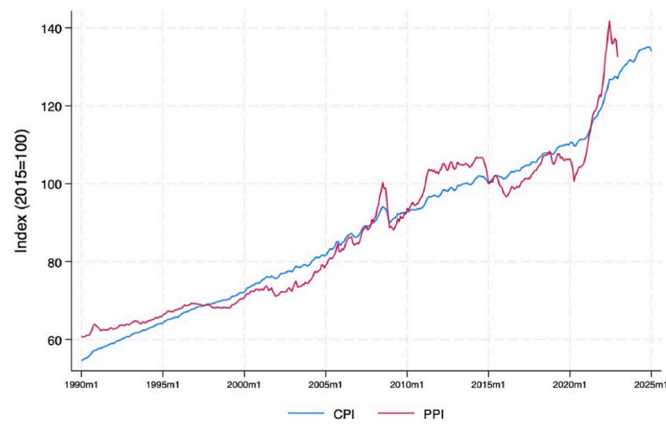


Fig. 5. CPI and PPI, US.
Source: OECD.

Table 1
Variables descriptive statistics.

Variable	Median	Mean	St dev.	Min.	Max.
GBC ($)	51.18	56.39	28.82	14.49	141.93
GBC Germany (€)	43.35	45.40	21.82	10.90	95.78
GBC France (€)	43.04	45.48	22.03	10.96	97.85
GBC Portugal (€)	44.62	47.03	20.48	12.05	96.07
WIP	106.05	103.70	25.89	62.39	147.57
GEA	−5.57	3.18	59.45	−160.84	189.77
COP	200.9	232.5	77.32	119.2	417.0
CPI Germany	89.75	90.58	15.62	62.24	128.95
Core CPI Germany	91.16	91.47	13.82	63.31	124.72
PPI Germany	92.43	92.70	11.38	76.01	131.80
CPI France	90.72	90.67	13.91	66.42	122.46
Core CPI France	91.93	91.13	11.84	67.64	116.59
PPI France	94.25	93.00	10.91	77.73	129.80
CPI Portugal	90.88	86.26	19.53	42.23	123.74
Core CPI Portugal	91.49	85.33	20.44	36.38	121.42
PPI Portugal	97.30	89.75	19.03	57.06	139.00
CPI US	89.13	88.71	21.01	54.51	135.93
Core CPI US	88.09	89.17	19.97	55.17	135.36
PPI US	86.16	87.63	20.07	60.65	141.85

Source: Authors' computation.

both the oil price and inflation have exhibited new upward trends. Then, the COVID-19 pandemic in the first quarter of 2020 prompted additional price cuts. However, the economic recovery that began in 2021, combined with Russia's invasion of Ukraine in February 2022, has resulted in strong oil price growth, accompanied by a significant inflationary effect that reached its peak in 2022. In the US (Fig. 5), there were more significant effects on PPI than CPI during periods of higher oil price changes. In more critical periods, PPI is more sensitive, describing more pronounced drops than CPI. CPI shows a gradual increase over the entire time horizon and is less volatile than PPI.

The variables descriptive statistics are displayed in Table 1. The analysis of their standard deviations shows GBC prices in euros with a higher dispersion. In Germany, France, and the US, core CPI is less variable than CPI, whereas Portuguese CPI is less variable than core CPI. PPI variability is greater in Portugal and the US than in Germany and France.

Tables A.1 and A.2 in Appendix A display the correlation between the model variables. Each country's inflation indicators and the global oil price have a strong and positive correlation, which is especially accentuated for France and Portugal, and especially for PPI.

Table 2
Augmented Dickey-Fuller test.

Variables	Levels	First differences	Second differences
lnCOP	0.1944	−4.5631[a]	–
lnWIP	−1.2456	−5.9253[a]	–
GEA	−3.7733[b]	−9.1259[a]	–
lnGBC (US$)	−1.8668	−6.059[a]	–
lnGBC Germany (€)	−1.8319	−5.7472[a]	–
lnGBC France (€)	−1.8052	5.7744[a]	–
lnGBC Portugal (€)	−2.0513	5.777[a]	–
lnCPI (Germany)	−0.2596	−2.8394[c]	−11.2633[a]
lnCoreCPI (Germany)	−0.6475	−2.2231	−10.8721[a]
lnPPI (Germany)	0.7972	−4.0871[a]	–
lnCPI (France)	0.1392	−3.0663[b]	–
lnCoreCPI (France)	−0.075	−2.5749[c]	−12.2042[a]
lnPPI (France)	0.0253	−4.2517[a]	–
lnCPI (Portugal)	−0.6935	−3.6479[a]	–
lnCoreCPI (Portugal)	−1.1062	−3.2908[b]	
lnPPI (Portugal)	−0.8644	−4.4422[a]	–
lnCPI (US)	0.4562	−4.3039[a]	–
lnCoreCPI (US)	1.5153	−3.1793[b]	
lnPPI (US)	0.1033	−4.982[a]	

Note.
[a] denotes rejecting the null hypothesis at 1 % (critical value is −3.44).
[b] denotes rejecting the null hypothesis at 5 % (critical value is −2.87).
[c] denotes rejecting the null hypothesis at 10 % (critical value is −2.57).

Additionally, COP and GBC are weakly and negatively correlated for the US and weakly and positively correlated for European countries, while WIP and GBC are strongly and positively correlated for all countries.

Variables stationarity was verified using an Augmented Dickey-Fuller test presented in Table 2. CPI in Germany, and core CPI in Germany, and France were converted into second differences to become stationary.

3.2. *The structural VAR model*

This study employs the Structural Vector Autoregressive (SVAR) model to monthly data from January 1990 to November 2023 to estimate the impact of oil prices on headline and core CPI and PPI inflation of the U.S., France, Germany, and Portugal. Following Lütkepohl (2005), the SVAR(p) model can be represented as follows:

$$A_0 Y_t = \alpha + \sum_{i=1}^{p} A_p Y_{t-p} + \varepsilon_t \tag{1}$$

where Y_t represents a 5×1 vector of endogenous variables; α is a 5×1 vector of intercepts; A_0 is a 5×5 matrix of contemporaneous coefficients that captures instantaneous effects of the endogenous variables on each other; A_p is a 5×5 matrix of autoregressive coefficients; ε_t denote the mutually uncorrelated i.i.d. structural shocks; and p represents the number of lags defined based on information criteria. Y_t includes the endogenous variables World Crude Oil Price (COP), World Industrial Production (WIP), Global Price of Brent Crude (GBC), headline inflation (π) as captured by CPI, and core inflation (π^{core}) as captured by core CPI. In a second specification, the model comprises four endogenous variables, namely, COP, WIP, GBC, and inflation as captured by PPI, and the previous matrices dimension is reduced to 4. The lag order p is set to an upper bound of 12 lags (Kilian and Lütkepohl, 2017).

The reduced form of the SVAR model is obtained multiplying both sides of Eq. (1) by the lower-triangular matrix A_0^{-1}:

$$Y_t = c + \sum_{i=1}^{p} \phi_p Y_{t-p} + v_t \tag{2}$$

where $c = A_0^{-1}\alpha$, $\phi_p = A_0^{-1}A_p$, and $v_t = A_0^{-1}\varepsilon_t$, which represents the reduced-form errors, v_t, as linear combinations of structural shocks, ε_t.

After representing the model, we proceed to the identification of the restrictions, which implies defining constraints for the 5×5 matrix A_0. This identification is made through the recursive structure strategy (Kilian and Park, 2009; Clerides et al., 2022; Garzon and Hierro, 2021; Wen et al., 2021; Kim and Vera, 2022), in which A_0^{-1} is a lower-triangular matrix obtained by the Cholesky Decomposition method.[4]

The errors in the reduced form (v_t) will be identified in 2 models: one with CPI, another with PPI. The identification of the shocks will be defined as follows for the model that combines CPI and CPI core:

$$v_t = \begin{pmatrix} v_t^{COP} \\ v_t^{WIP} \\ v_t^{GPC} \\ v_t^{\pi} \\ v_t^{\pi Core} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{Oil\ Supply\ Shock} \\ \varepsilon_t^{Aggregate\ Demand\ Shock} \\ \varepsilon_t^{Oil-Specific\ Demand\ Shock} \\ \varepsilon_t^{4} \\ \varepsilon_t^{5} \end{pmatrix} \tag{3}$$

and as follows for the model with PPI inflation:

$$v_t = \begin{pmatrix} v_t^{COP} \\ v_t^{WIP} \\ v_t^{GPC} \\ v_t^{\pi} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{Oil\ Supply\ Shock} \\ \varepsilon_t^{Aggregate\ Demand\ Shock} \\ \varepsilon_t^{Oil-Specific\ Demand\ Shock} \\ \varepsilon_t^{4} \end{pmatrix} \tag{4}$$

The Cholesky Decomposition method defines the order of the model's variables based on their importance. The first variable is assumed to influence all the others, so it is considered the most exogenous. The last variable is defined as the most endogenous, and as such, it has no effect on the other variables while being influenced by all of them. In this way, we consider crude oil production to be predetermined with respect to the rest of the variables in the system.

Through the representation of the structural shocks, it is possible to verify the assumptions considered in their identification. Oil production only responds contemporaneously to the oil supply shock in the same month, not responding to other innovations within the same month. In this way, only the first identified structural shock has the capacity to affect oil production level. World industrial production responds contemporaneously to the oil supply shock and aggregate demand shock in the same month. The price of crude oil is influenced by the first three shocks identified, not responding to the others. The same strategy is used for both headline and core inflation rates. Like Kilian and Zhou (2022) and Clerides et al. (2022), the driving shocks of inflation are not specifically represented. In this way, possible innovations that could boost inflation without being related to oil reasons will be included in these shocks (Clerides et al., 2022).

The Impulse Response Functions (IRF) allow us to verify the impact that structural shocks have on the endogenous variables included in Y_t. Their analysis is performed using the following equation:

$$Y_t = \mu + \sum_{s=0}^{\infty} C_s v_{t-s} \tag{5}$$

in which emerges the IRF defined as:

[4] The remaining possible orders can be found in Appendix D, assuming inflation as the most endogenous variable in all, since the study focuses on the impact that the three shocks have on CPI and PPI. In the case of PPI, only this index is included in its aggregated form (headline inflation) assuming the position of the model's most endogenous variable.

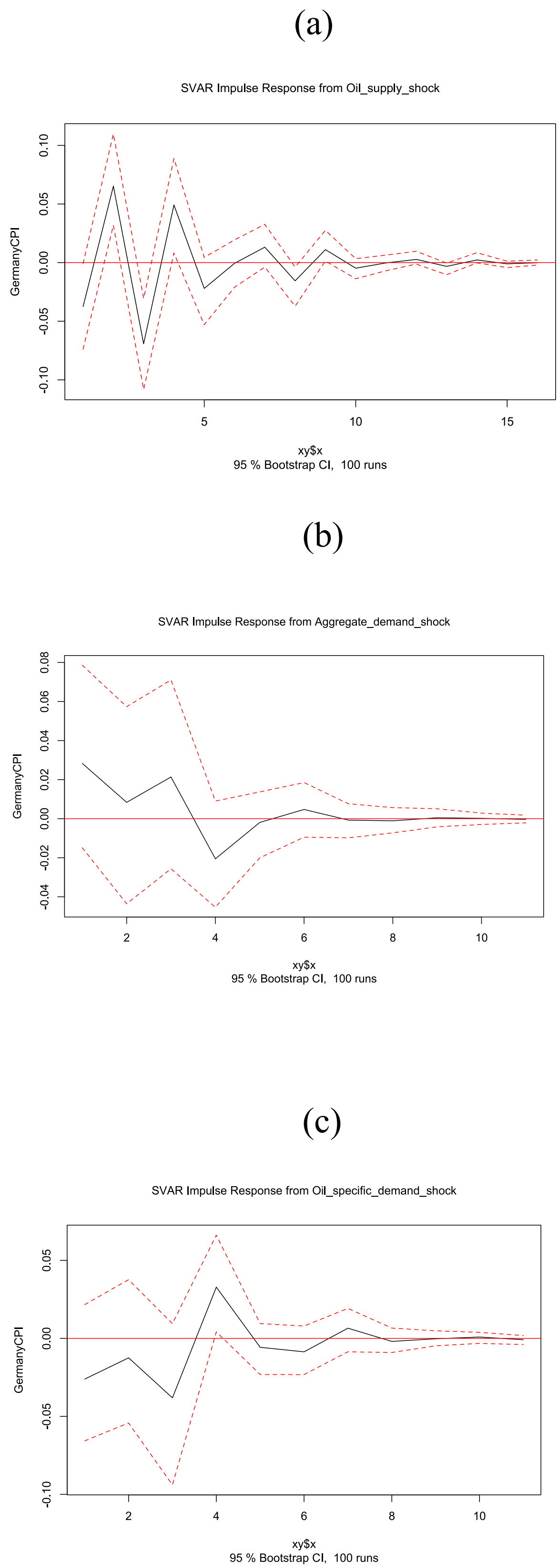


Fig. 6. Impulse response of CPI, Germany
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

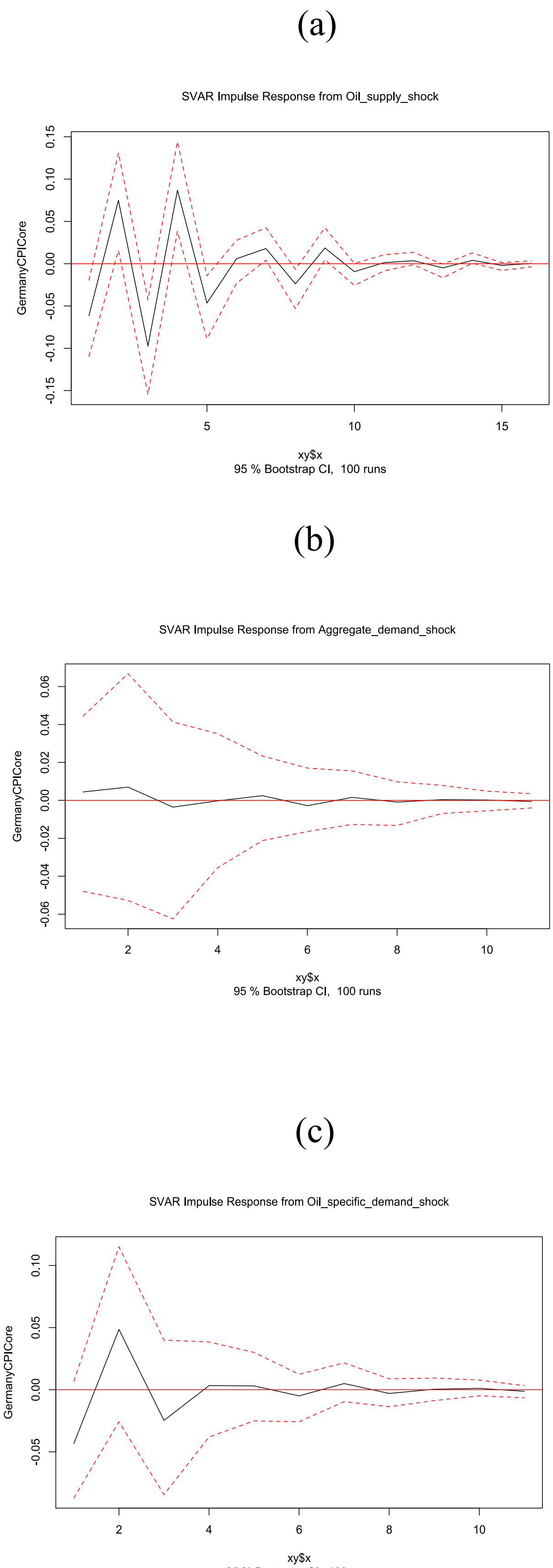


Fig. 7. Impulse response of core CPI, Germany.

$$C_{ij,h} = \frac{\partial Y_{i,t+h}}{\partial v_{j,t}} \tag{6}$$

where Y_t represents endogenous variables of the model and v_t denotes previously identified shocks. Through the IRF, we can observe the dynamic responses of each endogenous variable included in the model over **m** periods after a unit change in each shock.

The Forecast Error Variance Decomposition (FEVD) are computed to identify which of the three shocks, oil supply, aggregate demand, and oil-specific demand, contribute most significantly to the variability of inflation. This analysis is carried out at the end of the 1st quarter and at the end of one year, to understand whether there is any change in results in the short and long term.

Due to the size of the sample and given the crisis events that occurred over the analyzed period, we followed Cuñado and de Gracia (2003) and introduced dummy variables in periods marked by greater oil price fluctuations (2008M08–2009M01, 2014M09–2015M03, 2020M03–2020M12 and 2022M03–2022M06).

4. Estimation results

4.1. Impulse response analysis: CPI and core CPI

This empirical analysis covers the period from 1990M1–2025M01, with 407 monthly observations. The IRFs presented convey the estimated inflation metrics response to a forecast error impulse in each of the three types of shocks with 95 % bootstrapped error bands.

Figs. 6 and 7 show the IRF estimated for Germany, distinguishing CPI from core CPI respectively. Immediately after an increase in oil production, CPI and core CPI decrease, with a more pronounced effect in the latter, and then describe an oscillation around zero along the time horizon, indicating a non-statistically significant impact. Over time, the response stabilizes, pointing to a neutral long-term effect. The initial negative impact suggests that increased oil production lowers global oil prices, reducing import costs for Germany, which directly impacts consumer prices. The increase in oil prices that follows the initial impact may be revealing that markets and agents tend to adjust slowly, with price-setters updating their pricing based on expectations. As a result, firms may initially cut prices in reaction to lower energy input costs, but they may later raise or lower prices as demand or wages change. In their turn, aggregate demand shocks have an instantaneous positive impact on CPI inflation but cause some fluctuations afterwards, before stabilizing around zero. The impact on core CPI is almost null. An increase in global production stimulates demand for energy, pushing up prices and leading to a rise in CPI, but the fluctuations diminish over time, indicating a temporary impact that does not persist in the long run. This reflects Germany's reliance on global economic conditions, as it is a highly export-oriented economy. The comparison between the response of CPI and core CPI suggests that prices of food and energy make up the majority of the pass-through to CPI. Oil-specific demand shocks decrease CPI on impact to then increase it up to 4 months but have little significant long-term effects, while their transmission to core CPI is more significant initially, reaching 5 % in the second month, but not as persistent nor statistically significant. The difference in the transmission of oil prices to CPI and core CPI may reflect how the strong energy dependence of the German economy accelerates the pass-through to CPI. The slower transmission to core components indicates the presence of price rigidities, contract structures and the fact that they include services and rents, less directly energy sensitive. In Germany, the less pronounced and shorter-lived effects on core inflation may also indicate, as advanced by Kilian and Zhou (2023b), an economy with anchored inflation expectations.

The FEVD (Fig. 8) show a very small portion of oil prices and aggregate demand shocks explaining CPI and core CPI variation. The contribution of oil supply shocks to the variation of CPI and especially core CPI is more significant, reaching approximately 10 % of the latter at

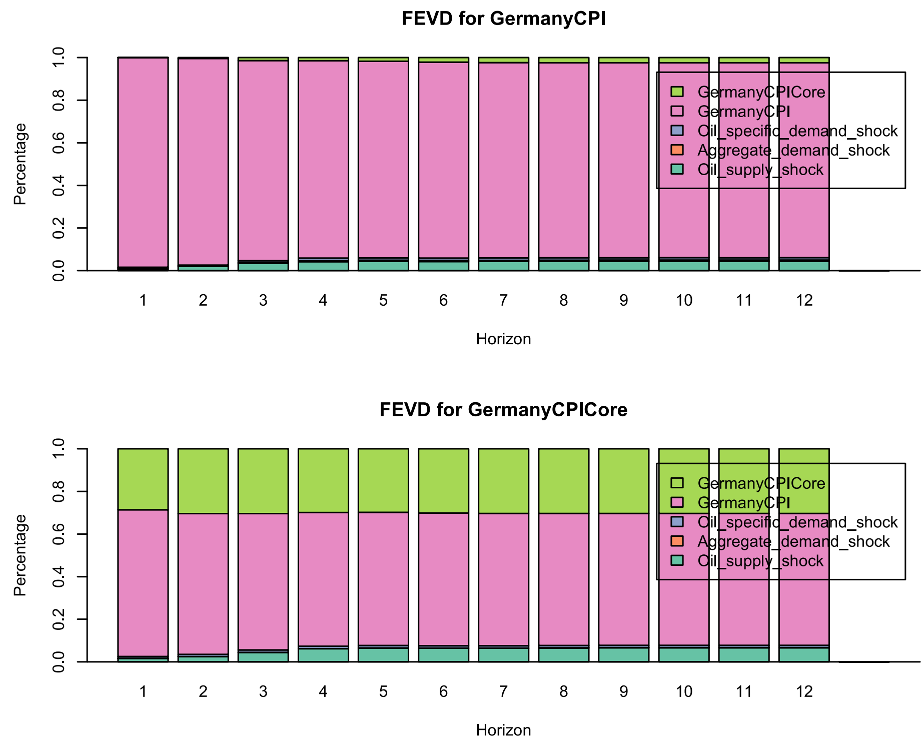


Fig. 8. FEVD for CPI and core CPI of Germany.
(Source: Authors' computation.)

the end of the first quarter.

For France, the IRF of CPI are displayed in Fig. 9, and of core CPI in Fig. 10. The reaction of inflation to an oil supply shock is considerable, but short-lived. There is an instantaneous negative impact on CPI after two months, that becomes statistically insignificant afterwards, and an opposite behavior of core CPI, showing a positive impact in period 2, and converging to zero afterwards. This suggests that a positive oil supply shock declines global oil prices, directly impacting CPI due to less energy inflation, but this effect is filtered out of core CPI. This may reflect France's reliance on imports for most of its oil as well as the impact of price controls and slower, less competitive adjustments to core CPI sectors. Aggregate demand shocks also cause diverse instantaneous impacts on CPI and core CPI, but the effect fades away over the time horizon. Thus, if the responses of both are positive at the time of the impact, the increase in core CPI is almost null and followed by a drop, while CPI increases for three months. It seems that rising food and energy costs tend to drive up inflation following a demand shock. Once again, this points to barriers in the pass-through of inflation to core sectors, possibly reflecting the presence of strong institutions. As in Germany, and as suggested by Kilian and Zhou (2023b), France is under an inflation targeting regime with high credibility, which tends to absorb oil shocks more effectively, showing muted pass-through to core inflation. Furthermore, core CPI displays a stronger oscillation than CPI. The pass-through of oil price increases produces a different scenario. CPI reacts sharply upward, indicating a direct and significant inflationary effect of higher oil prices. The effect decays gradually but remains positive for a prolonged period before stabilizing near zero. Core CPI displays a less statistically significant behavior. Thus, French CPI and core CPI are sensitive to the three types of shocks with often initial inflationary impacts, followed by complex responses that vary in magnitude and direction over time.

CPI and core CPI responses to oil supply, aggregate demand, and oil price shocks in France differ from Germany. France's reduced reliance on fossil fuels may help to explain this, as it lessens the direct impact of oil price shocks on electricity prices, which make up a significant portion of CPI. Nonetheless, divergence may still arise from core CPI responding indirectly through policy responses or wider cost pressures. At the headline level, Germany is more vulnerable to disruptions in the energy and oil supply, but its contracts and industrial policy may protect the core sectors.

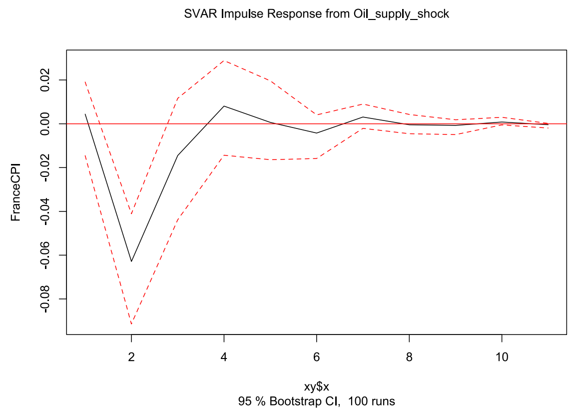
According to the FEVD (Fig. 11), CPI jointly derives from itself, core CPI, and oil-specific demand shocks, the latter representing about 15 % of the variation in headline inflation. In contrast, core CPI is explained by itself in about 90 %.

Portugal's IRF are shown in Figs. 12 and 13. An oil supply shock causes these inflation metrics to strongly oscillate around zero, describing a negative and significant impact of almost 10 % in period 2, with a not statistically significant response over the time horizon. An increase in aggregate demand has a negative effect on CPI and core CPI in the first period, that is about 5 %, an impact that is only significant in period 3 and it is not persistent. The fact that both oil supply shocks and world aggregate demand shocks have statistically insignificant effects on CPI and core CPI, reflects the fact that Portugal is a small, open economy and a price-taker in global markets. Also, the fact that aggregate demand causes a decrease in Portuguese consumer prices indicates that Baumeister's WIP may not be an adequate proxy to represent Portugal's exposure to external demand. The transmission of the oil-specific demand shocks to consumption inflation is strongly positive on impact on CPI and negative on CPI core and not statistically significant over the time horizon, with a more expressive initial impact on CPI. As in Germany and France, regulations may cushion the immediate pass-through of oil supply shocks to core consumer prices. In Portugal, inflation dynamics are less sensitive to external shocks, likely due to a combination of institutional protections, price regulations, and low economic scale. Also, the Portuguese economy seems to respond to the various shocks with a lag, compared to the other nations under analysis.

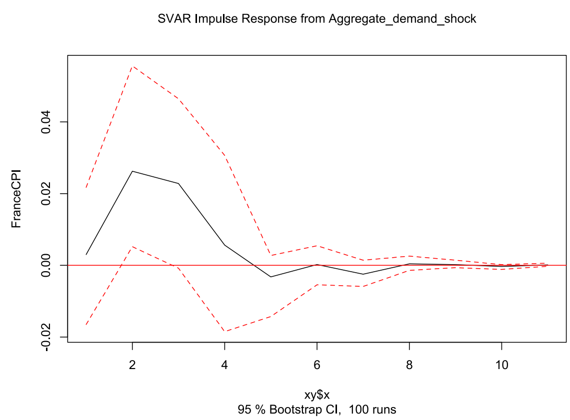
The FEVD for CPI (Fig. 14) displays it strongly explained by itself, with oil supply assuming great explanatory power, when compared to the remaining shocks. Core CPI is mostly explained by shocks in CPI, followed by Core CPI, which represent almost 20 %. Regarding other shocks, oil supply stands out from period 2, as in CPI.

The comparison between the three European countries corroborates

(a)



(b)



(c)

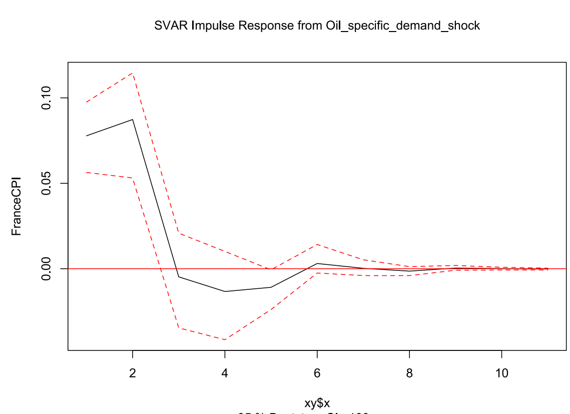


Fig. 9. Impulse response of CPI, France
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

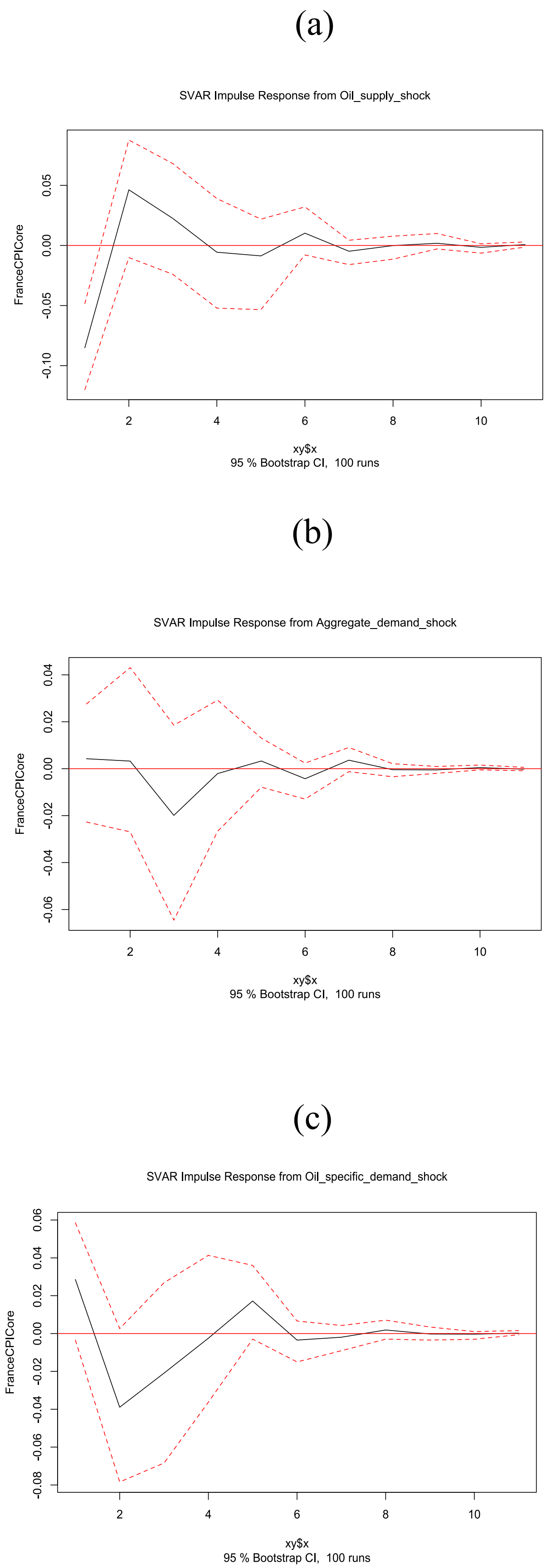


Fig. 10. Impulse response of core CPI, France.

Baumeister's (2023) findings that there is heterogeneity in the pass-through of oil supply shocks within the Euro area, in which we attest that being either a large or a small economy is relevant for the transmission process.

Figs. 15 and 16 present the US's IRF of CPI and core CPI, respectively. Oil supply shocks transmit to CPI with an initial negative impact, followed by a positive and statistically significant response up until period 4, and subsequently disappearing. Core CPI response on impact is negative, to increase until period 4, and then fade away as CPI. The response of both inflation metrics to an increase in aggregate demand shocks is positive but not statistically significant, converging to zero over the time horizon. An oil-specific demand shock has a pronounced positive effect, immediately rising to 15 %, lasting for four periods, that is less accentuated for core CPI, which increases to 3 % on impact and presents a more volatile and less statistically significant path. Thus, as in European countries but especially in France, oil-specific demand shocks incite a more accentuated effect on CPI compared to core CPI. Overall, these results are in line with Kilian (2009) for the US, displaying aggregate demand and oil-demand shocks as being stronger than oil supply shocks. Nevertheless, and contrary to Kilian, the influence of the world production index is more transiently, with its effect dissipating faster compared to oil price shocks, a behavior which may reflect the choice of a different indicator to represent world demand.

Fig. 17, which presents the FEVD for the U.S., shows CPI mainly explained by itself, followed by oil-specific demand, which is more pronounced from period 2, representing about 40 % of its variation after one year. Concerning core CPI, besides itself, it is explained by CPI, and in about 10 % by oil specific-demand shocks from the beginning of the second quarter.

Several points can be highlighted from the analysis of CPI and core CPI responses to oil shocks. Firstly, the inflationary impact of oil price shocks is not uniform across countries, as verified by, *e.g.*, Kilian and Zhou (2023b). Secondly, and as expected, CPI is more reactive to all shocks and in all countries than core CPI, a result explained mainly by the effect these shocks cause in energy inflation. The behavior of CPI and core CPI differs after an oil-specific demand shock, with a more significant and persistent impact of oil price changes in the former, as can be observed in Germany and France. Kilian and Zhou (2022), studying the effects of gasoline price shocks, state that these tend to be more significant and less persistent in headline inflation than in core, which is confirmed by the present analysis in terms of significance. Choi et al. (2018) and Garzon and Hierro (2021) argue that oil shocks promote less significant and less persistent impacts on core inflation. Thirdly, consumer prices are mostly impacted by oil specific demand shocks, which have the strongest and most persistent effect on CPI, while oil supply shocks and aggregate demand shocks have more transitory impacts. Our results corroborate Kim and Vera's (2022) findings for the U.S. that show oil supply shocks with a minor inflationary effect in comparison to both aggregate demand and oil-market specific shocks. As suggested by Choi et al. (2018) this may also be the consequence of a better conduct of monetary policy, since, when targeting inflation, its tools are more suited to tackle aggregate demand. Additionally, as argued by LeBlanc and Chinn (2004), these results point to U.S. not standing out from European countries with respect to the effects caused by the fluctuations of oil prices on inflation. Fourthly, oil supply shocks impact consumer prices differently. In the US, the largest oil-producer, CPI decreases, while core CPI seems to respond with a lag. In the case of France, this shock has opposing effects on CPI and core CPI, however it is more meaningful in core CPI when compared to aggregate demand and oil-specific demand shocks. These results corroborate Baumeister's (2023) findings for the Euro area according to whom the response to an increase in oil prices due to an oil supply shock reveals cross-country heterogeneity, with stronger responses by countries that represent the Euro area core. However, while the author states that energy and core inflation in Germany have a larger response than in France and Portugal, our estimates indicate a stronger response in France, which may reflect

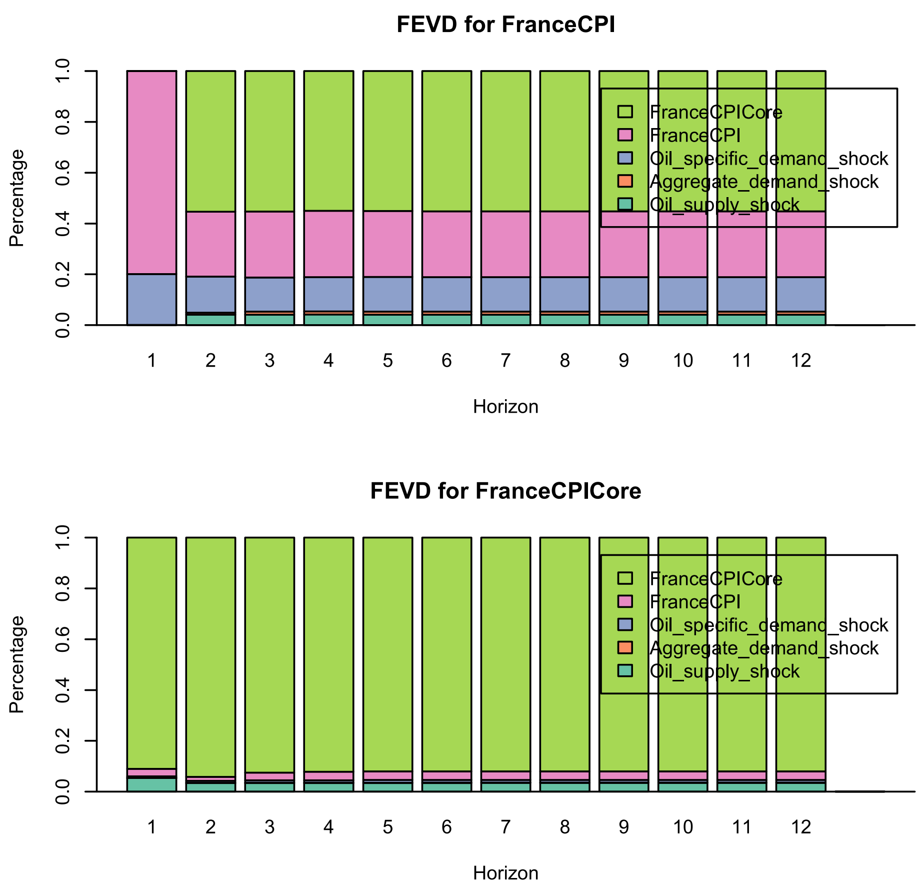
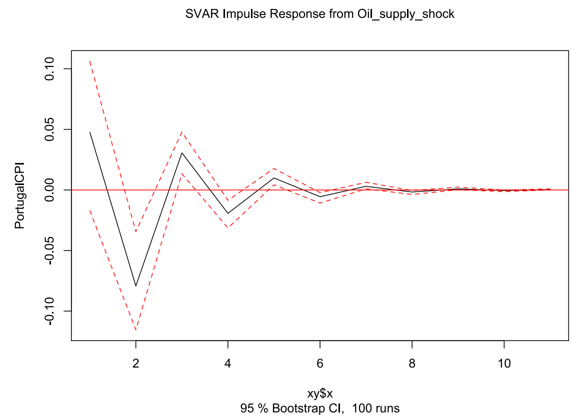
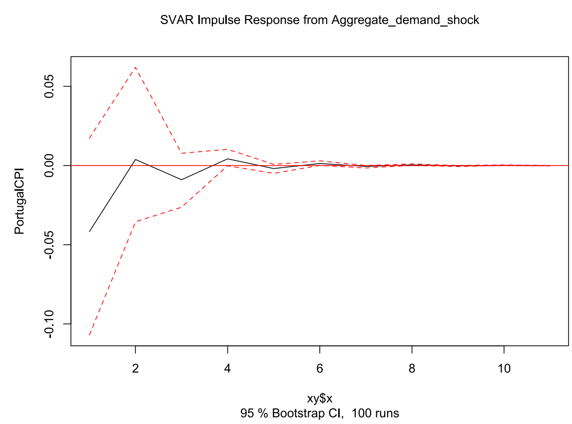


Fig. 11. FEVD for CPI and core CPI of France.
(Source: Authors' computation.)

(a)



(b)



(c)

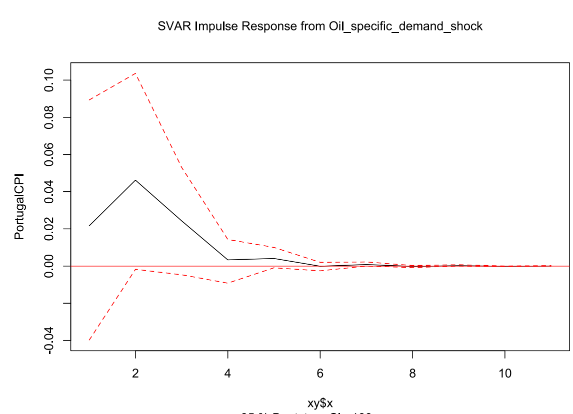
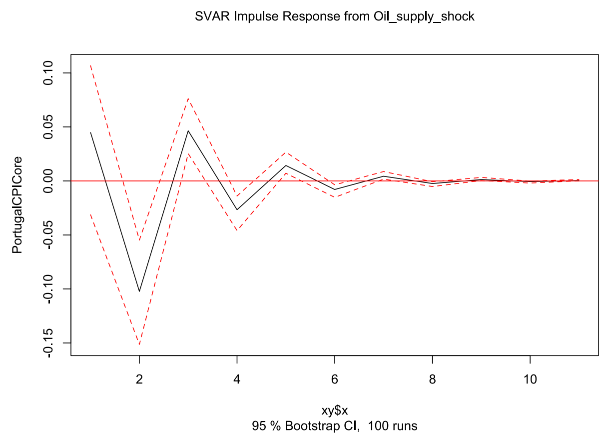
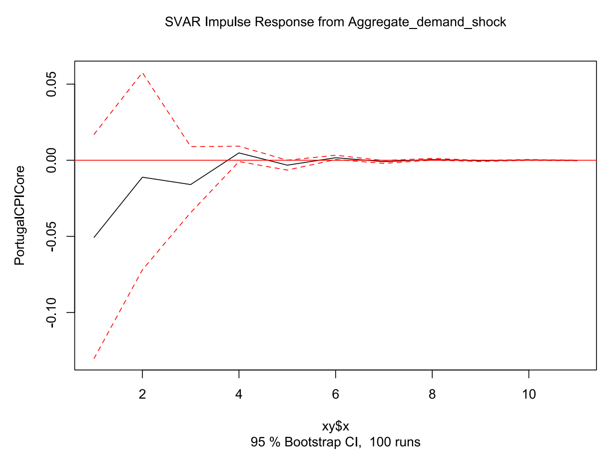


Fig. 12. Impulse response of CPI, Portugal
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

(a)



(b)



(c)

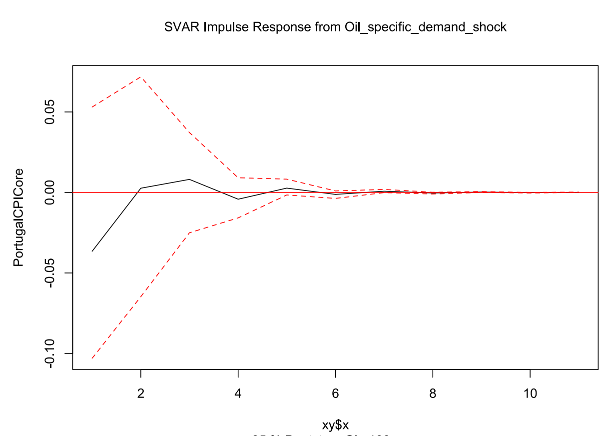


Fig. 13. Impulse response of core CPI, Portugal.

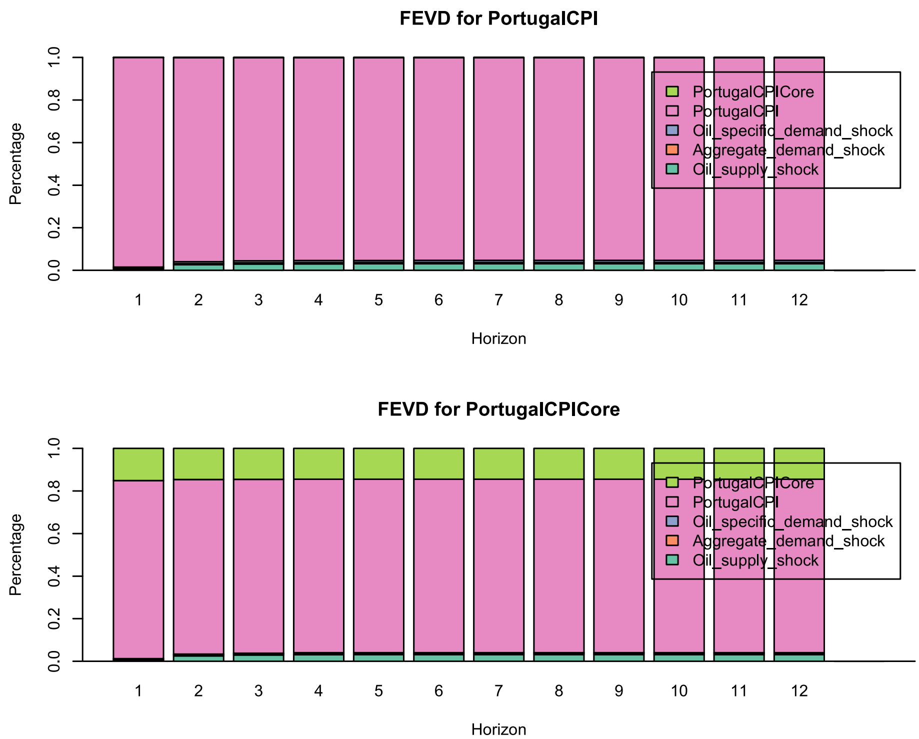


Fig. 14. FEVD for CPI and core CPI of Portugal.
(Source: Authors' computation.)

the period under analysis. Thus, regarding differences between countries, and contrary to what is defended by Wen et al. (2021), the supply side is not seen to assume a greater relevance in inflation in CPI of France. Finally, there is also a strong correlation between CPI and core CPI since the latter derives mostly from shocks to CPI.

4.2. Impulse response analysis: PPI

This section presents the IRF and the FEVD for a SVAR model that considers PPI as the measure of inflation. The IRFs for Germany are presented in Fig. 18. There is a positive small response of PPI to oil supply shocks at an early stage, that is not persistent nor statistically significant over the time horizon. The opposite behavior was observed for CPI and core CPI, assuming an initial negative impact and being more volatile than PPI. The response of PPI to an increase in aggregate demand is positive up to 2 months, reaching 2 %, but not statistically significant, followed by a gradual decrease. Thus, aggregate demand shocks do not foster significant inflationary impacts in Germany, independently of capturing inflation through consumption or production indicators. Oil-specific demand shocks transmit to producer prices with a pronounced inflationary impact, exceeding 15 % after an initial shock and fading away after 8 months. Hence, of all the shocks considered, oil-specific demand shocks stand out as having the most visible effects. However, this is only true for PPI.

The FEVD depicted in Fig. 19 confirm the strong explanatory share of the oil-specific demand shock, which is responsible for 30 % of PPI behavior throughout the entire period. From the producer and consumer perspective in Germany, the weight of supply and demand shocks differs markedly. Contrary to what is observed for PPI, oil-specific demand shocks are not significant in the variability of CPI and core CPI.

The IRF derived from France's PPI SVAR are shown in Fig. 20. Oil supply shocks temporarily decrease PPI, converging to zero after 5 months, implying that the supply side has less statistically significant impact on producer prices, when compared to consumer prices. The dynamic response of PPI to aggregate demand shocks is positive and close to 6 % on impact, to gradually decrease, and become insignificant after 6 months. Thus, aggregate demand shocks have a short-lived impact inflation in France. There is a more lasting and significant pass-through of oil-specific demand shocks to PPI when compared to the remaining, with an initial peak in inflation of about 30 %. Furthermore, producer prices are more reactive to this type of shock than consumer ones.

Through the FEVD, displayed in Fig. 21, we observe that approximately 40 % of PPI is explained by oil-specific demand shocks, with no significant differences in the short and long-term. In comparison with the consumer perspective, we see a strong sensitivity of PPI to oil-specific demand shocks. CPI is also explained by the variability of oil prices, while an explanatory share of core CPI was from oil supply shocks, which does not occur with PPI.

For Portugal, the IRF are displayed in Fig. 22. The transmission of oil supply shocks to PPI is negative on impact, followed by an upward trend for 2–3 months, achieving close to 4 %, and disappearing in the long-term. These insignificant inflationary effects after a shock to the supply side were also found for consumer prices. A shock to aggregate demand increases inflation from period 2, reaching almost 15 %, but the impact is short-lived. In comparison to CPI and core CPI, the response of PPI is more pronounced in the subsequent period. After an oil-specific demand shock, PPI reaches about 40 % in 2 months, a statistically significant response, again confirming a more reactive behavior of PPI. In general, all shocks have a greater impact on PPI in Portugal than on CPI or core CPI, with a greater significance for the oil-specific demand shock.

In Fig. 23, the FEVD confirms that oil-specific demand shock assumes

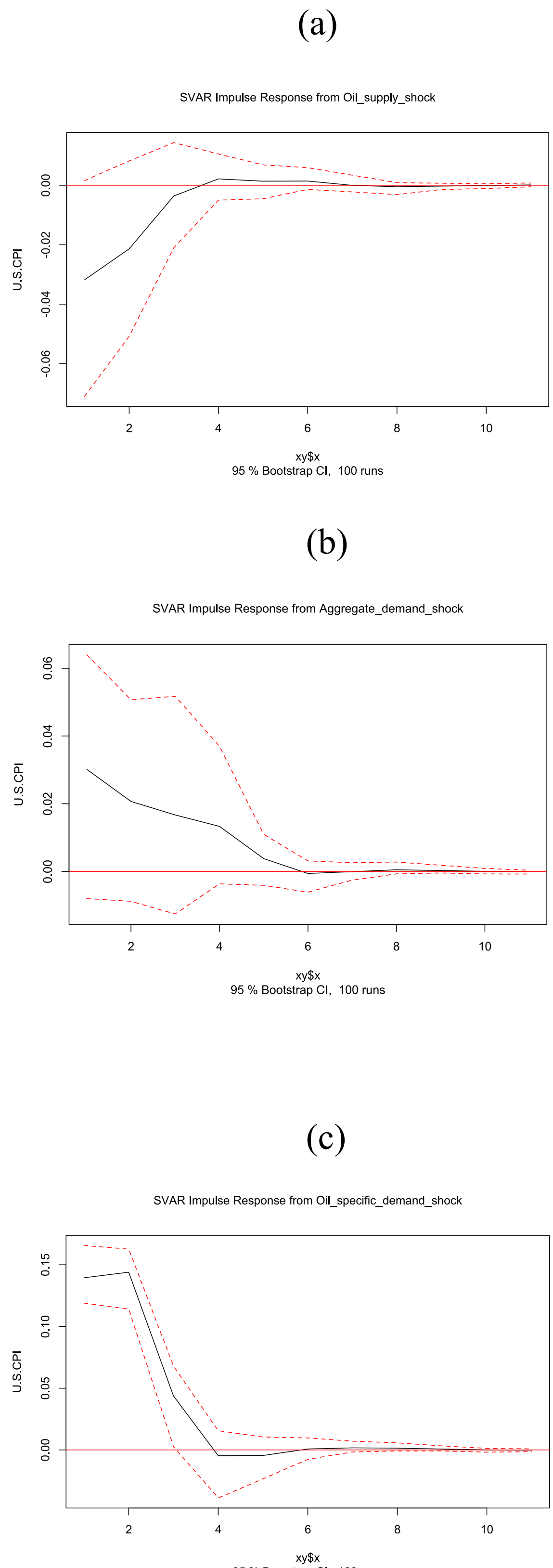
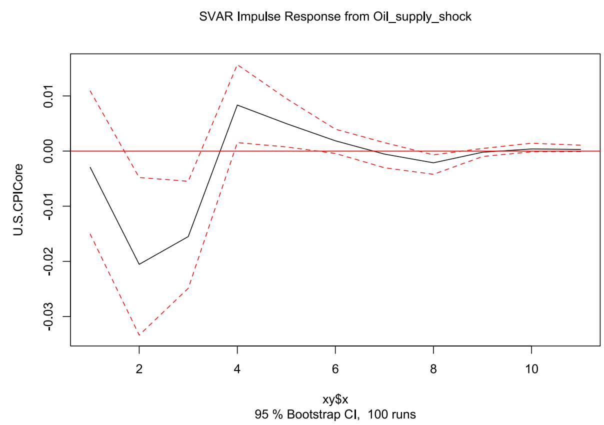
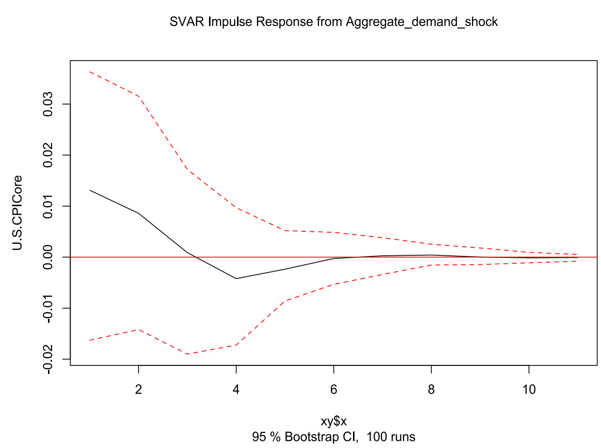


Fig. 15. Impulse response of CPI, US
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

(a)



(b)



(c)

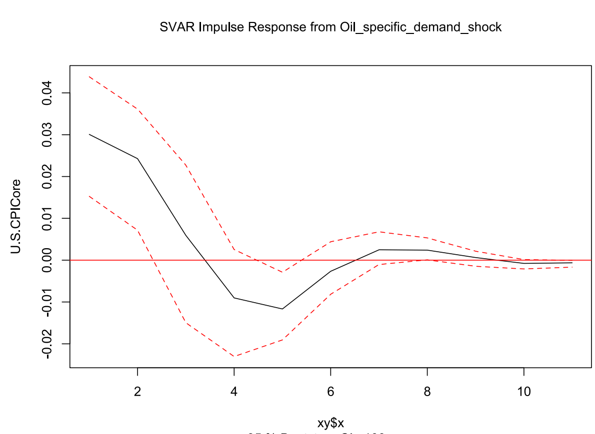


Fig. 16. Impulse response of core CPI, US.

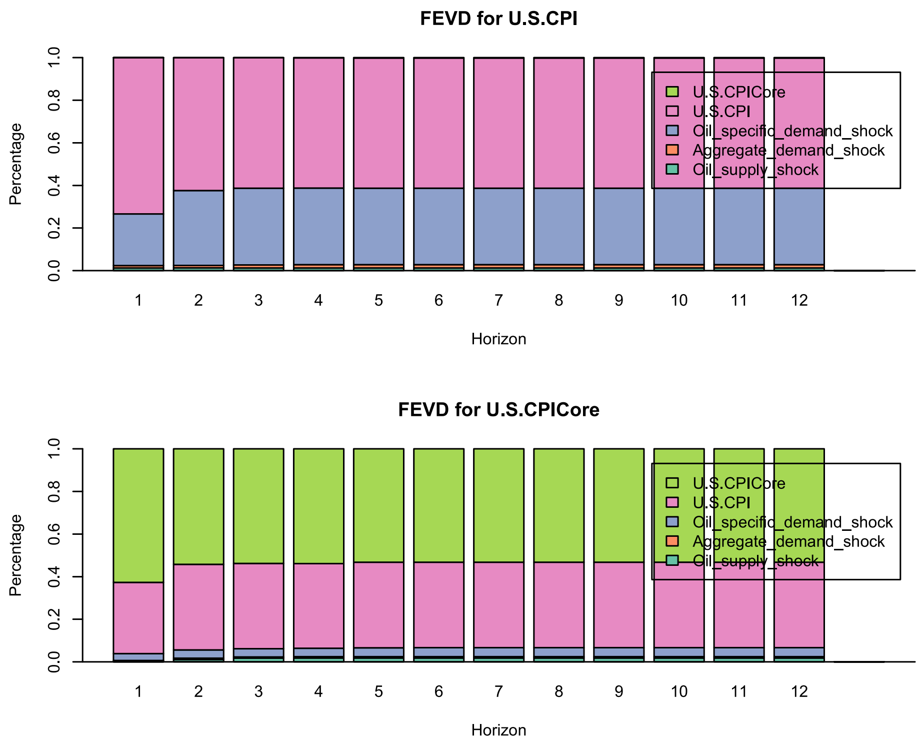


Fig. 17. FEVD for CPI and core CPI of the US.
(Source: Authors' computation.)

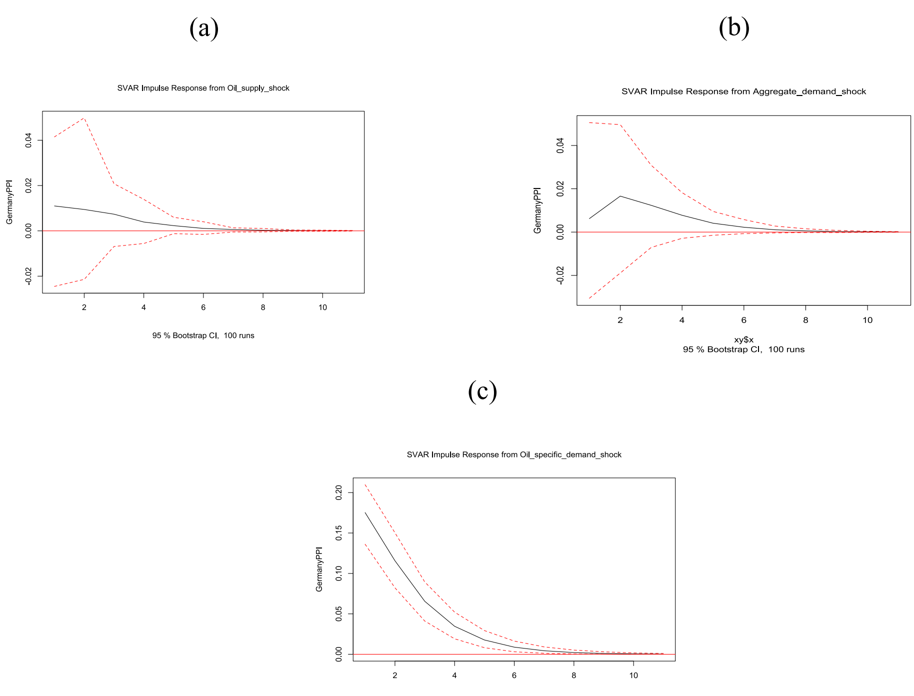


Fig. 18. Impulse response of PPI, Germany
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

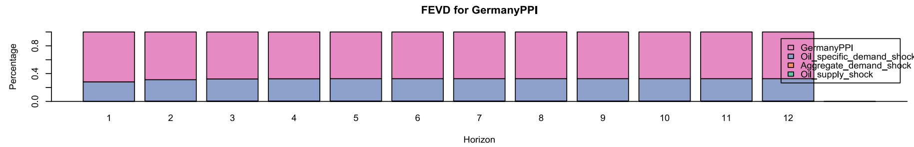


Fig. 19. Fevd for PPI of Germany.
(Source: Authors' computation.)

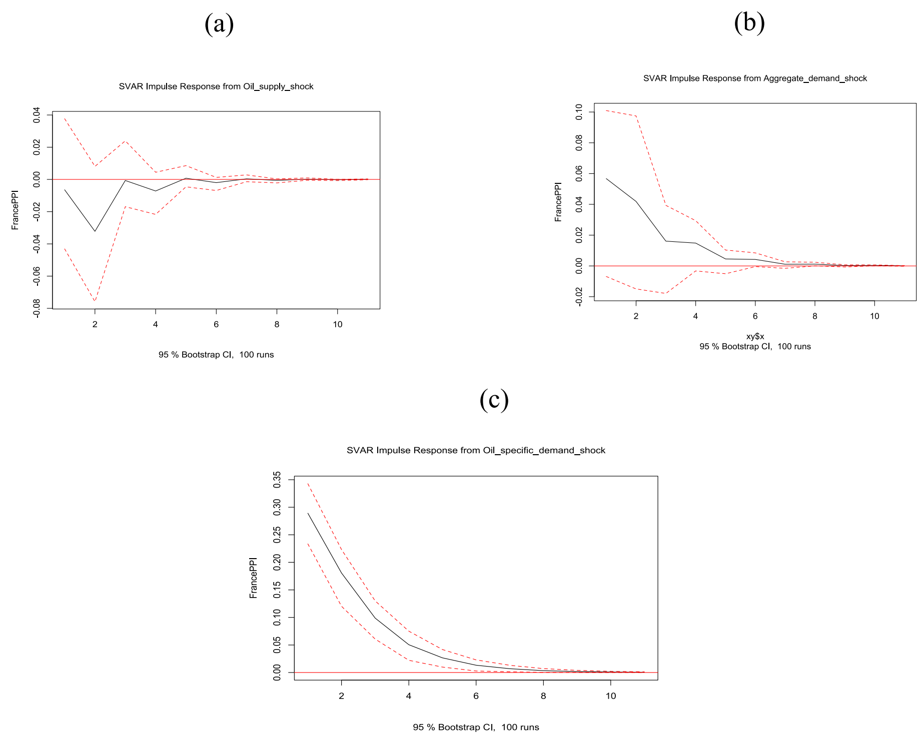


Fig. 20. Impulse response of PPI, France
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

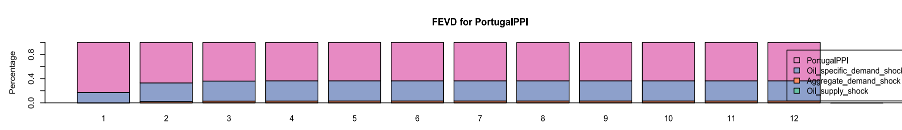


Fig. 21. Fevd for PPI of France.
(Source: Authors' computation.)

greater explanatory power over the year, contributing close to 40 % to changes in the producer prices after 2 months. In contrast, CPI and core CPI are mostly explained by oil supply and aggregate demand shocks. A marked discrepancy in the weights of each shock in the variation of consumer and producer prices is also confirmed.

Regarding the U.S., the IRF are shown in Fig. 24. Oil supply shocks have a temporarily negative impact on PPI that is statistically insignificant. The initial negative impact was also verified for core CPI, being more pronounced and less volatile on PPI. Aggregate demand shocks foster an instantaneous increase in inflation, exceeding 10 %, and disappearing after 5 months. Again, these shocks impact is stronger on PPI than on CPI and core CPI. The transmission of oil-specific demand shocks to PPI is impactful and statistically significant, reaching close to 50 %, and tending to disappear in the long-term. This shock, as observed in other countries, has a more prominent impact on PPI compared to CPI and core CPI. These results depict a positive relationship between U.S. inflation and oil price fluctuations during the period under analysis, contradicting the idea of Castillo et al. (2020) that this ratio had declined since 2002.

The FEVD in Fig. 25 shows oil-specific demand shock significantly contributing to the variation of producer prices, reaching close to 60 %, and becoming more pronounced during the first quarter. Once again,

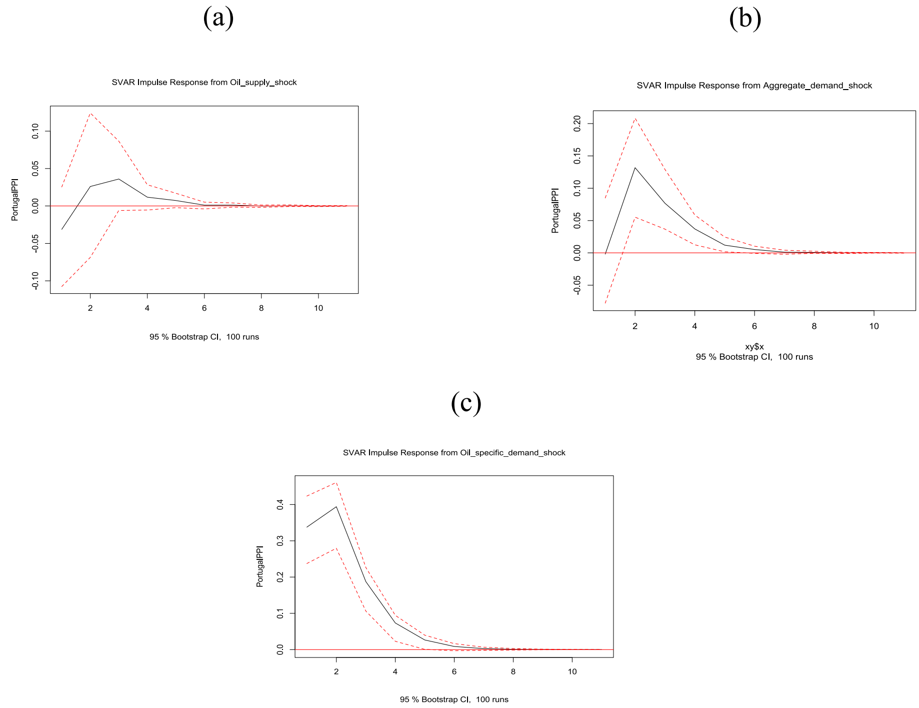


Fig. 22. Impulse response of PPI, Portugal
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

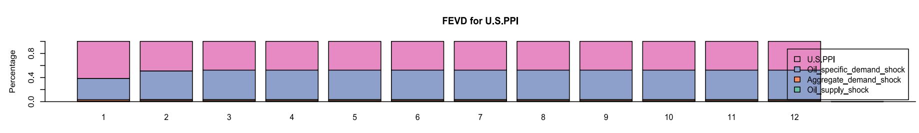


Fig. 23. Fevd for PPI of Portugal.
(Source: Authors' computation.)

shocks produce different impacts on producer and consumer prices, with a larger contribution of oil supply to consumer prices.

As expected, a strong sensitivity of both inflation indicators, PPI and CPI, to oil price variations is verified, revealing a crucial factor in determining the general level of prices in the U.S. economy.

PPI analysis reveals other relevant points. Firstly, the oil-specific demand shock has a more pronounced impact on producer inflation, being the one that contributes most significantly to its fluctuations in all countries when compared to other shocks, with emphasis on the U.S and Portugal. Secondly, the oil supply shock has less statistically significant effects on PPI, while aggregate demand shocks are slightly significant but do not impact PPI as noticeably as the oil-specific demand. Therefore, the demand side has a greater impact on PPI than the supply one. Thirdly, inflation in Portugal behaves differently from other countries, since the impact of oil shocks on PPI is not immediate, becoming more significant over the time horizon, as is the case of aggregate and oil-specific demand shocks. This promotes a more volatile general level of producer prices in Portugal when compared to France and Germany. According to Esteves and Neves (2004), the greater sensitivity of Portuguese inflation to oil shocks can be explained by a strong dependence on oil imports and a high degree of openness in the economy.

In sum, the analyses conclude for the existence of different responses from producer and consumer prices, more perceptible in the strong sensitivity of PPI to increases in oil prices in all the countries analyzed. This scenario is identical to that described for Malaysia (Sek, 2023), as well as for Indonesia and Thailand (Husaini and Lean, 2021). Finally, and contrary to expectations, the impacts of oil shocks on inflation indicators are evident and more significant in the short-term, becoming statistically insignificant in the long-term, confirming a small persistence of inflationary effects resulting from oil price shocks, as defended by Brief (2022) and Kilian and Zhou (2022).

There are some possible reasons to support these results. Energy intensity is pointed out as one of the main explanatory reasons for the impact of oil price fluctuations on inflation and more specifically in the U.S. (LeBlanc and Chinn, 2004; Van den Noord and André, 2007; Barrell and Pomerantz, 2008; Renou-Maissant, 2019; Wen et al., 2021; Kpodar and Liu, 2022). European countries are also strongly dependent on imports of fossil fuels, as is the case of oil, coal, and natural gas, even if a greater focus on renewable energy is expected over the coming years, which will contribute to greater energy autonomy for Europe (European

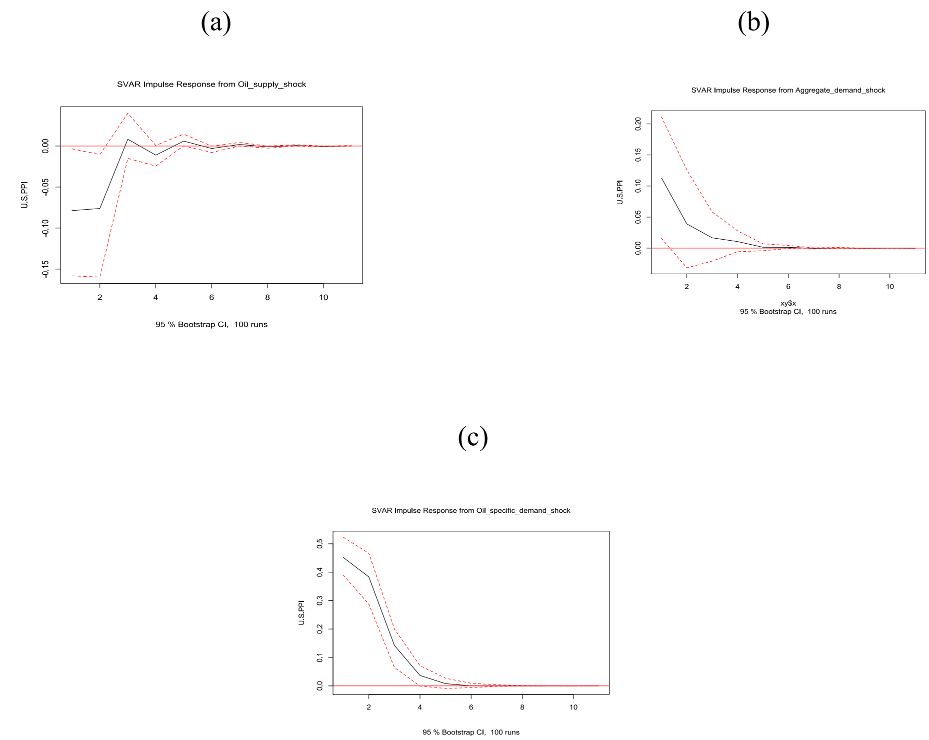


Fig. 24. Impulse response of PPI, U.S.
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

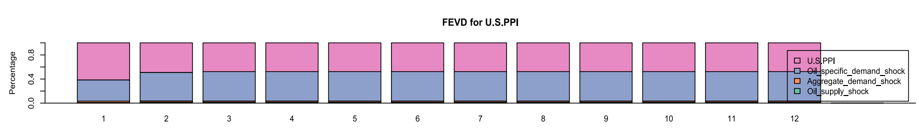


Fig. 25. Fevd for PPI of the US.
(Source: Authors' computation.)

Parliament, 2023). Lastly, the credibility of the monetary policy of central banks may be a key reason for the different responses of inflation to variations in the price of oil between countries (Van den Noord and André, 2007; Bachmeier and Cha, 2011; Choi et al., 2018; Renou-Maissant, 2019; Castillo et al., 2020; Baba and Lee, 2022; Kpodar and Liu, 2022; Sek, 2023), helping to contain inflationary effects through increased interest rates.

5. A different proxy for aggregate demand shocks

To validate the effectiveness of the previous results, we tested the models replacing Baumeister's WIP by Kilian's GEA, keeping the variables that represent oil-supply and oil specific demand shocks, namely COP and GBC deflated by each country CPI. The substitution was made in both types of models, those with CPI and core CPI as the inflation metrics, and those with PPI as the inflation indicator, and the IRF and FEVD estimations are displayed in appendix B. To be consistent with the models from section 4, we introduce the GEA index in first differences.

Kilian's GEA is based on shipping rates for dry bulk commodities, capturing global demand for industrial commodities. Kilian and Park (2009) argues that this index reflects broader global economic conditions, particularly emerging markets' demand, being more sensitive to commodity-intensive global economic activity (*e.g.*, infrastructure booms in China, global industrial demand). In contrast, Baumeister's WIP is based on global industrial production data, emphasizing actual production output more than commodity trade. It is less noisy than Kilian's index, and perhaps more representative of advanced economies' economic cycles as suggested by Baumeister and Hamilton (2019).

As in previous estimations, oil market shocks are seen to have short-run inflationary effects, independently of the inflation metric or country considered. In models that examine how oil price shocks affect CPI and core CPI, and compared to our previous estimations, adopting GEA as the proxy for overall aggregate demand generally does not change the results of the IRFs for oil supply and oil-specific demand shocks (Fig. B1 to B12). However, we detect distinct patterns on how aggregate demand shocks affect CPI and core CPI inflation, particularly for Germany and Portugal. In Germany, following an aggregate demand shock, both CPI and core CPI fall on impact and then tend to increase, stabilizing after half a year. This result is counterintuitive, indicating that WIP may be more appropriate to capture the sort of aggregate demand shocks that affect the German economy. The FEVD reveal oil-supply shocks explaining almost 80 % of CPI and core CPI after one year. For France, the new IRF estimations show a small change in the answer of core CPI to aggregate demand shocks, becoming slightly negative on impact. The FEVDs display both oil-specific demand and oil supply shocks explaining most of CPI, representing respectively 35 % and 30 % at month 12, while oil supply shocks are responsible for about 60 % of core CPI. Aggregate demand shocks contribute to increase Portuguese CPI and core CPI on impact in about 12 and 14 percentage points respectively stabilizing around month 5, while in the FEVDs they are now seen to explain both CPI and core CPI in about 5 %, a change with respect to the estimations that use WIP as the proxy for this type of shocks. The fact that Portuguese results are in line with economic theory, suggests that Kilian's business cycle index may be a better indicator of the international pressures that affect this small open economy. Finally, for the US, and similar to the IRFs for France, a positive aggregate demand shock causes a decrease on core CPI inflation on impact followed by oscillations and its stabilization after about 8 months. Nevertheless, the FEVDs for this big economy do not change, still putting oil specific demand shocks explaining about 40 % of CPI.

The analysis of the models that consider PPI as the inflation metric disclose FEVDs identical to those that were estimated using WIP as the proxy of aggregate demand shocks and changes in some of the IRF results, especially for Germany and Portugal. For Germany, and differently from the estimations for CPI, it is the response to oil supply shocks that is altered by using GEA, although not being statistically significant. Once more, for Germany, the estimates using WIP yield results that are more consistent with economic theory. The estimation results for France show slight variations in the PPI's reaction to shocks to aggregate demand, which currently rise for two months before beginning to decline. The most notable shift is seen in the Portuguese estimations of the response to shocks to oil supply, which initially show no significant impact and then enter into negative field. Once more, this outcome is more consistent with economic intuition than the estimates derived from WIP. For the US, the IRF results do not display relevant differences concerning previous estimations.

As a whole, our results are robust to changes in the variables that proxy aggregate demand. However, the changes that are detected for German and Portuguese estimations point to the relevance of choosing the adequate index to represent aggregate demand shocks, as has been pointed out in the literature on oil shocks. Specifically, Baumeister's index may align better with the transmission mechanisms of a highly industrialized and export-oriented economy like Germany. Its inflation dynamics are more tightly linked to global industrial output and cycles, which Baumeister's index captures well. Kilian's index might pick up commodity-driven demand (*e.g.*, in emerging markets) that doesn't immediately boost German exports or prices. In the case of Portugal, a smaller, more open economy, heavily dependent on trade and tourism, its inflation dynamics may be more imported or externally driven, particularly via energy and food prices. Thus, Portuguese CPI might rise more directly with increases in global shipping and input prices, as suggested by Kilian's index. Baumeister's index may not reflect Portugal's exposure to global trade cycles and commodities, leading to a weak or negative pass-through.

The fact that we do not observe these discrepancies for France and the US suggests that these economies may have a broader or more balanced response to both industrial and commodity-driven global demand. Hence, domestic inflation dynamics might be less sensitive to which aggregate demand proxy is used, due to diversified production and consumption structures. It is possible that their larger domestic markets buffer the influence of global shocks, making both indices perform similarly.

All in all, these findings may reflect differential transmission channels of global demand shocks, filtered through the structure of each economy (size, openness, and industrial vs. service orientation), the nature of the proxy (commodity-sensitive vs. production-sensitive) and the degree of integration with global supply chains.

6. Conclusion

This study investigated the influence of oil price fluctuations on inflation, comparing the U.S. with three Eurozone countries (Germany, France, Portugal) following the economic disruptions caused by the pandemic and the Russia-Ukraine conflict. A Structural Vector Autoregression (SVAR) model was employed to analyze the dynamic impacts of oil supply shocks, global aggregate demand shocks, and oil-specific demand shocks on headline and core CPI inflation, as well as producer price inflation.

Overall, the discussion highlights the complex relationship that exists between oil prices and inflation, where the impact of oil shocks can vary depending on the country, the type of shock and the inflation metric. An oil price increase has a slightly more noticeable effect on both consumer and producer prices in all countries, with emphasis on the US. When compared to CPI, PPI reveals a greater sensitivity to the fluctuation of oil prices. Among European countries, Portuguese PPI shows greater fluctuations in response to this type of shock. Additionally, the short-term impacts of oil shocks on inflation are more significant than the long-term impacts, indicating limited persistence of inflationary effects from oil price shocks.

This paper supports Kilian's (2009) conclusions that considering various types of shocks is essential to comprehending how changes in oil prices affect inflation but goes one step further by showing that the analysis must be expanded to include other economies and their unique paths, especially those that do not produce oil.

Our evidence indicates that focusing on CPI alone as a measure of inflation will tend to underestimate the whole inflationary impact of oil market shocks. Also, the response of inflation metrics differs by type of shock, highlighting the need to consider them all to get a complete portrait.

Furthermore, testing the appropriate proxy to represent aggregate demand shocks is crucial, even when examining advanced economies. The World Industrial Production Index or the Global Real Economic Activity Index may be the best measures of an economy's overall exposure to global demand depending on factors like its level of industrialization, integration into global production chains, and reliance on the markets for raw materials.

Our findings have several implications for policy. Firstly, if taming inflation is a priority for central banks, it is important to focus on different metrics, among which PPI can be quite relevant. Secondly, as argued by several scholars, in order to comprehend the extent of inflation and the potential for countering it with conventional monetary mechanisms, it is imperative to determine the type of oil shock that is causing it. Our results indicate that this fact may pose an additional obstacle for European countries, specifically the disparity between core countries and all others in terms of their susceptibility to shocks to the oil price and how it affects inflation. Thirdly, in this context and in light of the recent challenges brought about by the conflict between Russia and Ukraine, it is critical to think about alternatives to oil, not only because they are relevant in addressing the pressing environmental problems but also because they can help reduce these nations' reliance on oil for energy. The adoption of renewable energies, which despite recent significant growth still represents a negligible share, is essential to overcoming the instability brought on by the fluctuation of oil prices in all the countries studied, but particularly in non-oil producing European nations.

Several limitations could be pointed out to this analysis. Firstly, it was not possible to use producer inflation at a disaggregated level, since it is not available for all the countries analyzed. Secondly, the analysis of PPI only covers the period up to the end of 2022, given data availability.

Additionally, due to the importance that this topic assumes today and will continue to assume in the coming years given the impact that the most recent economic crisis has had worldwide, it would be interesting to further analyze other components that can affect inflation, such as the price of food and natural gas. Also, given that global energy markets and inflation dynamics have changed significantly in recent years, a sub-period analysis that would cover the periods that preceded and followed either the global financial crisis, the pandemic or even the invasion of Ukraine could enrich the debate on this topic. Moreover, future research could explore the long-term consequences of oil price fluctuations on inflation as economies transition towards renewable energy sources.

CRediT authorship contribution statement

Joana Gago: Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sofia Vale:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition.

Funding

Fundação para a Ciência e Tecnologia, under grant UIDB/00315/2020, is gratefully acknowledged. The funding body had no influence on the design of the study, collection, analysis, or interpretation of data, or in writing the manuscript.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Sofia Vale reports article publishing charges was provided by ISCTE. Sofia Vale reports a relationship with ISCTE that includes: employment and funding grants. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resourpol.2025.105667.

Appendix A. – Correlation matrices

Table A.1
Correlations between COP, WIP and GBC

	COP	WIP	GEA	GBC US	GBC GER	GBC FRA	GBC POR
COP	1	0.48	−0.42	−0.02	0.10	0.12	0.13
WIP		1	−0.09	0.65	0.74	0.76	0.71
GEA			1	0.23	0.12	0.11	0.12

Source: Authors' computation.

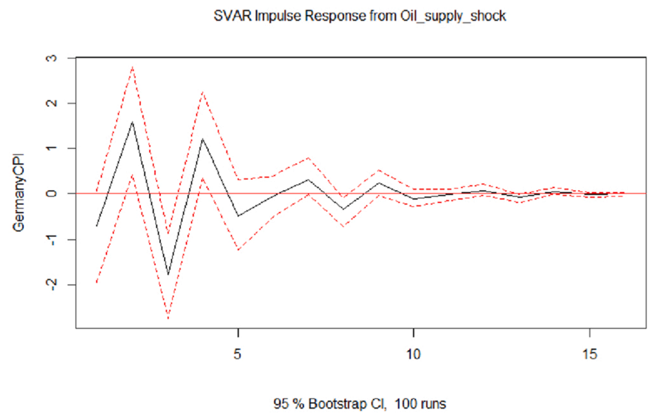
Table A.2
Correlations between CPI, PPI, COP, WIP, GEA and GBC

	Germany		France		Portugal		United States	
	CPI	PPI	CPI	PPI	CPI	PPI	CPI	PPI
COP	0.49	0.37	0.49	0.29	0.49	0.20	0.49	0.35
WIP	0.99	0.98	0.99	0.93	0.99	0.92	0.99	0.98
GEA	−0.11	−0.08	−0.11	−0.01	−0.11	−0.01	−0.11	−0.07
GBC US	–	–	–	–	–	–	0.63	0.75
GBC GER	0.73	0.78	–	–	–	–	–	–
GBC FRA	–	–	0.75	0.89	–	–	–	–
GBC POR	–	–	–	–	0.70	0.85	–	–

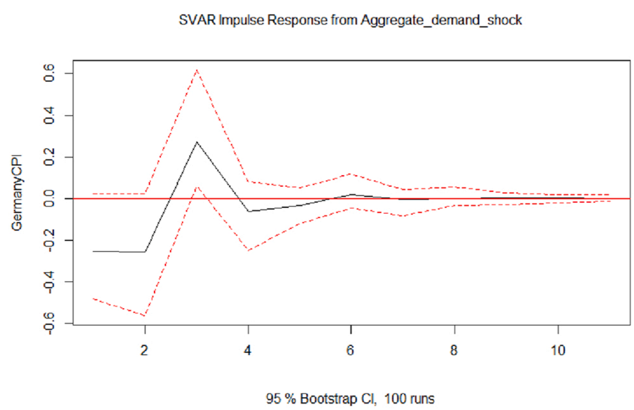
Source: Authors' computation.

Appendix B. Robustness checks

(a)



(b)



(c)

Fig. B1. Impulse response of CPI, Germany
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

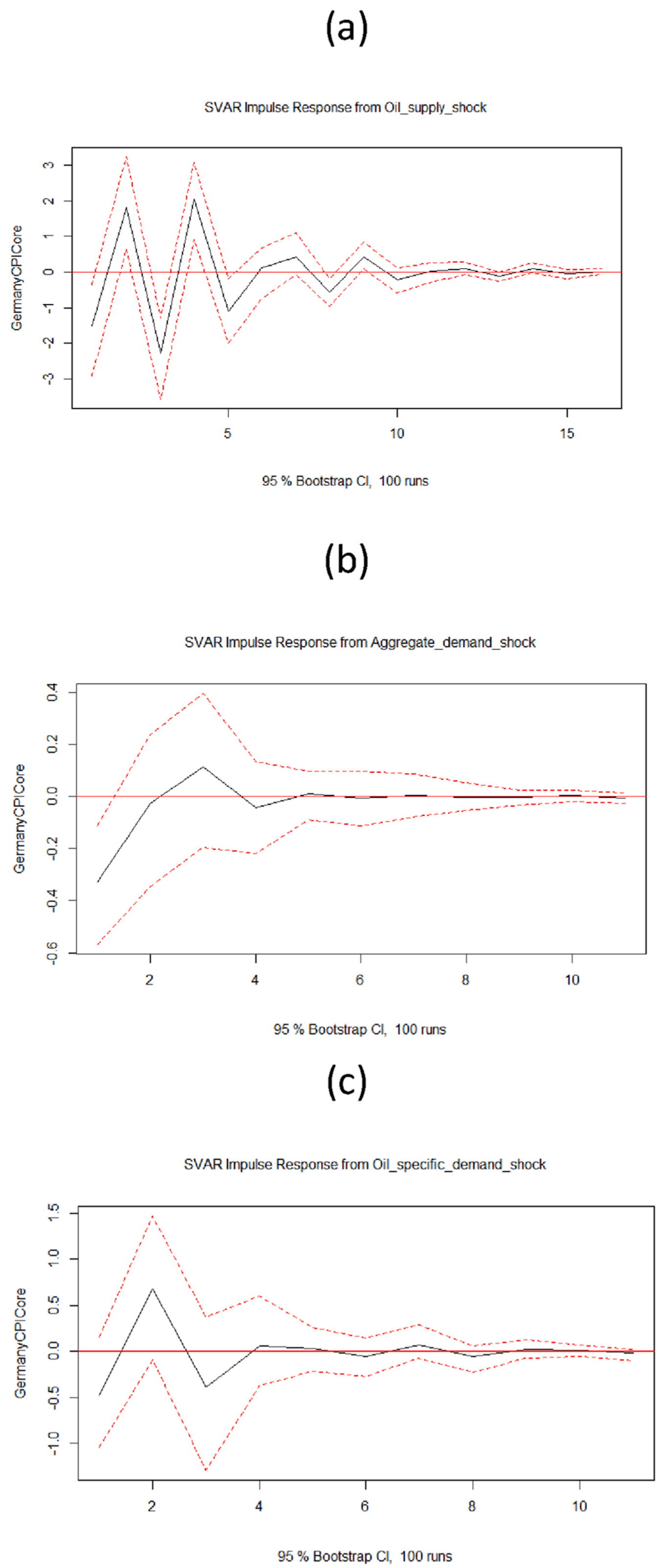


Fig. B2. Impulse response of core CPI, Germany
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

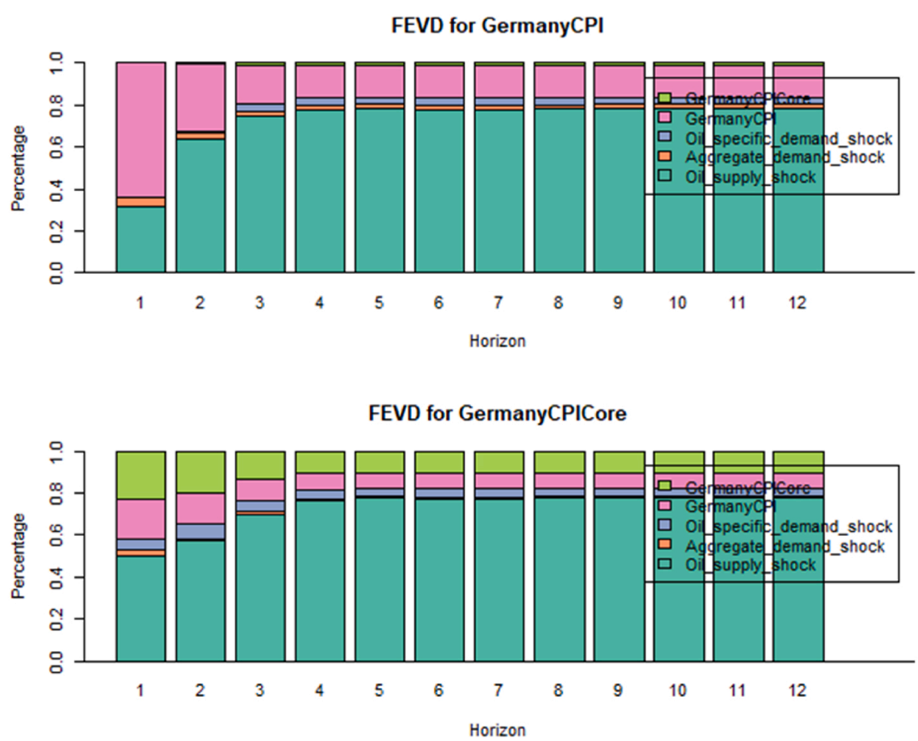


Fig. B3. FEVD for CPI and core CPI, Germany.
(Source: Authors' computation.)

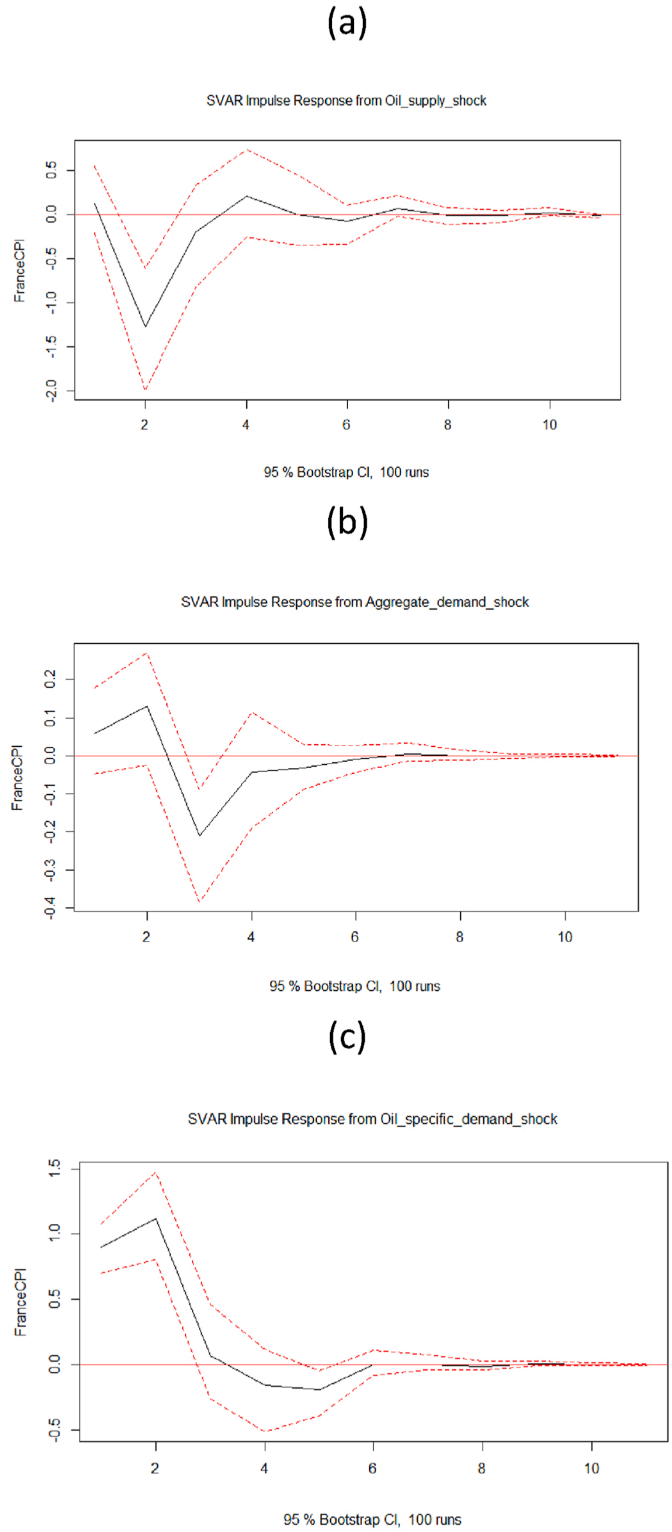


Fig. B4. Impulse response of CPI, France
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

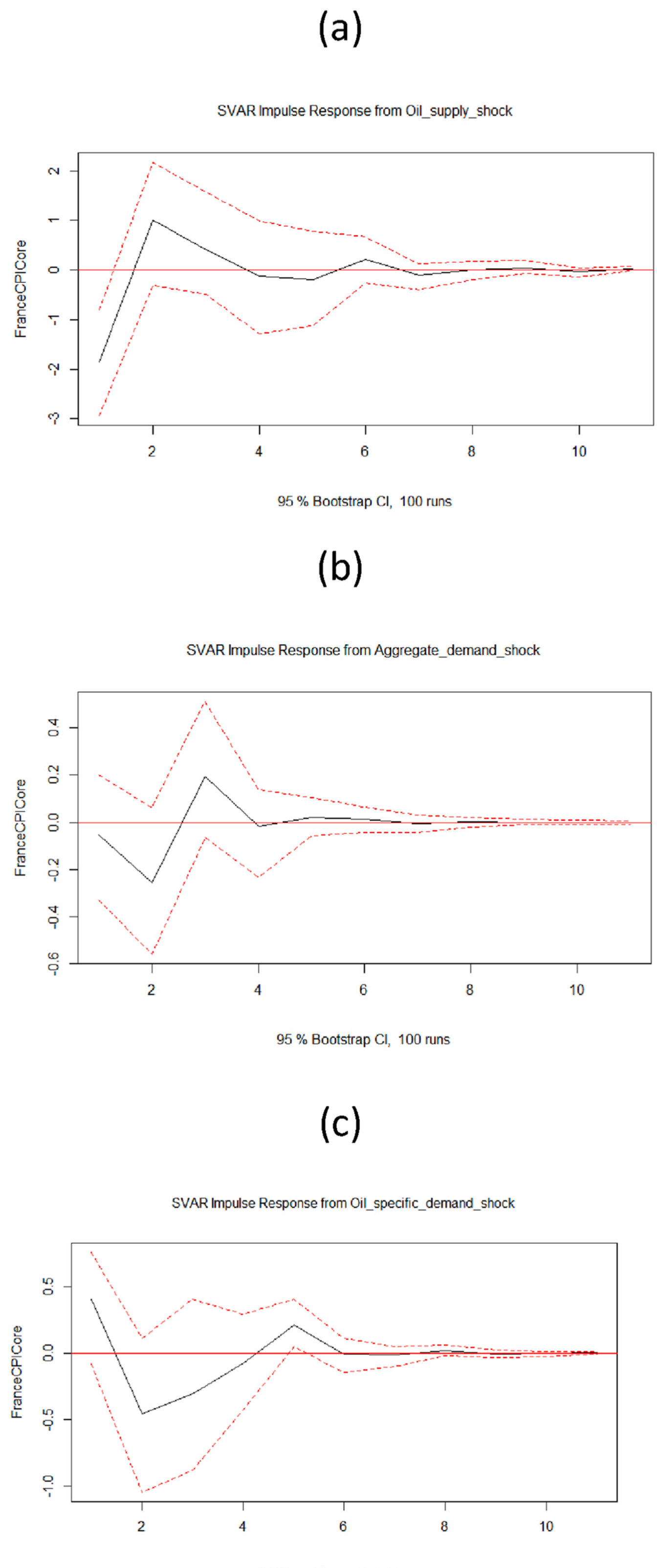


Fig. B5. Impulse response of core CPI, France
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

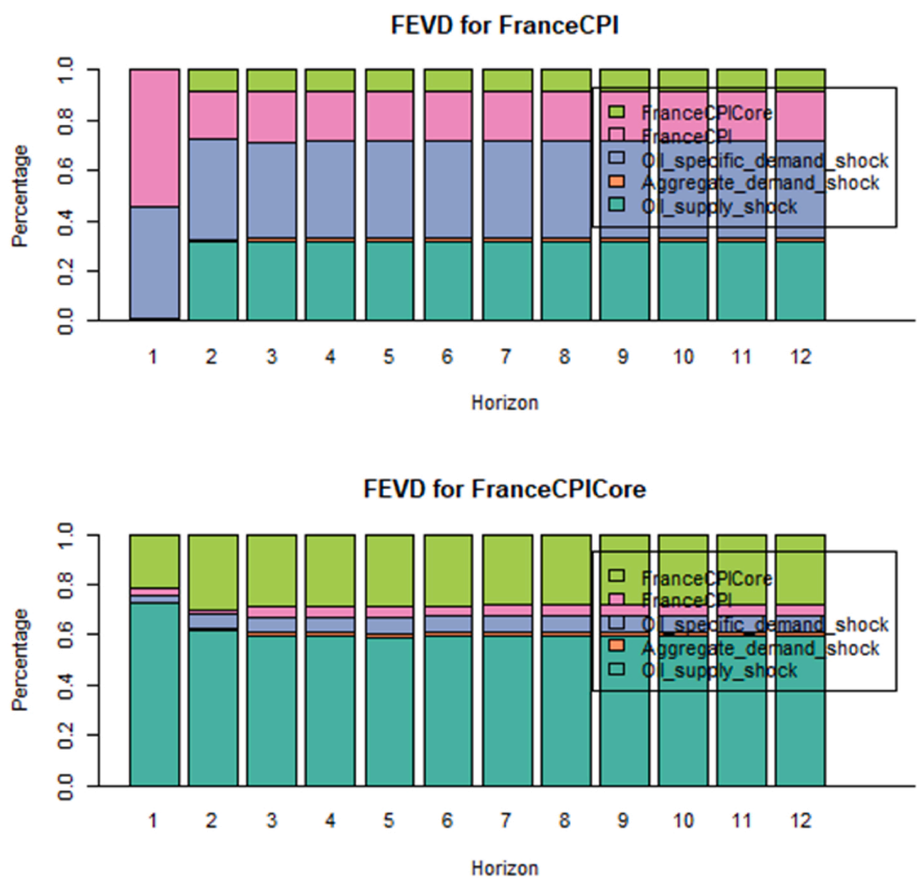


Fig. B6. FEVD for CPI and core CPI, France.
(Source: Authors' computation.)

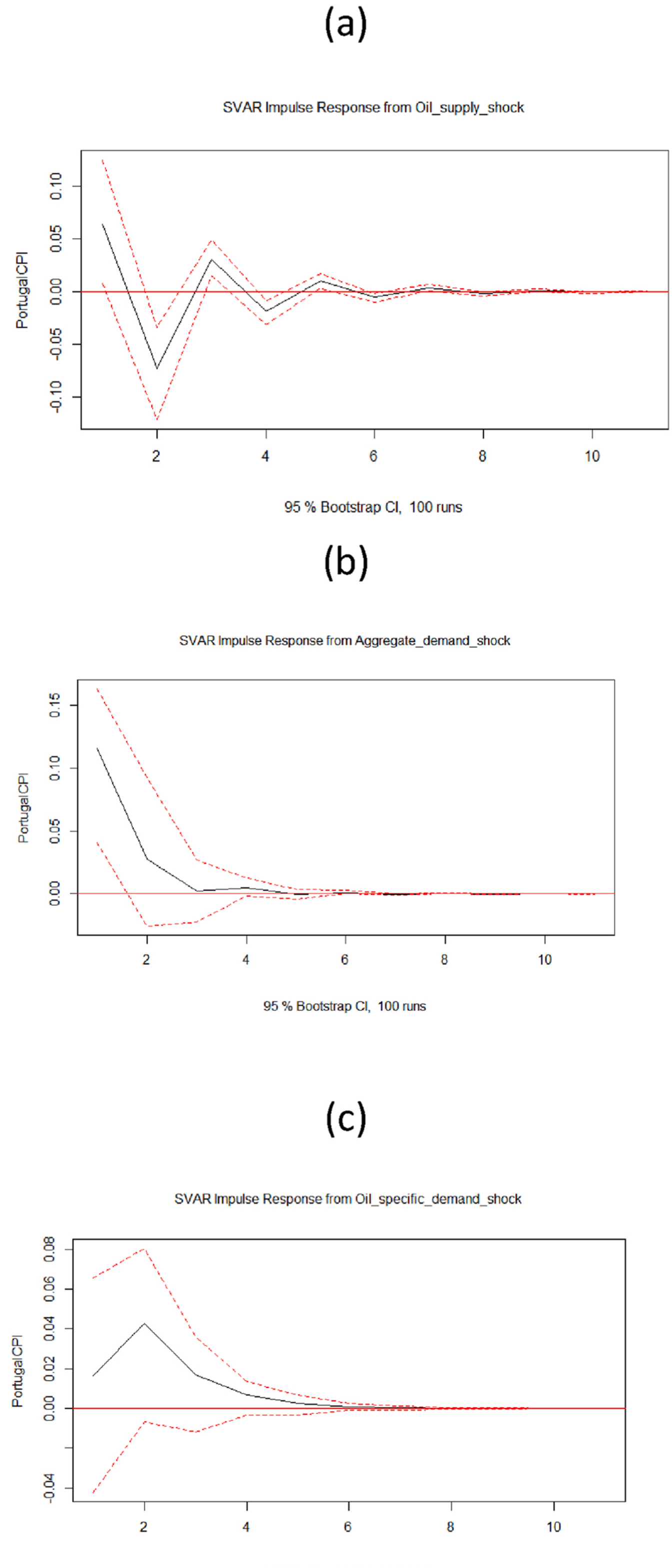


Fig. B7. Impulse response of CPI, Portugal
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

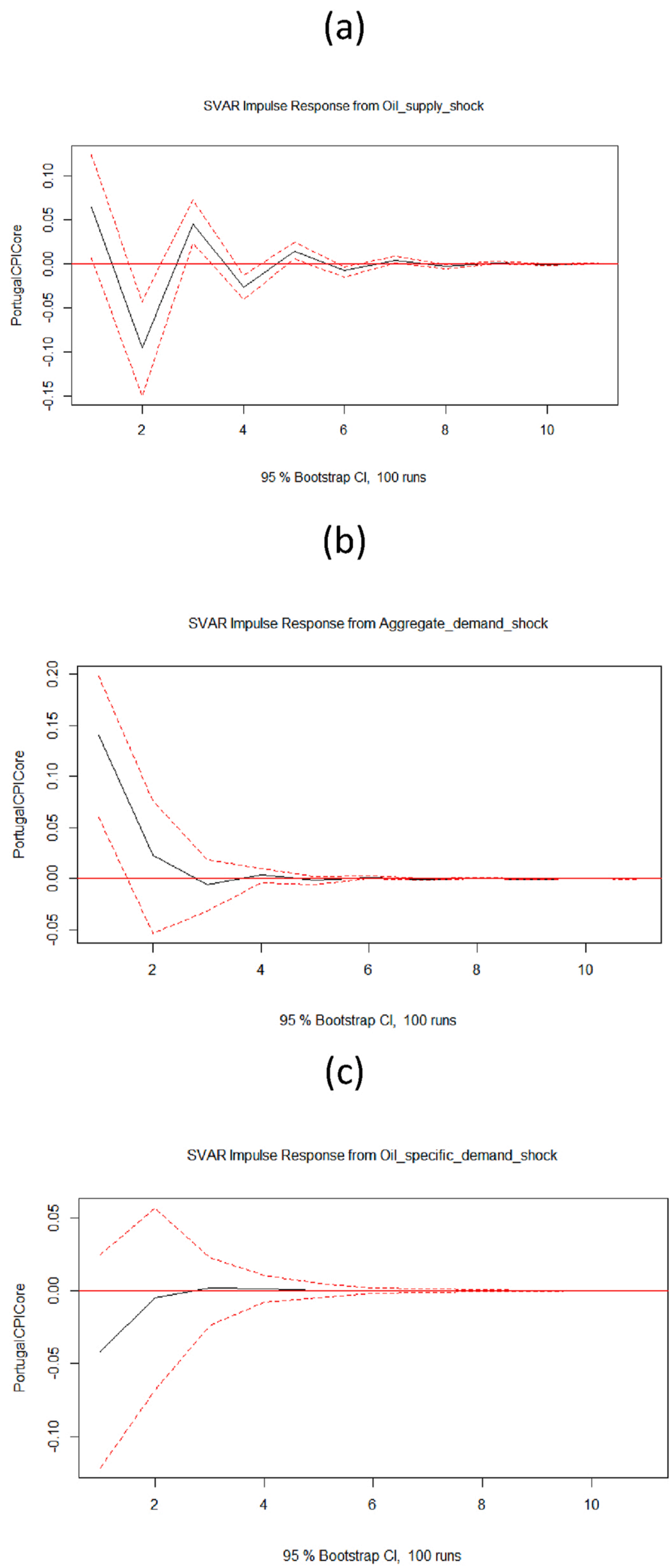


Fig. B8. Impulse response of core CPI, Portugal
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

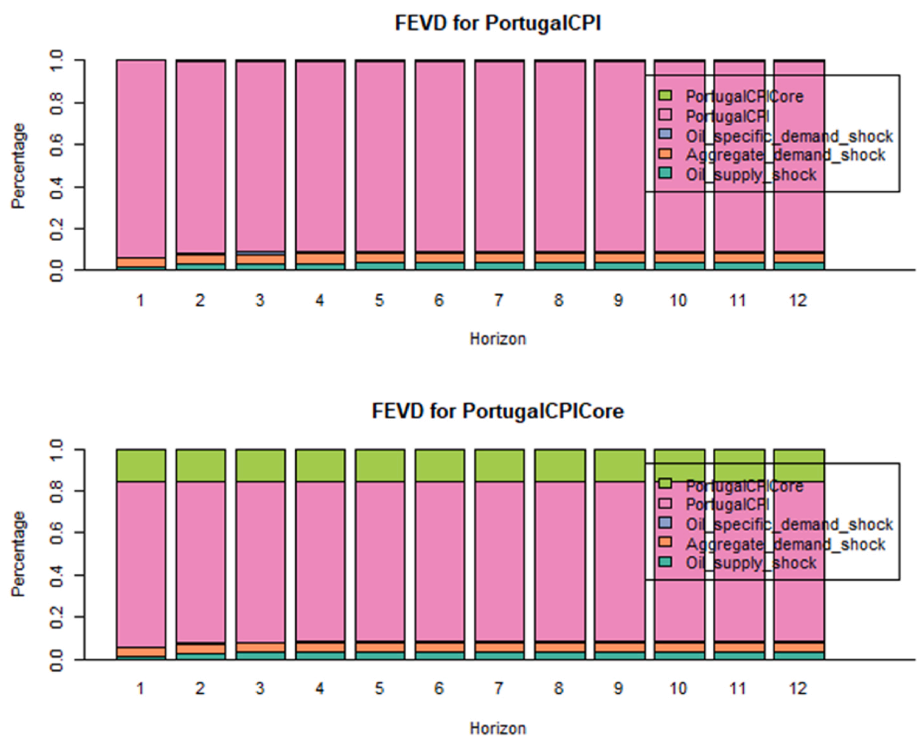


Fig. B9. FEVD for CPI and core CPI, Portugal.
(Source: Authors' computation.)

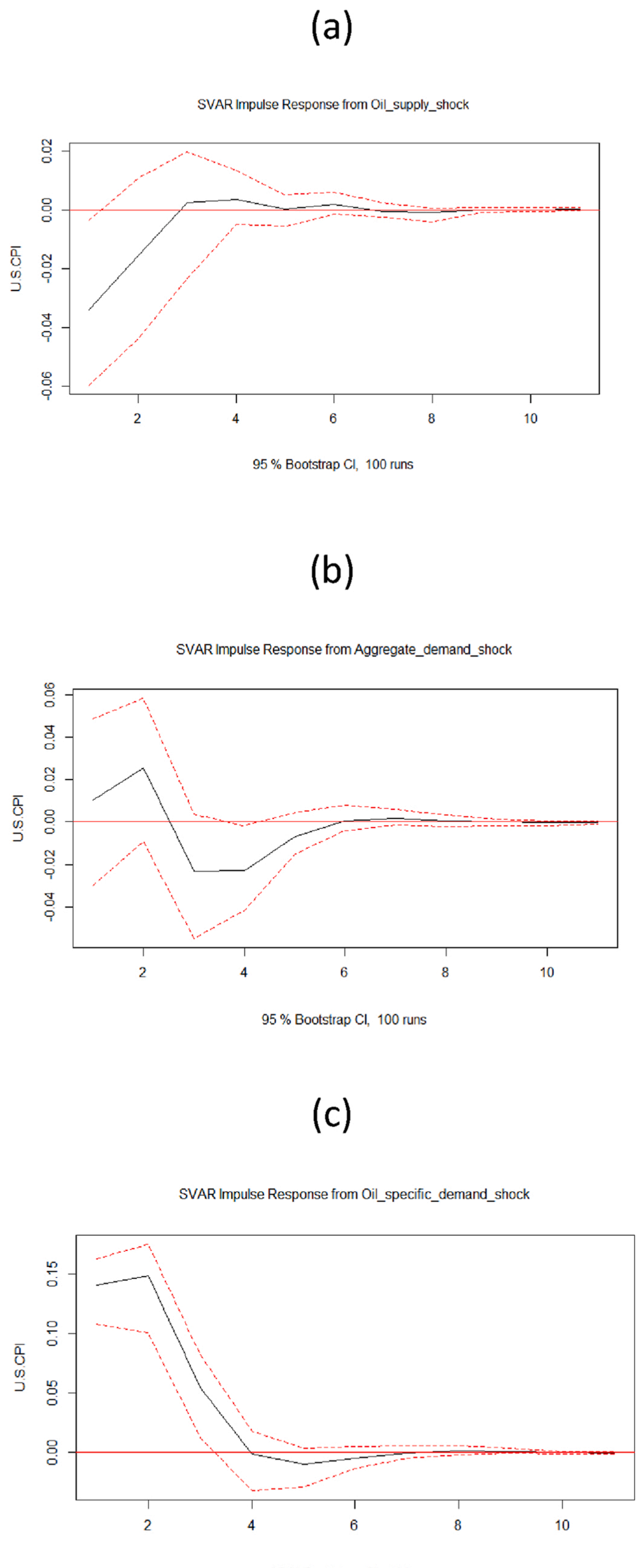


Fig. B10. Impulse response of CPI, US

Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

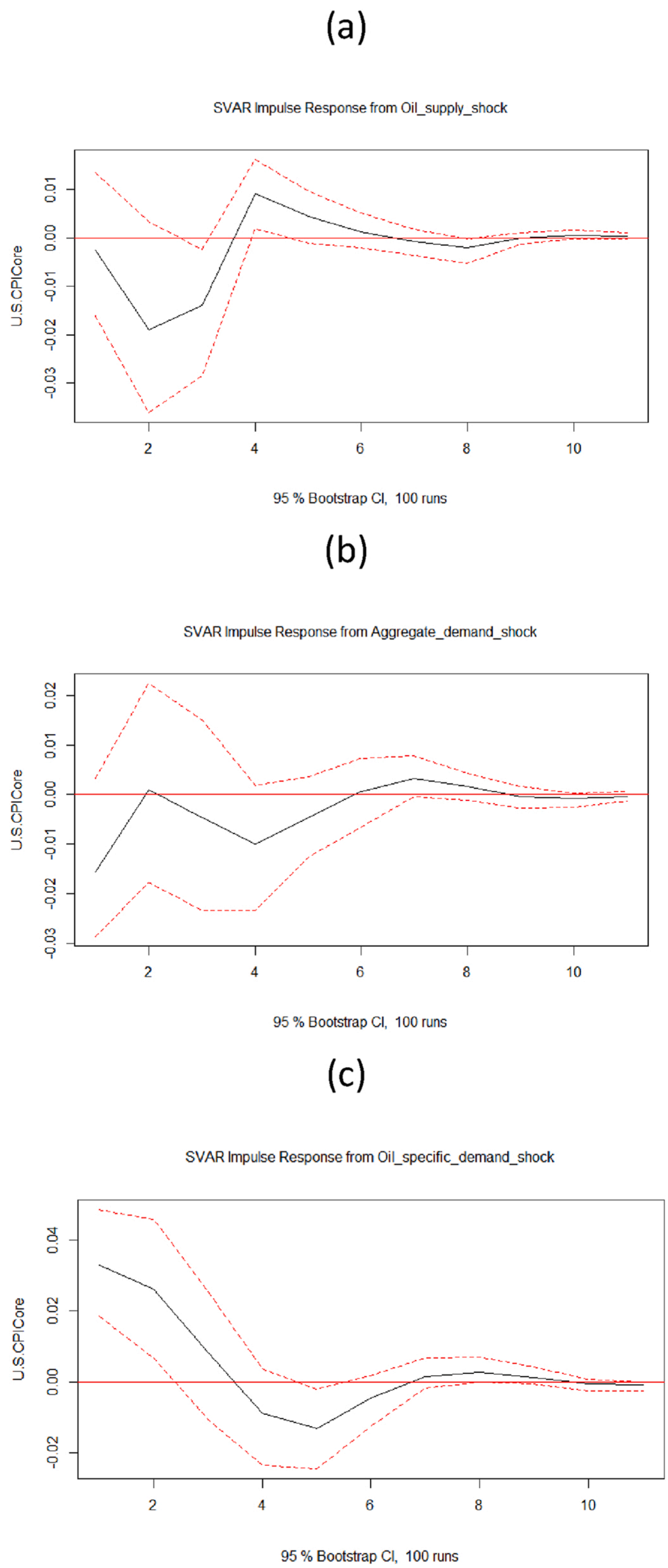


Fig. B11. Impulse response of core CPI, US
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

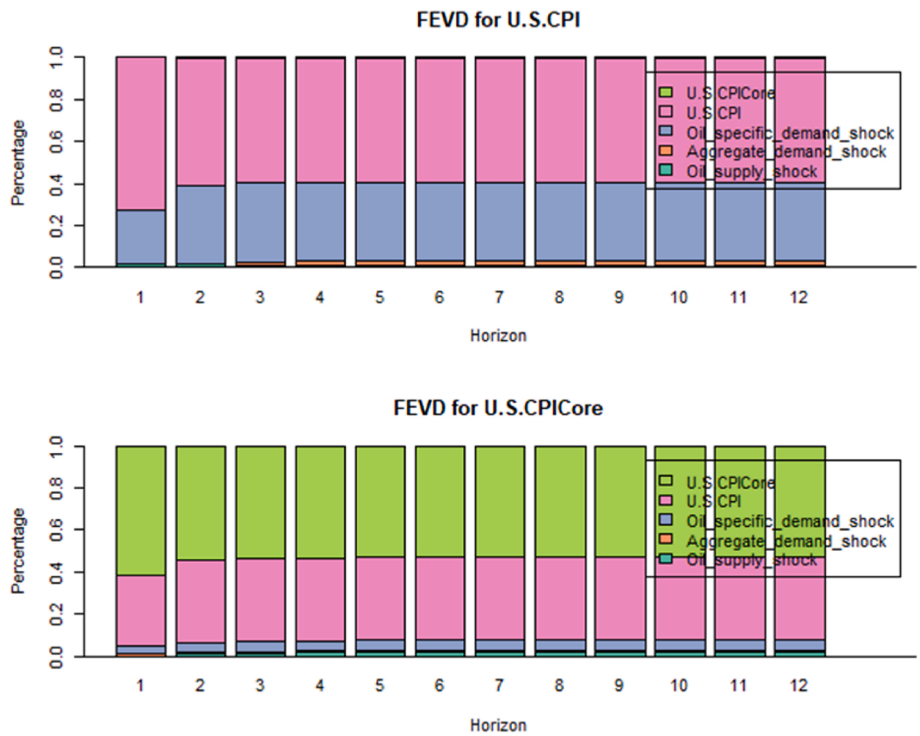
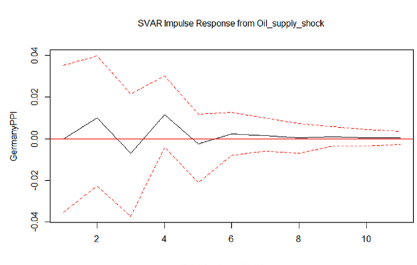
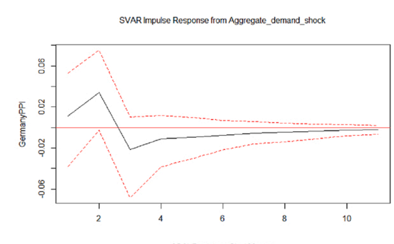


Fig. B12. FEVD for CPI and core CPI, US.
(Source: Authors' computation.)

(a)



(b)



(c)

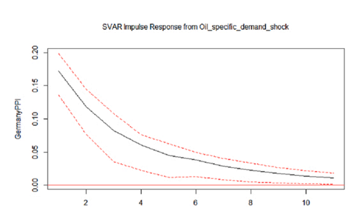


Fig. B13. Impulse response of PPI, Germany
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

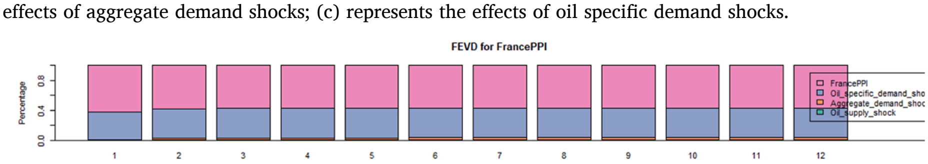


Fig. B14. FEVD for PPI, Germany.
(Source: Authors' computation.)

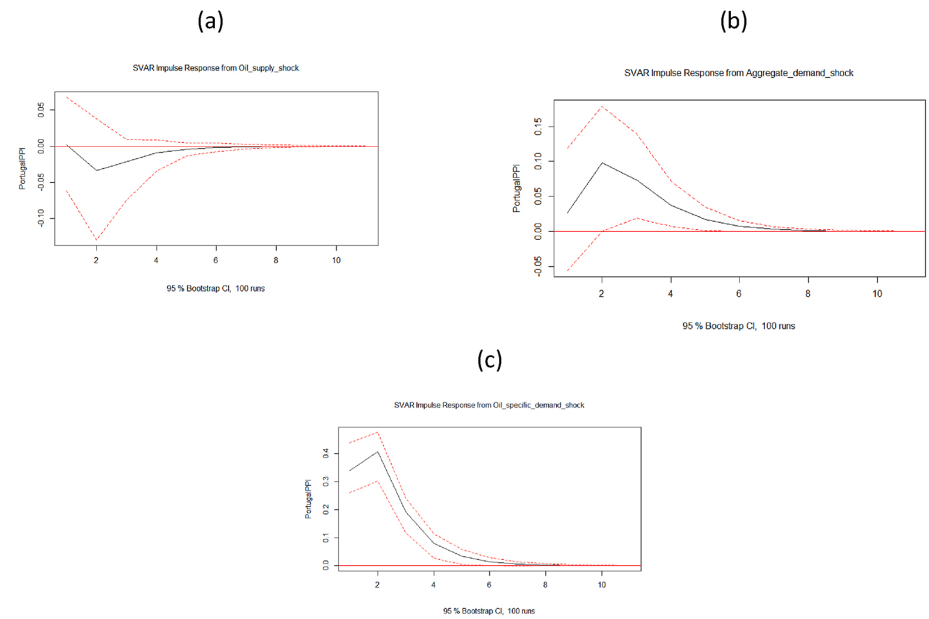


Fig. B15. Impulse response of PPI, France
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

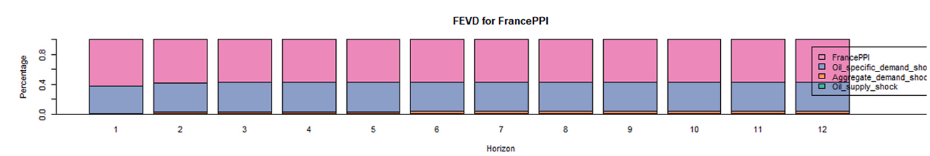


Fig. B16. FEVD for PPI, France.
(Source: Authors' computation.)

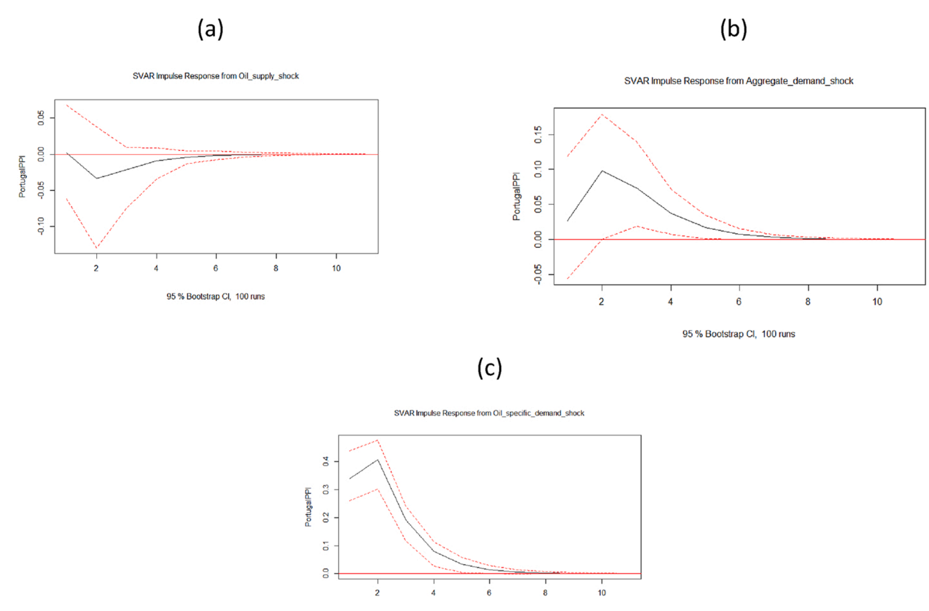


Fig. B17. Impulse response of PPI, Portugal
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

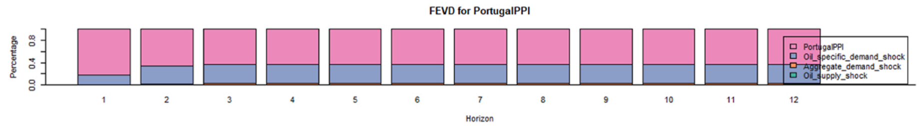


Fig. B18. FEVD for PPI, Portugal.
(Source: Authors' computation.)

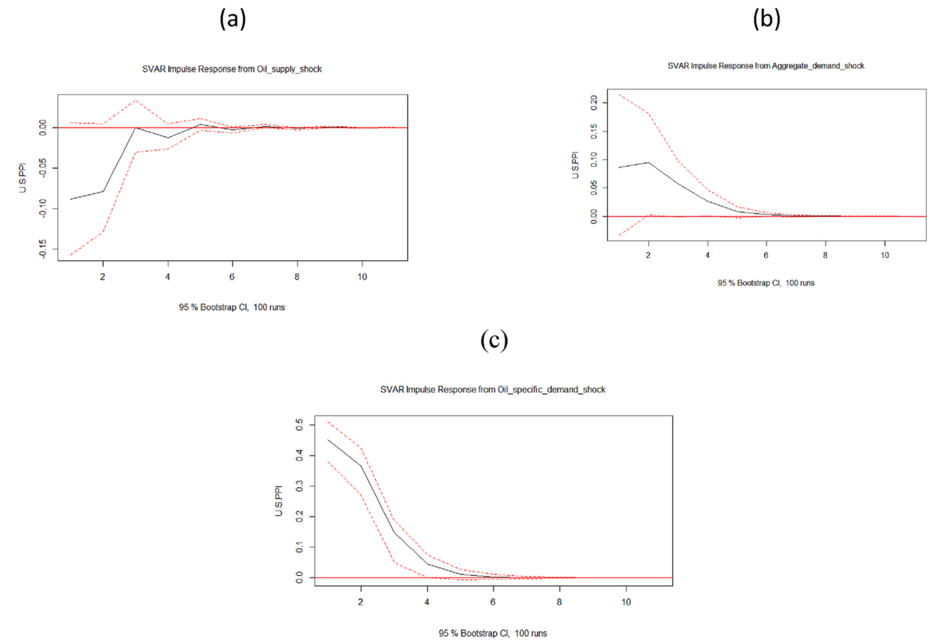


Fig. B19. Impulse response of PPI, US
Notes: The solid lines represent the variables response to shocks. The dashed red lines represent the 95 % confidence intervals. (a) represents the effects of oil supply shocks; (b) represents the effects of aggregate demand shocks; (c) represents the effects of oil specific demand shocks.

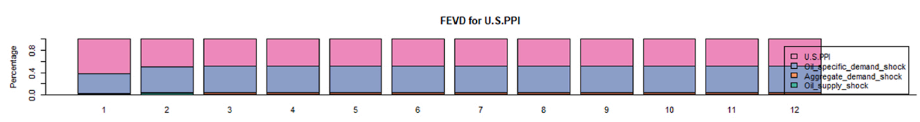


Fig. B20. FEVD for PPI, US.
(Source: Authors' computation.)

Data availability

Data will be made available on request.

References

Álvarez, L.J., Hurtado, S., Sánchez, I., Thomas, C., 2011. The impact of oil price changes on Spanish and euro area consumer price inflation. Econ. Modell. 28 (1–2), 422–431.

Baba, C., Lee, J., 2022. Second-Round Effects of Oil Price Shocks–Implications for Europe's Inflation Outlook.

Bachmeier, L.J., Cha, I., 2011. Why don't oil shocks cause inflation? Evidence from disaggregate inflation data. J. Money Credit Bank. 43 (6), 1165–1183.

Ball, L.M., Leigh, D., Mishra, P., Spilimbergo, A., 2021. *Measuring US Core Inflation: the Stress Test of COVID-19* (No. w29609). National Bureau of Economic Research.

Barrell, R., Pomerantz, O., 2008. Oil prices and world inflation. Natl. Inst. Econ. Rev. 203 (1), 31–34.

Baumeister, C., 2023. Pandemic, War, Inflation: Oil Markets at a Crossroads? (No. w31496). National Bureau of Economic Research.

Baumeister, C., Hamilton, J.D., 2019. Structural interpretation of vector autoregressions with incomplete identification: revisiting the role of oil supply and demand shocks. Am. Econ. Rev. 109 (5), 1873–1910.

Baumeister, C., Peersman, G., 2013. Time-varying effects of oil supply shocks on the US economy. Am. Econ. J. Macroecon. 5 (4), 1–28.

Bilgin, D., Ellwanger, R., 2024. A simple model of global fuel consumption. Energy Econ. 130, 107254.

Bodenstein, M., Erceg, C.J., Guerrieri, L., 2008. Optimal monetary policy with distinct core and headline inflation rates. J. Monetary Econ. 55, S18–S33.

Brief, S.P., 2022. Macroeconomic Implications and Differences of Oil and Gas Price Shocks.

Cai, Y., 2025. US-China tensions, global supply chains pressure, and global economy. Econ. Lett., 112283.

Caldara, D., Cavallo, M., Iacoviello, M., 2019. Oil price elasticities and oil price fluctuations. J. Monetary Econ. 103, 1–20.

Castillo, P., Montoro, C., Tuesta, V., 2020. Inflation, oil price volatility and monetary policy. J. Macroecon. 66, 103259.

Chen, M., Wen, Y., 2011. Oil price shocks and inflation risk. Economic Synopses 2011 (2011–07-06).

Choi, S., Furceri, D., Loungani, P., Mishra, S., Poplawski-Ribeiro, M., 2018. Oil prices and inflation dynamics: evidence from advanced and developing economies. J. Int. Money Finance 82, 71–96.

Ciner, C., 2011. Commodity prices and inflation: testing in the frequency domain. Res. Int. Bus. Finance 25 (3), 229–237.

Clerides, S., Krokida, S.I., Lambertides, N., Tsouknidis, D., 2022. What matters for consumer sentiment in the euro area? World crude oil price or retail gasoline price? Energy Econ. 105, 105743.

Conflitti, C., Luciani, M., 2019. Oil price pass-through into core inflation. Energy J. 40 (6).

Cuñado, J., de Gracia, F.P., 2003. Do oil price shocks matter? Evidence for some European countries. Energy Econ. 25 (2), 137–154.

Donovan, P., 2015. The Truth About Inflation. Routledge, New York.

Esteves, P.S., Neves, P.D., 2004. Efeitos económicos das flutuações do preço do petróleo. Boletim Económico. Banco de Portugal.

European Parliament, 2023. How the EU is boosting renewable energy. https://www.europarl.europa.eu/topics/en/article/20221128STO58001/how-the-eu-is-boosting-renewable-energy.

Gamber, E.N., Smith, J.K., Eftimoiu, R., 2015. The dynamic relationship between core and headline inflation. J. Econ. Bus. 81, 38–53.

Garzon, A.J., Hierro, L.A., 2021. Asymmetries in the transmission of oil price shocks to inflation in the eurozone. Econ. Modell. 105, 105665.

Garzon, A.J., Hierro, L.A., 2022. Inflation, oil prices and exchange rates. The Euro's dampening effect. J. Pol. Model. 44 (1), 130–146.

Hamilton, J.D., 2021. Measuring global economic activity. J. Appl. Econom. 36 (3), 293–303.

Herrera, A.M., Lagalo, L.G., Wada, T., 2015. Asymmetries in the response of economic activity to oil price increases and decreases? J. Int. Money Finance 50, 108–133.

Herrera, A.M., Pesavento, E., 2009. Oil price shocks, systematic monetary policy, and the "Great Moderation". Macroecon. Dyn. 13 (1), 107–137.

Hijazine, R., Al-Assaf, G., 2022. The effect of oil prices on headline and core inflation in Jordan. OPEC Energy Review.

Hong, M., Wang, X., Li, Z., 2022. Will oil price volatility cause market panic? Energies 15 (13), 4629.

Huntington, H.G., 2018. Measuring oil supply disruptions: a historical perspective. Energy Policy 115, 426–433.

Husaini, D.H., Lean, H.H., 2021. Asymmetric impact of oil price and exchange rate on disaggregation price inflation. Resour. Policy 73, 102175.

Jiménez-Rodríguez, R., 2022. Oil shocks and global economy. Energy Econ. 115, 106373.

Kilian, L., 2008a. The economic effects of energy price shocks. J. Econ. Lit. 46 (4), 871–909.

Kilian, L., 2008b. Exogenous oil supply shocks: how big are they and how much do they matter for the US economy? Rev. Econ. Stat. 90 (2), 216–240.

Kilian, L., 2009. Not all oil price shocks are alike: disentangling demand and supply shocks in the crude oil market. Am. Econ. Rev. 99 (3), 1053–1069.

Kilian, L., Lütkepohl, H., 2017. Structural Vector Autoregressive Analysis. Cambridge University Press.

Kilian, L., Park, C., 2009. The impact of oil price shocks on the US stock market. Int. Econ. Rev. 50 (4), 1267–1287.

Kilian, L., Zhou, X., 2023a. The econometrics of oil market VAR models. In: Park, Joon Y. (Ed.), Econometric Methodology in Empirical Applications. Emerald Publishing Limited, pp. 65–95. Essays in honor of.

Kilian, L., Zhou, X., 2023b. Oil Price Shocks and Inflation.

Kilian, L., Zhou, X., 2022. The impact of rising oil prices on US inflation and inflation expectations in 2020–23. Energy Econ. 113, 106228.

Kim, G., Vera, D., 2022. The effect of oil price fluctuation on the economy: what can we learn from alternative models? J. Appl. Econ. 25 (1), 856–877.

Kpodar, K., Liu, B., 2022. The distributional implications of the impact of fuel price increases on inflation. Energy Econ. 108, 105909.

LeBlanc, M., Chinn, M.D., 2004. Do high oil prices presage inflation? The evidence from G-5 countries. UC Santa Cruz Economics Working Paper 561, 04-04.

Lütkepohl, H., 2005. *New introduction to multiple time series analysis*. Springer Science & Business Media.

Renou-Maissant, P., 2019. Is oil price still driving inflation? Energy J. 40 (6).

Sek, S.K., 2023. A new look at asymmetric effect of oil price changes on inflation: evidence from Malaysia. Energy Environ. 34 (5), 1524–1547.

Valcarcel, V.J., Wohar, M.E., 2013. Changes in the oil price-inflation pass-through. J. Econ. Bus. 68, 24–42.

Van den Noord, P., André, C., 2007. Why has Core Inflation Remained so Muted in the Face of the Oil Shock?.

Wang, G., Sharma, P., Jain, V., Shukla, A., Shabbir, M.S., Tabash, M.I., Chawla, C., 2022. The relationship among oil prices volatility, inflation rate, and sustainable economic growth: evidence from top oil importer and exporter countries. Resour. Policy 77, 102674.

Wen, F., Zhang, K., Gong, X., 2021. The effects of oil price shocks on inflation in the G7 countries. N. Am. J. Econ. Finance 57, 101391.