Erasmus University Rotterdam

Erasmus School of Economics

Master Thesis

MSc Economics and Business - Financial Economics

The impacts on the world economy through the commodities market of the conflict between Russia and Ukraine from 2014 to 2022

A case study of the consequences for the Netherlands' imports and exports

Author:

Alexandre Nelva-Pasqual (499548an)

Supervisor:

Dr. P.J.P.M. (Philippe) Versijp

Second Assessor:

(Unknown yet)

May 30, 2022

ERASMUS UNIVERSITEIT ROTTERDAM

Erasmus School of Economics

Abstract

In this research we study the impacts of the Russian invasion of Ukraine in 2022 on the commodities for which these countries are major exporters, but also on the economic activity, expected inflation rate, and economic policy uncertainty. We compare these results with the same study for the impacts of the annexation of the Crimean peninsula in 2014. We lastly investigate the impact of the war in 2022 for the economy of the Netherlands through its imports and exports. To analyze the impacts of the war on the commodities we use Wald, likelihood-ratio, and cumulative sum tests for structural breaks and parameter stability. With regards to the impacts of the war on the economy in general we establish a short run structural vector autoregression model. Finally, for the impacts of the war on the Netherlands we study the importance of imports and exports in the investigated commodities and their percentage destinated and originating from Ukraine and Russia. We found evidence for increased volatility in the prices of commodities as a result of the war in Ukraine in 2022. We also found significant impacts of the war on economic activity, expected inflation rate, and economic policy uncertainty, although we have not determined a clear direction for these effects. Ultimately, we have established that for the Netherlands the main concern is with regards to disruptions in imports of crude oil, as these would lead to decreased production and exports of refined petroleum, the most lucrative Dutch export.

Keywords : War / Russia / Ukraine / Commodities / Economy / Netherlands

JEL Classification: E39, E44, E69, F00, F14, F40, G01, G15

Acknowledgements

First and foremost I would like to thank and express my sincere gratitude to my thesis supervisor Dr. P.J.P.M. Philippe Versijp for his guidance and feedback during the writing of the thesis, but also for his motivation, encouragement, and inspiration. I would also like to offer my special thanks to my girlfriend Natalia Kutina for her assistance at every stage of the research project and for her insightful comments, suggestions and continuous motivation in the accomplishment of this research. I would like to extend my sincere thanks to my parents François-Xavier and Anikó, my sisters Laetitia, Marie-Laure, and Emilie, and my grandparents Jean-Michel, Mathias, Mártha, and Anne-Marie for their unwavering support and belief in me.

NON-PLAGIARISM STATEMENT

By submitting this thesis, the author declares to have written this thesis completely by himself/herself, and not to have used sources or resources other than the ones mentioned. All sources used, quotes and citations that were literally taken from publications, or that were in close accordance with the meaning of those publications, are indicated as such.

Table of Contents

1. Introduction

On Thursday the 24th of February 2022 early in the morning, the president of the Russian Federation Vladimir Putin declared the beginning of a military ''special operation'', translating on the field as an invasion of the Ukrainian territory[1]. This event was actually a ramp up in the conflict between Russia and Ukraine which was going on since at least eight years when the Crimean peninsula was annexed by Russia (Havlik, 2014) (Bebier, 2015). At that time, the western democracies punished the Russian Federation with severe sanctions which were partly responsible for the considerable depreciation or the Russian ruble and contraction of the Russian gross domestic product (GDP), and for important depreciations in the European currencies (Kholodilin & Netsunajev, 2016). Yet, the sanctions imposed by the west on the Russian Federation since February 2022 were unprecedented in history both by their type and by their size (U.S. Department of the Treasury, 2022), portending unequalled impacts on both the Russian economy and the western economies. That is why now governments, companies, academics and all economists in general are facing an exceedingly difficult task which is of predicting as precisely as possible the various damages and consequences caused originally by the Russian invasion of Ukraine (Economic Intelligence, 2022).

It is established that Ukraine and Russia are major exporters of several key commodities which can be classified into three categories: energy, agricultural, and metals (The Observatory of Economic Complexity, 2022). These commodities will be further detailed and described later in this paper, but for the purpose of emphasizing the importance or Russia and Ukraine in the exports of these products, we refer the reader to the figures one to four in appendix five (Figure 1, Appendix 5) (Figure 2, Appendix 5) (Figure 3, Appendix 5) (Figure 4, Appendix 5). Because of the preponderance in the exports of these commodities, these two countries possess the power to move the prices of said products, whether voluntarily or not, by drastically changing their supply. Therefore, it is expected that any disruption in the supply of these goods would lead to an increase of their price. Moreover, we know that such disruptions already occurred in at least two aspects. The first one would be the direct impediments to production and exportation caused by the war such as the blockade around Ukraine's coasts preventing any exports through shipping (Wintour, 2022), or the looting of the goods and equipment by the Russian army (Liste & Fylyppov, 2022). The second disruption would be caused by the nature of the sanctions imposed on the Russian Federation. Indeed, one of the first sanctions against Russia was the exclusion of its major banks from the Swift banking system (Hotten, 2022).

[1] For this historical event we refer the reader to mainstream newspapers and media, in particular to CNN and the Financial Times (Hodge, Lister, Kottasova, & Helen, 2022) (Seddon, Reed, Olearchyk, Ivanova, & Foy, 2022).

These coercive measures might not have reached their purpose of ending the war but have caused severe hindrance for financial transactions between Russia and its trade partners especially in the EU (Energy Intel, 2022). More specifically, the sanctions have led to tensions where Russia started to request payments to be fulfilled in rubles currency (Reuters, 2022), and to close supply of gas to Poland and Bulgaria (BBC, 2022). Lastly, the European Union is planning to impose an embargo on Russian oil and gas, which foresees greater uncertainty as of the prices of related commodities.

If it is acknowledged that the war between Russia and Ukraine should significantly influence the market prices and volatilities of specific commodities, the size and the direction of this influence remains unknown. Moreover, it is unclear what consequences these changes in the commodities market would be for the rest of the economy. We expect the commodities crisis to be contagious, but we do not know to which extent it infects the stock market more broadly or by how much it increases inflation. We also are unsure about the risks of economic recession: if the prices of raw materials increase significantly, will the economic activity keep up? Will production be sustained at stable levels? Or will we see a drop in production along with plunges in GDP growths, sinking so low it would reach negative values? All these uncertainties are relevant issues which have to be investigated in order to help governments, firms, and institutions to take adequate steps to limit or at least prepare for the damaging consequences which would stem from the war between Russia and Ukraine.

This leads us to the research question of this paper. Indeed, in this study we address the issues raised previously, namely, we investigate the direct impact of the Russia-Ukraine war on the commodities market for the goods for which the two countries are large exporters. In particular, we look at the suspected effect on commodity prices and volatilities and compare it to the same effects when the Crimean Peninsula was annexed in 2014, in an attempt to determine whether this invasion started in February 2022 is more significant or not. Furthermore, we study the implicit, or the alleged, indirect effect of the war on the economy in general. We do so by exploring the effects of the commodity price changes on some key macroeconomic indicators such as inflation, economic activity, or economic uncertainty. Lastly, we utilize our results to specifically probe the case of the Netherlands, also distinctly pointed out the consequences at the government, firm, and individual level. Whence our research question:

What are the impacts: on and through the commodities for which Russia and Ukraine are major exporters, on the economic activity, inflation, and economic policy uncertainty; caused by the conflict between Russia and Ukraine from 2014 to 2022; how are these effects compelling in 2022 and how does it affect the Netherlands peculiarly?

With this question and throughout this paper we explore the effects of the crisis between Russia and Ukraine since 2014 by constructing models predicting the commodity prices for which Russia and Ukraine are major exporters, and we show that these models are significantly different before and after the invasion of February 2022. We proceed likewise for models predicting macroeconomic indicators, namely inflation, economic activity, and economic policy uncertainty based on the same commodity prices. By analyzing and comparing these statistical constructions we can potentially forecast and predict short- and long-term future trends impacting also the global stock market, and from this assay determine the significance and repercussion for the Netherlands. Specifically, we look at the importance of the commodities, for which Russia and Ukraine are major exporters, and their proportion in the imports and exports of the Netherlands.

This study serves the aim to achieve social relevancy, inasmuch as it, especially for the Netherlands, provides indications on the importance of some factors, for individuals, firms, or government, to get a clearer picture on some reasons of the changes in daily costs, operations, or budget spendings and incomes in the next following months and, conceivably, years. Knowing the important factors pressuring the prices of bread and petrol (MacFarlane, 2022) (BBC , 2022), disrupting the production chain of some goods (Hanna, 2022), and provoking a dearth of national revenue from exports; all the afflicted parties can take better informed decisions.

Furthermore, this research has the ambition to deliver effective and practical material to the academic community of economic researchers. In point of fact, this paper comes amongst the first analyses of the conflict between Russia and Ukraine as of February 2022. Thence the study provides a foundation for future research on a topic which should draw particular attention from the economists, as such sanctions from these magnitudes never occurred yet in history. All in all, we contribute to the scientific community by pioneering with early investigation on what seems to be an unparalleled economic crossroads for the world.

The rest of the paper is structured as follows. In section 2. Literature review we go over the existing literature, describe what is already documented, and based on what is missing we establish a set of hypotheses. In the ensuing propreantepenultimate section 3 we outline the experimental design of this study and define the methodology used to analyze the data. In the subsequent preantepenultimate section 4. Data we provide a clear depiction of the data used throughout this research, with a basis for why, how and from which reliable source it was obtained. In the following antepenultimate section 5. Results we present the results of the analysis for each hypothesis established in section 2. Literature review. In the penultimate section 6. Discussion we make the links between our results and the existing literature; we expose the limitations of the research and form suggestions for future research. Finally, the ultimate section 7. Conclusion concludes.

2. Literature review

Before going over the existing literature, we define some important notions which are linked to this research. The most important concept is the Russian invasion of Ukraine as of February 2022. This act of war is an event that is a turning point in a conflict which has lasted for at least the eight preceding years, starting with the Russian annexation of the Crimean Peninsula (Bebier, 2015). This invasion, qualified as a ''special operation'' by the Russian president Vladimir Putin, occurred after rising tensions between Russia and Ukraine, increased military presence at the borders, and threats about and against Ukraine joining the North Atlantic Treaty Organization (NATO) (Kirby, 2022). The initial expectations of a so called ''blitzkrieg'' war have now transformed into fears of a long term war where Russia already conquered vast territories in the South and the East of Ukraine, and where the Ukrainians, armed by the West, are now determined to reclaim their lost ground (NPR, 2022) (Lutz, 2022) (Bella, 2022).

Another important notion for this paper is the commodities market. Commodities are raw materials or primary products, usually split in two categories: hard commodities including metals which are used for industrial production; soft commodities which include agricultural products such as corn or wheat (Hayes, 2021). Commodities can otherwise be classified in three main categories, namely agricultural, energy, and metals (Bloomberg, 2022) (Markets Insider, 2022). These three categories will be part of the statistical analyses later in this paper, in the results section 5. Results.

The economic activity has already been mentioned earlier but was not defined yet. An economic activity is characterized by a chain starting with an input of products followed by a production process and ending with an output of products (European Commision, 2020). In this research, by economic activity we refer mainly to the levels of industrial production worldwide. As later explained in the data section 4. Data, we use the Baltic Dry Index (BDI) to represent the economic activity. The BDI is an index updated on a daily basis and measuring the costs of shipping raw materials (Kopp, 2021). It consists of three indices (Capesize, Panamax and Supramax) and assesses the freight costs on shipping routes around the globe (Corporate Finance Institute, 2022).

In the introduction of this study, we discussed economic policy uncertainty. This uncertainty is defined on Wikipedia as a type of economic risk representing the unsettled expectations of future government policy (Wikipedia, 2022). In our study we introduce in the data section 4. Data the global Economic Policy Uncertainty (EPU) index to represent this risk previously defined. The EPU created by Baker, Bloom and Davis (2016) is a proxy for national uncertainty based on newspaper coverage frequency and it is used as a predictor for changes in investment, GDP, and unemployment. The global EPU is a weighted average of the EPU's of 21 countries with the most influent economies (Baker, Bloom, & Davis, 2022). We chose this indicator rather than another which would be more focused and would better capture the magnitude of the consequences of the war (for example the credit default swap spread on Ukrainian assets). We reach this decision for practical reasons and also as the results with the EPU are more easily comparable with the results of other researches.

The last but not least important notion to understand for this research is inflation. Inflation is defined as the decline over time in purchasing power of a currency (Fernando, 2022). To measure the inflation, economists look at the increase in the average price of a number of necessary and primary goods (Alchian & Klein, 1973).

2.1 The impact of the Russian invasion of Ukraine on the commodities market

The existing literature reports numerous evidence for significant impact of the supply and demand on the prices and volatility of commodities. Indeed, it was proved by Stuermer (Stuermer, 2018) based on 174 years of data that especially the prices of mineral commodities were mainly driven by demand and supply shocks. Stuermer determined that demand shocks remain for 15 years whereas supply shocks remain for 5 years (Stuermer, 2018). Also, Piesse and Thirtle (Piesse & Thirtle, 2009) argue that the main driver of the increase in price of agricultural commodities in 2007-2008, is the lower level of supply for these goods. Other research find a link between economic activity and the commodity prices (Gargano & Timmermann, 2014) (Alquist, Bhattarai, & Coibion, 2014) (Alquist, Bhattarai, & Coibion, 2020) (Liu & Serletis, 2021) (He, Wang, & Lai, 2010) (Cheung & Morin, 2007). The economic activity can be viewed as a proxy for the level of industrial production which is a proxy for the demand of raw materials thus commodities in general (Labson & Crompton, 1993) (Herrera, Lagalo, & Wada, 2011).

On the other hand, we know from extensive literature that an exogenous event can cause structural breaks in time series regressions (Cró & Martins, 2017). There is empirical evidence that structural breaks have an effect on, among other variables, the financial returns (Andreou & Ghysels, 2009) (Lamoureux & Lastrapes, 1990a) (Lamoureux & Lastrapes, 1990b) (Andreou & Ghysels, 2006a) (Aue & Horváth, 2013). Moreover, it is possible to determine if a time series has a structural break whether the suspected date of the break is known or not, and it is also possible to scan the time series for multiple potential breaks (Glynn, Perera, & Verma, 2007) (Stock, 1994) (Perron, 2006) (Pástor & Stambough, 2001) (Perron & Zhu, 2005) (Rumelt, 2009) (Breitung & Eickmeier, 2011) (Rapach & Strauss, 2008). From this literature we understand that an event can be considered to have an effect on a financial indicator if this event is the source of structural breaks in the time series of this financial indicator.

Furthermore, the latest literature analyzing the Russia-Ukraine war of 2022 already observe the impact of this war on the commodities market as Russia and Ukraine are major exporters of key products such as oil, gas, titanium, platinum and other metals and agricultural commodities (The Observatory of Economic Complexity, 2022) (Liadze, Macchiarelli, Mortimer-Lee, & Juanino, 2022). More specifically, the current research identifies the effects of the war as disruptions and shortage in the supply of key exported products from Russia and Ukraine (Mbah & Wasum, 2022) (Liadze, Macchiarelli, Mortimer-Lee, & Juanino, 2022). As a direct consequence of these disruptions, researchers point the increased prices and volatility for these same commodities (Guenette, Kenworthy, & Wheeler, 2022) (Costola & Lorusso, 2022) (Canuto, 2022) (Umar, Polat, Choi, & Teplova, 2022).

Based on the aforementioned literature, we can question whether the Russian invasion of Ukraine is affecting key exported commodities like it is advocated in the existing literature. More specifically, we can investigate whether the invasion of Ukraine is the source of structural break (or breaks) in the time series of specific exported products. Whence the first hypothesis of this research:

H1: The Russian invasion of Ukraine in 2022 had a significant permanent effect on the returns of key commodities for which Russia and Ukraine are large exporters.

With this hypothesis we expect to address the first problem raised in our research question, namely whether the war of 2022 has a noticeable effect on the commodities market. However, the research question of this paper also includes a similar investigation for the year 2014. Indeed, we would like to determine whether the Crimean annexation of 2014 also significantly affected the commodities market. Moreover, we would like to compare the significance of the effects of 2022 to the effects of 2014. This leads to the following two hypotheses:

H2: The Russian annexation of Crimea in 2014 had a significant permanent effect on the returns of key commodities for which Russia and Ukraine are large exporters.

H3: The effects found in the first hypothesis are considerably more significant than the effects found in the second hypothesis.

The results of the second hypothesis are therefore a reference base which we compare to the results of the first hypothesis in order to answer the third hypothesis. With the third hypothesis we show the relative importance of the war of 2022 when compared to the closest most similar event. These three hypotheses are enough for us to determine whether the Russian invasion of Ukraine in 2022 had a real effect on the commodities market. These hypotheses also allow us to gauge the importance and magnitude of these effects.

2.2 The impact of the Russian invasion of Ukraine on the economy in general

We have already discussed the observed impacts of demand on commodity prices. We saw that the economic activity had an impact on commodity prices (Stuermer, 2018). However, there also exists a relationship on the other way around, namely that commodity prices impact the economic activity. Indeed, the academic literature found evidence for a significant effect mostly of the oil commodity prices on the global economic activity (He, Wang, & Lai, 2010) (Rafiq, Salim, & Bloch, 2009) (Cunado & De Gracia, 2005) (Ahmed & Sarkodie, 2021). Researchers also find a significant effect of agricultural commodities and metals on macroeconomic variables including the economic activity (Oviedo-Gómez, Viafara, & Candelo, 2022) (Robinson, et al., 2015) (Morris, Kaplinsky, & Kaplan, 2012) (Karanasos & Yfanti, 2021).

Furthermore, there also exists evidence of influence of the commodities market on inflation. The literature suggests that a rise in commodity prices leads to a rise in inflation through a strong and significant statistical relationship (Bhattacharya & Bhattacharyya, 2001) (Moreira, 2014) (Kirchene, 2008) (Ciner, 2011). There is a general consensus about this relationship such that, based on these findings, investment strategies were establish for hedging against the inflationary risk (Crawford, Liew, & Marks, 2013) (Zaremba, Umar, & Mikutowski, 2019). However, the literature also shows that finding accurate and high precision measurement of the impact on inflation remains very complex (Diewert, 1998). Moreover, empirical data appears to indicate a degradation over the years of the strength of the impact of commodity prices on inflation (Furlong & Ingenito, 1996). Specifically, recent research emphasizes on the impacts of higher energy prices, and particularly oil prices, on inflation in Europe (Moessner, 2022) and Asia (Binti Mohd Shafie, Tan, & Sek, 2022) (Iqbal, Nadim, & Akbar, 2022).

With regards to the potential links between the commodities market and policy uncertainty, the literature is weak and does not provide consensus. Indeed, there is no evidence of the commodities having an impact on economic policy uncertainty. The literature rather tends to study the impact of uncertainty on the commodity prices and find significant statistical relationships (Shahzad, Raza, Balcilar, Ali, & Shahbaz, 2017) (Khalifa, Otranto, Hammoudeh, & Ramchander, 2016) (Gevorkyan & Gevorkyan, 2012) (Tapiero, 2008).

Lastly, there already is academic research investigating the impact of the Russian invasion of Ukraine in 2022 on the macroeconomic indicators discussed previously. Indeed, there are numerous studies suggesting risks of lower permanently damaged economic activity worldwide and potential recessions (Ozili, 2022) (Astrov, Grieveson, Kochnev, Landesmann, & Pindyuk, 2022) (Neely, 2022). The papers also show direct evidence of increased inflation due to the increased commodity prices due to the war in Ukraine (Dräger, Gründer, & Potrafke) (Yeoman, 2022) (Canuto, 2022). However, there is little to no investigation about the impact of commodities instability (due to the war) on the economic policy uncertainty, only indirectly studies lead to believe that the unstable commodities market could be the cause for increased policy uncertainty (Boubaker, Goodell, Pandey, & Kumari, 2022) (Pestova, Mamonov, & Ongena, 2022).

Based on the previously discussed literature, we can question whether the Russian invasion of Ukraine is affecting the economy in general, thus whether the economic activity, the inflation, and the uncertainty were affected by the invasion. Whence the fourth hypothesis of this research:

H4: The Russian invasion of Ukraine in 2022 had a significant effect on the global economic activity, inflation, and uncertainty.

With this hypothesis we expect to address the second problem raised in our research question, namely whether the war of 2022 has a noticeable effect on the economy in general. However, the research question of this paper also includes a similar investigation for the year 2014. Indeed, we would like to determine whether the Crimean annexation of 2014 also significantly affected the economy in general. Moreover, we would like to compare the significance of the effects of 2022 to the effects of 2014. This leads to the following two hypotheses:

H5: The Russian annexation of Crimea in 2014 had a significant effect on the global economic activity, inflation, and uncertainty.

H6: The effects found in the fourth hypothesis are considerably more significant than the effects found in the fifth hypothesis.

The results of the fifth hypothesis are therefore a reference base which we compare to the results of the fourth hypothesis in order to answer the sixth hypothesis. With the sixth hypothesis we show the relative importance of the war of 2022 when compared to the closest most similar event. These three hypotheses are enough for us to determine whether the Russian invasion of Ukraine in 2022 had a real effect on the economy in general. These hypotheses also allow us to gauge the importance and magnitude of these effects.

2.3 The impact of the Russian invasion of Ukraine on the Netherlands

We have seen what the scientific community found so far about the effect of the war between Russia and Ukraine on the commodities market and the economy in general. For this research we also review the papers investigating the effects of the war on specific countries. There are of course analyzes of the impact on the Ukrainian and Russian economies, predicting decreases in GDP up to 16.5% (for Russia), recessions, and considerable losses in revenues due to the sanctions mostly on the traded energies (Astrov, Grieveson, Kochnev, Landesmann, & Pindyuk, 2022) (Pestova, Mamonov, & Ongena, 2022).

Other researchers studied the impacts on extra European countries. It was established that except some oil exporting countries (Algeria, Angola, Nigeria), African nations in general would suffer from important budget deficit mostly due to the more expensive food imports (Ali, Azaroual, Bourhriba, & Dadush, 2022). Similar results are found for Azerbaijan, where expensive food imports are compensated by larger revenues in exports due to higher prices in oil (Mammadov, 2022). For India, however, since the country is not exporting oil but importing it and since it does not export wheat, the consequences of the war are very costly and have a strong negative effect on the Indian economy (Dole, 2022). It therefore seems that a country would benefit from the war at least partially if it exports either agricultural products or oil. On the other hand, if a country is neither an exporter of food, nor an exporter of oil, then its economy is suspected from the literature to suffer considerably.

Regarding the impacts of the war between Russia and Ukraine, there are few to no study investigating the effects on European economies. Indeed, the literature suggests important consequences for the EU with respect to the USA, but mostly due to the energy trades between the EU and Russia, and not because of the food imports or exports (Astrov, Grieveson, Kochnev, Landesmann, & Pindyuk, 2022). For the German economy, highly dependent on the Russian energy imports, there are predictions of GDP declines of up to 3%, but these are presented as minor.

Based on this review we understand that the imports and exports of agricultural and energy products are important factors to take into consideration when observing the damages of the Russian war on an economy. But are those factors the only one that should be considered? This question will be treated as part of the following last hypothesis of this research:

H7: What are the impacts of the Russian invasion of Ukraine in 2022 on the Netherlands and its economy?

With this hypothesis we expect to address the third and last problem raised in our research question, namely whether the war of 2022 has a noticeable effect on the Dutch economy. For this issue we do not compare with the same effects following the annexation of Crimea in 2014. The results of the seventh hypothesis are therefore compared to the results of similar research to allow for an assessment of the relative importance of the consequences war of 2022 on the Netherlands. This hypothesis is thus enough for us to determine whether the Russian invasion of Ukraine in 2022 had real effects on the Dutch economy and will also allow us to gauge the importance and magnitude of these effects.

We justify the choice of the Netherlands for this study by firstly mentioning that similar research exists but not for the Netherlands, hence the new material brought to the academic literature. Moreover, the Netherlands is an interesting case as its main and most lucrative export is refined petroleum (The Observatory of Economic Complexity, 2022) while it heavily depends on Russian crude oil imports (Offshore Technology, 2022).

3. Methods

Throughout this research we test with structural breaks whether the Russian invasion of Ukraine in 2022 had an impact on the commodities markets. We then investigate with vector autoregressive models whether and how this war impacted the economy in general. Lastly we study the impacts of the war on the Netherlands mainly via the impacts on the imports and exports of the investigated commodities.

3.1 Methods for the commodities market

This study defines itself as an empirical research. Indeed, we draw conclusions based on empirical and verifiable data. These evidences can be obtained via quantitative and qualitative methods as explained below.

Indeed, for the first part of our research, namely the first three hypothesis, we aim to determine the effect of the war on the commodities market. To do so we build twelve simple linear regressions with each time the price of a commodity as the dependent variable and the Baltic Dry Index (representing market demand) as the main independent variable. Similarly as in (Stuermer, 2018), we use consumer prices for robustness checks except that our consumer prices are proxied by the expected inflation rate as discussed later in the Data section. The equations are as follows:

$$Commodity = \beta_1 \times BDI + \beta_2 \times Inflation + \varepsilon$$

Where $Commodity$ is the price of a commodity (corn, wheat, fertilizers, seed oils, crude oil, refined oil, petroleum gas, aluminum, steel, titanium, platinum, lead ore); BDI is the Baltic Dry Index; $Inflation$ is the expected inflation rate; β_i with $i = 1{,}2$ are the regression coefficient; and ε is the error term. Furthermore, we calculate standard errors robust to heteroskedasticity using the Eicker-Huber-White statistics:

$$V(\hat{\beta}) = \alpha(X^T X)^{-1}(\sum_{j=1}^{n} \hat{\varepsilon}_j^2 x_j^T x_j)(X^T X)^{-1}$$

With: $V(\hat{\beta})$ the so-called heteroskedasticity consistent estimator; X an $n \times k$ matrix of covariates; X^T the transposed matrix; $(X^T X)^{-1}$ a constant matrix; $\sum_{j=1}^{n} \hat{\varepsilon}_j^2 x_j^T x_j$ is the estimated variance of $X^T y$ with y the dependent variable; $\alpha = \frac{n}{(n-k)}$ is the default bias correction.

Then, for each regression we test for a single break without known date using supremum and average Wald test and likelihood-ratio (LR). These test determine whether the regression coefficients are constant between two periods split by an unknown break date. For each tests we use a symmetric trimming of 10% meaning that the first possible break date is the observation at the 10^{th} percentile, and the last possible break date is the observation at the 90^{th} percentile. The supremum Wald or LR test statistic takes the maximum value of all the

Wald and LR tests[2] at each observation point in the range of the potential break date (thus between the 10th and the 90th percentile in this case). The observation with the highest Wald or LR test statistic is the estimated break date. On the other hand, the average Wald or LR test does not yield an estimated break date but provides confirmation or invalidation of whether on average the sample tested shows significant parameter instability.
As a next step we perform the Wald test again with the assumed known break dates of the 24th of February and the 27th of February 2014. Lastly we compare the results and conclude with the help of a cumulative sum test for parameter stability. We provide more details about the cumulative sum test in Appendix A9.
We proceed likewise for the period around the Crimean annexation in February 2014. And to compare the results over the two periods: we store the results of each tests into two separate variable (one for 2014, and the other for 2022), and use a t-test to determine whether the test statistics are significantly higher in 2022 or not. Thus we use a two-sample t-test with equal variance as follows:

$$t = \frac{\bar{x} - \bar{y}}{s_p \sqrt{\frac{1}{n_x} + \frac{1}{n_y}}}$$

Where: t is the t statistic; $\bar{x}$ and $\bar{y}$ are the mean of the first sample and second sample respectively; n_x and n_y are the number of observations in the first sample and second sample respectively; s_x and s_y are the variance of the first sample and second sample respectively; s_p is the pooled variance equal to:

$$s_p^2 = \frac{(n_x - 1)s_x^2 + (n_y - 1)s_y^2}{n_x + n_y - 2}$$

We specify that the regressions for the 2022 period apply on a range between the 1st of January 2021 until the 1st of June 2022 with a total of 516 observations. Similarly, for the 2014 period, the regression is applied from the 1st of January 2013 until the 1st of January 2015 with a total of 730 observations.

3.2 Methods for the economy in general

For the second part of our research (hypotheses four, five, and six,), we investigate the effects of the war on the economy in general. We therefore set up a vector autoregressive model (VAR)[3] with the Baltic Dry Index (BDI), the inflation, the global Economic Policy Uncertainty index (GEPUI), and the twelve commodity prices as endogenous variables. The same range

[2] We provide the reader with a detailed explanation of the Wald and likelihood-ratio tests in Appendix A8.

of time is used as in the analysis for structural breaks described earlier in this section. The $VAR(p)$ model[4], with p the number of lags to be specified later, is therefore formally expressed as follows:

$$\begin{bmatrix} y_{1,t} \\ \vdots \\ y_{15,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ \vdots \\ c_{15} \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} a_{1,1}^i & \cdots & a_{1,15}^i \\ \vdots & \ddots & \vdots \\ a_{15,1}^i & \cdots & a_{15,15}^i \end{bmatrix} \begin{bmatrix} y_{1,t-i} \\ \vdots \\ y_{15,t-i} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ \vdots \\ e_{15,t} \end{bmatrix}$$

With: $\begin{bmatrix} y_{1,t} \\ \vdots \\ y_{15,t} \end{bmatrix}$ the 15 endogenous variables of our model (Baltic Dry Index, Economic Policy Uncertainty Index, Expected Inflation Rate, and the futures prices of: Corn, Wheat, Fertilizers, Seed Oils, Crude Oil, Refined Oil, Petroleum Gas, Aluminum, Steel, Titanium, Platinum, Lead Ore); $\begin{bmatrix} c_1 \\ \vdots \\ c_{15} \end{bmatrix}$ the constant term of each of the 15 regressions; $\begin{bmatrix} a_{1,1}^i & \cdots & a_{1,15}^i \\ \vdots & \ddots & \vdots \\ a_{15,1}^i & \cdots & a_{15,15}^i \end{bmatrix}$ the coefficients of each term in each regression; $\begin{bmatrix} y_{1,t-i} \\ \vdots \\ y_{15,t-i} \end{bmatrix}$ the lagged values of each variables; $\begin{bmatrix} e_{1,t} \\ \vdots \\ e_{15,t} \end{bmatrix}$ the error terms of each regression.

However, with 15 endogenous variables each having p lags, this would lead to a model with $15 \times 15 \times p$ or $225p$ regression coefficients which would lead to a laborious and tedious analysis without necessarily adding relevance to the study. Thence the decision to proceed with a structural vector autoregression (SVAR).

With the SVAR we are able to set short-run restrictions on the interactions between our variables and their lagged values. These restrictions are based on economic rationales and assumptions made in this research (those will be detailed later in this section). Our short-run SVAR model with no exogenous variables can thus be formally expressed as follow:

$$A\left(I_K - A_1L - A_2L^2 - \cdots - A_pL^p\right)y_t = A\epsilon_t = Be_t$$

With: L the lag operator; A, B and $A_1, \cdots, A_p$ are $K \times K$ restriction matrices; ϵ_t is a $K \times 1$ matrix of the residuals of the standard VAR model; e_t is a $K \times 1$ matrix of the residuals of the structural VAR model; K is the number of endogenous variables used in the model; y_t is a $K \times 1$ matrix of the endogenous variables.

With regards to the restrictions imposed on our model, we assume the following identifying restrictions. Firstly, for the Baltic Dry Index (BDI), the expected inflation rate (EIR), and the uncertainty index (UI), we do not impose restrictions as we expect each other variables to

[4] Concerning the VAR and Structural VAR models discussed in this section, we refer the reader to the excellent book of Lütkepohl, "New Introduction to Multiple Time Series Analysis" (Lütkepohl, 2005). We also refer to the STATA documentation (STATA, 2022), as well as relevant academic articles (Furlong & Ingenito, 1996) (Galesi & Lombardi, 2009) (Köse & Ünal, 2021).

affect these, additionally to the fact that these three variables are the most endogenous of our SVAR model. Only the BDI is restricted for the EIR and the UI and the EIR is restricted for the UI. Secondly, for the metal prices (titanium, aluminum, steel, platinum, and lead ore) we assume these to be external to the macroeconomic variables, therefore those are only affected contemporaneously by shocks in the other commodities. Next, for the energy commodities (crude oil, refined oil, and petroleum gas), we expect those to affect each other, but to be unaffected by price shocks in metal or macroeconomic variables. Lastly, the agricultural commodities are affected contemporaneously only by each other. Ideally, we would impose more restrictions on the interactions between the commodities, but that leads to an over-identified model which is significantly invalid in our case according to the likelihood ratio test for over-identification. Based on these restrictions, the A and B matrices can be expressed as follows:

$$A\epsilon_t = Be_t \iff$$

$$\begin{bmatrix}
1 & a_{1,2} & a_{1,3} & a_{1,4} & a_{1,5} & a_{1,6} & a_{1,7} & a_{1,8} & a_{1,9} & a_{1,10} & a_{1,11} & a_{1,12} & a_{1,13} & a_{1,14} & a_{1,15} \\
0 & 1 & a_{2,3} & a_{2,4} & a_{2,5} & a_{2,6} & a_{2,7} & a_{2,8} & a_{2,9} & a_{2,10} & a_{2,11} & a_{2,12} & a_{2,13} & a_{2,14} & a_{2,15} \\
0 & 0 & 1 & a_{3,4} & a_{3,5} & a_{3,6} & a_{3,7} & a_{3,8} & a_{3,9} & a_{3,10} & a_{3,11} & a_{3,12} & a_{3,13} & a_{3,14} & a_{3,15} \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{5,4} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{6,4} & a_{6,5} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{7,4} & a_{7,5} & a_{7,6} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{8,4} & a_{8,5} & a_{8,6} & a_{8,7} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{9,4} & a_{9,5} & a_{9,6} & a_{9,7} & a_{9,8} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{10,4} & a_{10,5} & a_{10,6} & a_{10,7} & a_{10,8} & a_{10,9} & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{11,4} & a_{11,5} & a_{11,6} & a_{11,7} & a_{11,8} & a_{11,9} & a_{11,10} & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{12,4} & a_{12,5} & a_{12,6} & a_{12,7} & a_{12,8} & a_{12,9} & a_{12,10} & a_{12,11} & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{13,4} & a_{13,5} & a_{13,6} & a_{13,7} & a_{13,8} & a_{13,9} & a_{13,10} & a_{13,11} & a_{13,12} & 1 & 0 & 0 \\
0 & 0 & 0 & a_{14,4} & a_{14,5} & a_{14,6} & a_{14,7} & a_{14,8} & a_{14,9} & a_{14,10} & a_{14,11} & a_{14,12} & a_{14,13} & 1 & 0 \\
0 & 0 & 0 & a_{15,4} & a_{15,5} & a_{15,6} & a_{15,7} & a_{15,8} & a_{15,9} & a_{15,10} & a_{15,11} & a_{15,12} & a_{15,13} & a_{15,14} & 1
\end{bmatrix}
\begin{bmatrix}
\epsilon_{1,t} \\ \epsilon_{2,t} \\ \epsilon_{3,t} \\ \epsilon_{4,t} \\ \epsilon_{5,t} \\ \epsilon_{6,t} \\ \epsilon_{7,t} \\ \epsilon_{8,t} \\ \epsilon_{9,t} \\ \epsilon_{10,t} \\ \epsilon_{11,t} \\ \epsilon_{12,t} \\ \epsilon_{13,t} \\ \epsilon_{14,t} \\ \epsilon_{15,t}
\end{bmatrix}$$

$$= \begin{bmatrix}
b_{1,1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & b_{2,2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & b_{3,3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & b_{4,4} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & b_{5,5} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & b_{6,6} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & b_{7,7} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{8,8} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{9,9} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{10,10} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{11,11} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{12,12} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{13,13} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{14,14} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{15,15}
\end{bmatrix}
\begin{bmatrix}
e_{1,t} \\ e_{2,t} \\ e_{3,t} \\ e_{4,t} \\ e_{5,t} \\ e_{6,t} \\ e_{7,t} \\ e_{8,t} \\ e_{9,t} \\ e_{10,t} \\ e_{11,t} \\ e_{12,t} \\ e_{13,t} \\ e_{14,t} \\ e_{15,t}
\end{bmatrix}$$

With the variables $y_{1,t}, \cdots, y_{15,t}$ in the following order: Baltic dry index, expected inflation rate, uncertainty index, corn, wheat, fertilizers, seed oils, crude oil, refined oil, petroleum gas, aluminum, steel, titanium, platinum, lead ore. Nonetheless, for just-identification the condition is to have precisely $K^2 + \frac{K(K-1)}{2} = 330$ restrictions, yet our restrictions amount to 330 which leads to a just-identified SVAR model. As explained earlier, our attempts to add more restrictions led to invalid over-identified models according to the likelihood ratio test for over-identification.

Before applying the previously described SVAR model, we have to add some specification and control the variables for stationarity for example, notably for the underlying VAR model. That is why we start by using the augmented Dickey-Fuller test for stationarity on each of the 15 variables of our model. The results show that for the 2022 period only the economic policy uncertainty index is stationary and that the 14 other variables are integrated of order one. Regarding the 2014 period, only the economic policy uncertainty and the lead prices are stationary at 1% and 5% respectively. The other variables are all integrated of order one. We then also use Akaike information criteria to select the optimal number of lags in our model (with a maximum of 10 lags), and the results suggest that two lags would be optimal both for the period around 2014 and the period around 2022. Finally, we test for cointegration between the non-stationary variable using the Johansen test, we assume a constant trend. For both period the results show no cointegration except between wheat and steel, aluminum and titanium, lead and platinum. However, we have restricted the impact of those variables on each other in our structural VAR with the assumption that those do not affect each other in the short nor in the long run. Therefore, we do not need to use a vector error correction model for more adequacy.

3.3 Methods for the case of the Netherlands

Lastly, for the seventh and last hypothesis, we describe and determine, based on the results obtained for the previous six hypotheses, the risks for the revenues of the Netherlands due to disruptions of imports and exports and price changes in the key investigated commodities. In particular, we use two-sample t-tests to determine whether the exports are significantly larger than the imports for each of the twelve commodities investigated in this paper. We then study the size of the imports and exports originating and destinated to Russia and Ukraine. Based on these observations we draw conclusions on the risks for the revenues and costs related to imports and exports for the Netherlands.

4. Data

For this research we investigate several commodities. To determine which commodities would be part of the research, we look at the yearly exported products for which Russia and Ukraine are major exporters between 2010 and 2020. To get this data, we use the Observatory of Economics Complexity (OEC) website. This website tracks and displays each traded products worldwide and gives useful information such as yearly exports and imports shares of each country in the world. This website was created in a laboratory of the Massachusetts Institute of Technology (MIT) which describe their website as ‘’the world's leading data visualization tool for international trade data’’ (Massachusetts Institute of Technology, 2022). This website is therefore considered as a reliable source of information.

After browsing through the data, we noticed three categories of commodities for which Russia and Ukraine are major yearly exporters between 2010 and 2020: metals, energy, agricultural. More specifically, we focus on the most important commodities: corn, fertilizers, seed oils, wheat, crude oil, oil gas, refined oil, aluminum, lead ore, platinum, steel, and titanium. We manually reported Russia and Ukraine’s common share of exports for each of these commodities in Table 1. For Russia and Ukraine’s separate shares of exports for each of these commodities we refer to Table 2 and Table 3 respectively. Since Ukraine represents less than 0.1% of exports in crude oil, oil gas, refined oil, aluminum, lead ore, and platinum, those are not displayed in Table 3.

From this data we observe the following facts. We see that the shares of exports remained stable overall except for four products. Indeed, we see increases in Russia’s share of exports in platinum (from 10% to 17%), seed oils (from 6% to 18%) and wheat (from 8% to 20%) reaching up to 26% in 2018. We also see important increases in Ukraine’s share of exports in seed oils (from 35% to 40%), wheat (from 3% to 10%), and corn (from 4% to 14%). In total, the Russian and Ukrainian share of export increased with an additional 17% for seed oils and 19% for wheat between 2010 and 2020. We notice that Russia and Ukraine together represent 30% of the world’s wheat exports and almost 60% of the world’s seed oils exports.

4.1 Data for the commodities market

Now that the commodities have been specified, we need to gather the data. For our research, we need the daily returns of the chosen commodities, and the exchange rates in order to convert all data collected into the same currency (in this case the euro). Almost all of the data is taken from the Investing.com website. This website is a popular source of financial data with more than 46 million monthly users and three billion monthly pageviews (Investing.com, 2022). The website has positive reviews and numerous partnerships with well-known and strictly regulated brokers (Investing.com, 2022). Investing.com is thus a renowned financial institution which systematically, regularly, and automatically collects market data, hence the reliable label of this data. The main advantage of using this website as a source for our data, is that it is free and easy of access. For the prices of aluminum we chose another source as Investing.com does not have earlier data than June 2014 for this commodity. We therefore collect the data from Finanzen.net, the most important market information provider of Germany, and a popular financial institution (Finanzen.net, 2022).

For each of the commodities and exchange rates we collect daily data from the 1st of January 2010 to the 1st of June 2022, leading to 3145 observations for each products. For most of the products we were able to find the corresponding futures, but for two commodities we had to use stocks instead and for one commodity we used a similar future. The list of all commodities with their corresponding representing market instrument and their currencies is to be found in Table 4 in Appendix A4.

It is important to note that we were unable to obtain data of futures prices for all commodities. This is the case for three commodities: fertilizers, titanium, and seed oils. For these instances we therefore either use futures prices on a closely linked commodity (soybean futures for seed oils), or we proxy the returns of the commodity by taking the returns of a company whose sole production is the commodity in question, that is one of the largest suppliers of this commodity, and that is not Russian or Ukrainian. In our study, we treat the returns of these stocks in the same way as for the returns of the futures.

As can be seen from Table 4 Appendix A4, fertilizers are represented by the ''Nutrien'' stock. This stock was selected to represent the returns of fertilizers as it is one of the world's most important supplier of fertilizers. We purposely selected a Canadian company instead of top suppliers which are Russian companies subject to other factors (such as financial sanctions) which might lead to biases in the returns. However, the investigation of fertilizers will only be done for the Russian invasion of 2022 as there is no earlier data than January 2018. Secondly, titanium is represented by the ''BaoJi Titanium Industry'' stock. Similarly, since no daily futures data is available for titanium, we selected the world's top non-Russian titanium supplier which is the Chinese ''BaoJi Titanium Industry''. Lastly, for the seed oils, again no daily futures data is available and we thus selected US soybean oil futures since there were also no data for sunflower oil futures[5]. Soybean oil futures is therefore the best proxy available for the returns of seed oils.

Additionally, Table 4 Appendix A4 shows that the data obtained is expressed in dollars, Indian rupee, pound sterling, and renminbi. We therefore also gather the dollar/euro, inr/euro, gbp/euro, and cny/euro exchange rates between 2010 and 2022 in order to convert all data into euro currency.

[5] Sunflower oil is the primary oil produced by Ukraine which alone accounts for 40% of the world's seed oils exports (The Observatory of Economic Complexity, 2022) (Vasylkovska, et al., 2021).

This data is enough to test the first three hypotheses and answer the first part of the research question. The daily frequency of the data is necessary as the Russian war on Ukraine leads to great daily price movements and crashes which would not be captured on a weekly or monthly basis. This frequency is however at the cost of extra noise in the analyses. Thus, this data is suitable for the research, to answer the research question and to reach insightful conclusions.

All data described above are already treated and stocked in ".csv" files by the websites cited previously. Those files must only be downloaded, imported, and converted in the chosen data treatment software (in this case STATA). For any instances of missing values in the data, either due to exceptional circumstances or particular public holiday, we solve the issue simply by filling the gaps in the sample with linear interpolation and extrapolation the values. This method is detailed further in Appendix A7. Interpolation and Extrapolation of Missing Values. This manipulation does not affect the graphs of the plotted values, but more importantly does not affect (not to say insignificantly) the summary statistics of the data.

After converting each commodity prices into euro denomination, we sketch the graphs of the time-series. These can be seen in Figure 5, 6, and 7 in Appendix A5. We also display graphs of the time series for the period of the Crimean annexation in 2014 (Figure 11, 12, and 13, Appendix A5) and the Russian invasion of Ukraine in 2022 (Figure 8,9, and 10, Appendix A5). We see from these figures that there appear to be a reaction in all commodity prices around the end of February 2022 when Russia started its invasion. Indeed, we notice a steep permanent increase in prices for aluminum, corn, fertilizers, crude oil, gas, refined oil, seed oils, and wheat. For lead, platinum, steel, and titanium we notice a high unique peak for that period. However, for the period of the annexation of Crimea (end of February 2014), the price reactions are less evident. Actually, there are only short peaks in price for aluminum, crude oil. Platinum, refined oil, and seed oils. Only for gas is the peak of great amplitude. Concerning steel, lead, titanium, and wheat we do not observe any price reaction.

We also show when possible the volume traded in each of these commodities for the same periods. It is interesting to see that there are surges in volumes in February 2022 for each of the commodities (Figure 14, 15, and 16, Appendix A5). For wheat and platinum we do not have the data about volumes for that period. We notice again that for the annexation of Crimea the effects are less apparent. We observe high volumes for corn, gas, and seed oils only. For crude oil, lead, refined oil, titanium, and wheat the data shows no volume reaction. For platinum, fertilizers, steel, and aluminum we do not have the data about volumes for that period.

Lastly, we provide descriptive statistics of the commodities time-series. These are shown in Table 6 in Appendix A4 for the data between 2010 and 2022. Table 7 Appendix A4 describes the data between 2021 and 2022. Finally, Table 8 Appendix A4 describes the data between

2013 and 2015. We observe that the mean and volatilities of the commodities are higher between 2021 and 2022 than between 2013 and 2015, and higher than the average between 2010 and 2022. Moreover, we note that the mean between 2021 and 2022 is always higher than the median for this period.

4.2 Data for the economy in general

After investigating the commodities market, we also investigate the impact of the Russian invasion of Ukraine in 2022 on the economy in general. For our research, we need daily data representing the economic activity, the economic policy uncertainty, and the inflation.

As mentioned earlier, we use the daily Baltic Dry Index (BDI) as a proxy for the economic activity. The BDI is an index measuring the costs of shipping raw materials (Kopp, 2021). It consists of three indices (Capesize, Panamax and Supramax) and assesses the freight costs on shipping routes around the globe (Corporate Finance Institute, 2022). This index is commonly used by researchers to represent the economic activity and has a proven relationship with the economic activity (Isserlis, 1938) (Tinbergen, 1959) (Bakshi, Panayotov, & Skoulakis, 2011) (Bildirici, Kayikçi, & Onat, 2015). This index is used in practice to predict changes in supply and demand (Geman & Smith, 2012). Indeed, when the BDI increases it is because of higher volumes of raw material shipped which translates into higher demand for primary good (Mowry & Pescatori, 2008). Since these products are the first part of the production chain, it implies an increase in industrial production, whence an increase in the economic activity (Hansen, 2022) (Tierney, 2022) (Lin & Sim, 2013). We obtain this data through the previously described Investing.com website.

Regarding the economic policy uncertainty (EPU), we use the daily index created by Baker, Bloom and Davis (2016) and available on their website (Global Economic Policy Uncertainty Index, 2022), which is one of the most used in the academic society (Hsiao, 2022) (Jurado, Ludvigson, & Ng, 2015) (Gulen & Ion, 2016). As explained in the first part of the Literature Review section 2, the EPU index is based on newspaper coverage of the term "uncertainty" and related. For this research we use the so called global EPU which is a weighted average of 21 EPU indexes of the 21 most important economies of the world. We also already mentioned that we do not use a more specific indicator such as Ukrainian CDS spreads as the data is hardly available and as the results would be less evident to compare to previous literature, whereas the EPU is a frequently used indicator with a myriad of results.

Lastly, concerning the inflation, as we need daily data, our best available and reliable proxy is the 10-year breakeven inflation rate. This rate is based on a measure of expected inflation determined from 10-year Treasury Constant Maturity Securities and 10-year Treasury Inflation-Indexed Constant Maturity Securities (TIICMS) (Federal Reserve Bank of St. Louis, 2022). The TIICMS represents the market expectations of the inflation for the next 10 years.

This data is collected and displayed by the well-known Federal Reserve Bank of St. Louis on their website (Federal Reserve Bank of St. Louis, 2022). This organization, working closely with the US government and their data, is hence a reliable source of economic data.
For each of these items we collect daily data from the 1st of January 2010 to the 1st of June 2022, leading to a minimum of 3145 observations for each time-series. This data is enough to test the fourth, fifth, and sixth hypotheses and answer the second part of the research question. The daily frequency of the data is necessary as the Russian war on Ukraine leads to great daily price movements and crashes which would not be captured on a weekly or monthly basis. This frequency is however at the cost of extra noise in the analyses. Thus, this data is suitable for the research, to answer the research question and to reach insightful conclusions.
All data described above are already treated and stocked in ".csv" files by the websites cited previously. Those files must only be downloaded, imported, and converted in the chosen data treatment software (in this case STATA). For any instances of missing values in the data, either due to exceptional circumstances or particular public holiday, we solve the issue simply by filling the gaps in the sample with linear interpolation and extrapolation the values. This method is detailed further in Appendix A7. Interpolation and Extrapolation of Missing Values. This manipulation does not affect the graphs of the plotted values, but more importantly does not affect (not to say insignificantly) the summary statistics of the data.
Furthermore, we convert the BDI, which is denominated in dollars, into euro. We then provide graphs of the BDI, the EPU index, and the inflation time-series between 2010 and 2022. These can be seen in Figure 19 in Appendix A5. We also display graphs of the time series for the period of the Crimean annexation in 2014 (2014, Figure 21, Appendix A5) and the Russian invasion of Ukraine in 2022 (Figure 20, Appendix A5). We see from these figures that there appears to be an increase in the Baltic Dry Index around the end of February 2022 when Russia started its invasion. We also notice a brief peak in the economic policy uncertainty around that period. Thirdly, we observe a steep permanent increase in the inflation rates. However, for the period of the annexation of Crimea (end of February 2014), the reactions are less evident. Indeed, that data does not show any reaction in inflation rates nor any peak in economic uncertainty. The data shows, nevertheless, a similar temporary increase in the Baltic Dry Index.
Finally, we provide descriptive statistics of the BDI, EPU index, and inflation time-series. These are shown in Table 10 in Appendix A4 for the data between 2010 and 2022. Table 11 Appendix A4 describes the data between 2021 and 2022. Finally, Table 12 Appendix A4 describes the data between 2013 and 2015. We observe that the mean economic indicators are all higher between 2021 and 2022 than between 2013 and 2015, and higher than the average between 2010 and 2022. The mean for the BDI is even almost three times higher between 2021 and

2022 than between 2013 and 2015. However, we note that the volatilities between 2021 and 2022 are lower than the average between 2010 and 2022, notwithstanding the fact that they are higher than the volatilities between 2013 and 2015.

4.3 Data for the Netherlands

Ultimately, for our research, we investigate the impact of the Russian invasion of Ukraine in 2022 on the Netherlands. To do this we use data concerning the exports and imports of the Netherlands, and especially with Ukraine and Russia, over the last ten years.

This data is obtained on the Observatory of Economics Complexity (OEC) website. As explained earlier, this website tracks and displays each traded products worldwide and provides information such as yearly exports and imports shares of each country in the world. This website is considered as a reliable source of information as it was created in a laboratory of the Massachusetts Institute of Technology (MIT). For more justification see the first part of the Data section 3. We also use data from the International Trade Center (ITC) to complete our information about the percent of each commodity exported or imported to Ukraine or Russia (International Trade Center, 2022). The ITC is an intergovernmental organization closely linked to the World Trade Organization and the United Nations (Wikipedia, 2022). Therefore, we consider that this website is a reliable and trustworthy source of information with regards to international trade.

We thus gather yearly data about the general exports and imports of the Netherlands between 2010 and 2020. We also collect the exports and imports between the Netherlands and Ukraine and Russia for the same period. This data is enough to test the seventh and last hypothesis and answer the third part of the research question. The yearly frequency of the data is the optimal choice as on one hand exports and imports are subject to contracts lasting several years, and on the other hand there is no monthly data available. Thus, this data is suitable for the research, to answer the research question and to reach insightful conclusions.

All data described above are already treated and stocked in ".csv" files by the website cited previously. Those files must only be downloaded, imported, and converted in the chosen data treatment software (in this case STATA). The data obtained does not present any missing value issue.

Finally, we report the data in Table 13, 14, 15, 16 in Appendix A4. Table 13 (Appendix A4) shows the export quantities of the Netherlands for the twelve investigated commodities. We notice on this table that refined oil constitutes an important part of exports revenues with 34 billion dollars in 2020. Refined oil is actually the commodity yielding the highest revenues for the Netherlands (The Observatory of Economic Complexity, 2022). We also see that steel is also an important source of revenues (10 billions of dollars in 2020) followed by fertilizers, seed oils, gas, and aluminum (more than a billion dollars in 2020). On Table 14 (Appendix

A4), we observe the imports of the Netherlands for the studied commodities. We notice that crude oil is a major import with over 21 billions of dollars in 2020, followed by refined oil with 17 billions of dollars. Also steel, aluminum, and see oils represent all between 5 and 10 billions of dollars in 2020. Looking at Table 15 Appendix A4 we can see that the Dutch exports to Ukraine and Russia are insignificant. However, Table 16 Appendix A4 shows that the country depends at 50% on Ukrainian corn, 25% on Russian crude oil, and 10% on Russian refined oil, even if Ukrainian and Russian imports represent less than 3% of the total Dutch imports.

5. Results

5.1 Hypothesis 1

In this section we describe the results obtained for the first hypothesis, namely whether the Russian invasion of Ukraine, started in February 2022, had a significant impact on the commodities for which Russia and Ukraine are major exporters. We test this hypothesis using tests for structural breaks.

As explained previously, we start with the period around the Russian invasion of Ukraine in 2022 by running twelve simple linear regressions of commodity prices on economic activity and expected inflation rate. The results of the regressions are displayed in Table 17 in Appendix A4. We observe from this table that the coefficients are, for all regressions, mostly significant at 1%. Indeed, the constant in always significantly negative at 1% except for lead and platinum where it is significantly positive at 1%, and for titanium where it is positive at 5%. For the Baltic Dry Index, the coefficients are in majority significantly negative at 1% except for seed oils and lead where it is positive at 1%, aluminum at 5%, steel at 10%, and titanium insignificant. Concerning the expected inflation, all the coefficients are significantly positive at 1% except for platinum where the coefficient is insignificant. We also note that the coefficient for the BDI have much smaller magnitude compared to the coefficients of the inflation and the constant which seem to be of the same scale.

We then perform the series of Wald and Likelihood-Ratio tests without known date on the outcome of each regressions. The graphs of the Wald tests are to be found in Figures 22, 23, and 24, whereas the graphs of the LR tests are to be found in Figures 25, 26, 27, all those figures are found in Appendix A5. The estimated break dates as well as the test statistics of both the Wald and LR tests are displayed in Table 18 in Appendix A4. We notice instantly on the Figures 22 to 27 that, for both the LR and the Wald tests, the test statistics are relatively high after January 2022 except for most metals, namely aluminum, platinum, lead ore, and titanium. On Table 18 (Appendix A4), we see that all the test statistics of the LR and Wald tests are significant at 1%. We also observe that the estimated break dates of both tests are relatively close for each commodities except for titanium, and that these break dates are also estimated in or after January 2022 except for the metals making the exception in Figures 22 to 27 and for fertilizers. Indeed, for those commodities the break dates are estimated to be in 2021.

Thereafter, we perform the Wald test with the assumed date to be the 24th of February 2022. We also run cumulative sum (CUSUM) test for parameter stability. The resulting test statistics can be found in Table 19 Appendix A4. We also add Figures 28, 29, and 30 (Appendix A5) displaying the results of the CUSUM tests. What we take into consideration is that the Wald tests are all significant at 1% except for platinum where it is insignificant. We also point our attention to the CUSUM test statistics which are all significant at 1%, and from the graphs we clearly see the rejection of the null hypothesis of parameter stability, even for platinum. However, we do note that parameter instability seems limited with regards to seed oils.

Based on all these observations, it seems that the commodities regression indeed present a break during the period of the Russian invasion of Ukraine in 2022, except for platinum. However, we notice that the CUSUM tests show high parameter instability suggesting potential multiple breaks. Moreover, we see that the Wald and LR tests with unknown test all suggest different break dates, although these dates are in the period of the invasion in 2022 except for the metals commodities. In the end, our results only allow us to confirm a structural break around the invasion in 2022 for the agricultural and energy commodities and for steel, but not the other metals. Concerning, the other metals, namely aluminum, lead ore, platinum, and titanium, we can only consider a break in this period probable except for platinum, but we cannot confirm it with certainty because the estimated break dates all occur in 2021, and the CUSUM test only allow us to suggest but not affirm multiple breaks.

This high parameter instability can be explained on one hand by the war in Ukraine, but the statistics show us that this instability existed prior to the war. To this we suggest the explanation of the fears of rising inflation and the actual high inflation which started in the year 2021. The Covid-19 in 2020 may also have contributed to instable commodity prices due to the shocks it caused on world production.

Thus, we cannot reject our first hypothesis as we have evidence for structural breaks in commodities during the invasion of Ukraine by Russian in early 2022. We therefore conclude by supporting the fact that the Ukraine war in 2022 significantly impacted at least the returns of agricultural and energy commodities for which Russia and Ukraine are major exporters.

5.2 Hypothesis 2

In this section we describe the results obtained for the second hypothesis, namely whether the Russian annexation of the Crimean Peninsula in February 2014, had a significant impact on the commodities for which Russia and Ukraine are major exporters. We test this hypothesis using tests for structural breaks.

As for the first hypothesis previously, we start by running eleven simple linear regressions of commodity prices on economic activity and expected inflation rate (as explained in the Data section, we do not have data for fertilizers futures prices during this period). The results of the regressions are displayed in Table 20 in Appendix A4. We observe from this table that the coefficients are, for all regressions, mostly significant at 1%. Indeed, the constant in always significantly positive at 1% except for wheat and refined oil where it is significantly negative at 1%, for corn where it is negative at 5%, and seed oils negative at 10%. For the Baltic Dry Index, the coefficients are in majority significantly negative at 1% except for crude oil where it is positive at 1%, and wheat and petroleum gas which are insignificant. Concerning the expected inflation, all the coefficients are significantly positive at 1% except for refined oil, aluminum, and titanium where the coefficient are significantly negative at 1%. We also note that the coefficient for the BDI have much smaller magnitude compared to the coefficients of the inflation and the constant which seem to be of the same scale.

We then perform the series of Wald and Likelihood-Ratio tests without known date on the outcome of each regressions. The graphs of the Wald tests are to be found in Figures 31, 32, and 33, whereas the graphs of the LR tests are to be found in Figures 34, 35, 36, all those figures are found in Appendix A5. The estimated break dates as well as the test statistics of both the Wald and LR tests are displayed in Table 21 in Appendix A4. We notice instantly on the Figures 31 to 36 that, for both the LR and the Wald tests, the test statistics do not seem particularly higher or lower around February 2014, except for crude and refined oil, and petroleum gas. On Table 21 (Appendix A4), we see that all the test statistics of the LR and Wald tests are significant at 1%. We also observe that the estimated break dates of both tests are relatively close for each commodities except for wheat, seed oils, and petroleum gas where the dates differ by more than two months. Furthermore, none of these break dates are estimated in the period around the annexation of Crimea except for refined oil and steel.

Thereafter, we perform the Wald test with the assumed date to be the 27th of February 2014. We also run cumulative sum (CUSUM) test for parameter stability. The resulting test statistics can be found in Table 22 Appendix A4. We also add Figures 37, 38, and 39 (Appendix A5) displaying the results of the CUSUM tests. What we take into consideration is that the Wald tests are all significant at 1%. We also point our attention to the CUSUM test statistics which are all significant at 1%, and from the graphs we clearly see the rejection of the null hypothesis of parameter stability. However, we do not observe parameter instability around the period of the annexation except for lead and steel.

Based on all these observations, it is unclear whether the commodities regression indeed present a break during the period of the Russian annexation of the Crimean Peninsula of Ukraine in 2014. Moreover, we notice that the CUSUM tests show significantly high parameter instability between 2013 and 2015, and suggesting potential multiple breaks. Furthermore, we see that the Wald and LR tests with unknown test all suggest break dates which are several months away from the Crimean annexation. However, the Wald test with known date all show significant result suggesting that the 27th of February (day of annexation), is a valid break date for every tested commodities. In the end, our results do not allow us to confirm a structural break around the annexation in 2014 for any commodities. Additionally, the CUSUM tests indicating high parameter instability between 2013 and 2015 leads us to believe that the annexation of Crimea only had a small impact on the commodities regressions.

Thus, we reject our second hypothesis as we do not have enough evidence supporting the hypothesis of structural breaks in commodities during the annexation of Crimea by Russian in early 2014. We therefore conclude by stating that the Russian annexation of the Crimean peninsula in 2014 did not impact the returns of commodities for which Russia and Ukraine are major exporters.

5.3 Hypothesis 3

In this section we describe the results obtained for the third hypothesis, namely whether the structural breaks observed in the period of the Russian invasion of Ukraine in 2022 are considerably more significant than the structural breaks observed in the period of the Russian annexation of Crimea in 2014. We test this hypothesis by using two sample t-tests on the test statistics obtained previously from the Wald, LR, and CUSUM tests for structural breaks and parameter stability.

We thus perform for two-sample t-tests between the 2014 and 2022 samples of the test statistics of the Wald and LR test with unknown break date, the CUSUM tests, and the Wald tests with known date. The results of the t-tests are displayed in Table 23 in Appendix A4. We observe from this table that the t statistics are relatively small, and the they are insignificant. Indeed, we see that the p-value is above 10% for every tests performed.

Based on all these observations, we cannot consider a significant difference between all the tests. Thus, we do not have evidence to support our third hypothesis and declare that it should be rejected. We therefore conclude by stating that the Russian invasion of Ukraine in 2022 did not have a more significant impact on the returns of the commodities for which Russia and Ukraine are major exporters, then the annexation of the Crimean peninsula in 2014.

5.4 Hypothesis 4

In this section we describe the results obtained for the fourth hypothesis, namely whether the Russian invasion of Ukraine, started in February 2022, had a significant impact on the global economy. We test this hypothesis using a short run structural vector autoregression model, and observe the results with impulse response functions.

As explained previously, we start by running the restricted vector autoregression as describe in the Methods section 3, for the period between the 1st of January 2020 and the 1st of June 2022. We worry primarily about the effects on the three macroeconomic variables, namely the Baltic Dry Index (representing the global economic activity), the expected inflation rate, and the global economic policy uncertainty. The results of the regressions are displayed in Table 24 in Appendix A4. In this table the each column represents one of the three macroeconomic variables, and each row represent one of the 15 endogenous independent variables. We observe from this table that the coefficients for corn, aluminum and titanium are significantly and negatively affecting the BDI at 5 and 10%. Indeed, an increase of one euro in the prices of corn, aluminum, and titanium lead respectively to a decrease in euro of the BDI of 0.497, 0.184, and 25.394. Concerning the expected inflation rate, we see that fertilizers, seed oils, crude oil, refined oil, and steel all have a significantly negative impact at 1%. Indeed, an increase of one euro in the prices of fertilizers, seed oils, crude oil, refined oil, and steel lead respectively to a decrease in percentage of the EIR of 0.006, 0.004, 0.001, 0.003, and 0.001. Lastly, we notice that petroleum gas has an important positive impact of the global economic policy uncertainty. Indeed, an increase of one euro in the price of petroleum gas causes an increase of 36.011 in the index of the GEPUI with a significance of 5%.

The most interesting results of this model are displayed in the impulse response functions which can be seen in Figures 40 to 48 in Appendix A5. We set the BDI, EIR, and GEPUI as response variables. The impulse response functions show the response of a variable to a one standard deviation errors change in another variable. On Figures 40 to 42, we see that crude oil, corn, fertilizers, lead, titanium, and wheat have a long term negative effect on the BDI. On the other hand, petroleum gas, seed oils, and steel have a positive long term effect on the BDI. Concerning platinum, refined oil, and aluminum do not seem to have an impact on the BDI. On Figures 43 to 45, we see that all commodities cause a significant short term increase in the EIR, except aluminum, crude oil, and corn for which the opposite happens. We also see that the impact of all commodities converges to reach levels at zero or slightly below, except for aluminum and steel where the impact keeps increasing in the long term. Lastly, on Figures 46 to 48, we see that an impulse in the prices of steel, platinum, petroleum gas, and aluminum all cause a short term increase in the GEPUI. Oppositely, crude oil, corn, fertilizers, lead, refined oil, seed oils, titanium, and wheat all cause a short term decrease in the GEPUI. We note, however, that impulses, and for every commodities, all converge to zero in the long term after the first five periods.

Based on all these observations, it seems that there is a clear effect of the commodities on the macroeconomic variables. Indeed, an impulse in all commodities always leads to a short term reaction in EIR and GEPUI, and most of the time leads to long term effects for BDI and EIR. We also observe that the three categories of commodities (agricultural, energy, and metal) do not seem to be relevant in finding common trends in the responses of the variables. We actually observe radically opposite response for impulses in commodities sharing the same category. For example, an impulse in steel or aluminum leads to a long term increase in the response of the EIR, whereas for impulses in lead or titanium we observe the exact opposite effect. In the end, our results allow us to confirm clear effects of the commodities on the economy in general, but do not allow us to determine a clear direction for the effects. Indeed, the impulse response function shows clear responses of the macroeconomic variables to impulses in commodities for which Russia and Ukraine are main exporters, but the effects are mitigated and go in both directions, namely they both lead to increases and decreases in the value of the macroeconomic variables.

Thus, we cannot reject our fourth hypothesis as we have evidence for clear impacts of the commodities on the economic variables, even if we cannot determine the overall direction of the effects. However, we previously reached the conclusion that the Russian war in Ukraine in 2022 had a clear impact on the commodities for which Russia and Ukraine are major exporters. Since now we come to the conclusion that these same commodities affect the macroeconomic variables, by transition we conclude that the Russian invasion of Ukraine in 2022 has an impact on the economy in general. This supports our fourth hypothesis which we therefore cannot reject.

5.5 Hypothesis 5

In this section we describe the results obtained for the fifth hypothesis, namely whether the Russian annexation of the Crimean peninsula in February 2014 had a significant impact on the global economy. We test this hypothesis using a short run structural vector autoregression model, and observe the results with impulse response functions.

As explained previously, we start by running the restricted vector autoregression as described in the Methods section 3, for the period between the 1st of January 2013 and the 1st of January 2015. However, remind that for this period we do not have data for fertilizers and it is thus excluded from the analysis. We consider mainly the effects on the three macroeconomic variables, namely the Baltic Dry Index (representing the global economic activity), the expected inflation rate, and the global economic policy uncertainty. The results of the regressions are displayed in Table 25 in Appendix A4. In this table the each column represents one of the three macroeconomic variables, and each row represent one of the 14 endogenous independent variables. We observe from this table that the coefficients for steel is significantly and negatively affecting the BDI at 5%. Indeed, an increase of one euro in the prices of steel leads to a decrease in euro of the BDI of 0.386. Concerning the expected inflation rate, we see that wheat, seed oils, petroleum gas, and lead all have a significantly positive impact at 1% and 5%. Indeed, an increase of one euro in the prices of wheat, seed oils, petroleum gas, and lead cause respectively an increase in percentage of the EIR of 0.002, 0.004, 0.021, and 0.001. Lastly, we notice that corn has an important negative impact on the global economic policy uncertainty. Indeed, an increase of one euro in the price of corn causes a decrease of 0.413 in the index of the GEPUI with a significance of 5%.

The most interesting results of this model are displayed in the impulse response functions which can be seen in Figures 49 to 57 in Appendix A5. We set the BDI, EIR, and GEPUI as response variables. The impulse response functions show the response of a variable to a one standard deviation errors change in another variable. On Figures 49 to 51, we see that crude oil, corn, aluminum, lead, petroleum gas, and steel all have a long term negative effect on the

BDI. On the other hand, refined oil and titanium have a positive long term effect on the BDI. Concerning wheat, seed oils, and platinum, these do not seem to have an impact on the BDI. On Figures 52 to 54, we see that petroleum gas, platinum, seed oil, and titanium all have a long term negative effect on the EIR. On the other hand, crude oil, steel, and wheat have a positive long term effect on the EIR. Concerning aluminum, corn, lead, and refined oil, these do not seem to have an impact on the EIR. Lastly, on Figures 55 to 57, we see that an impulse in the prices of crude oil, corn, lead, titanium, and wheat all cause a short term increase in the GEPUI. Oppositely, aluminum, petroleum gas, platinum, refined oil, and seed oils all cause a short term decrease in the GEPUI. We note, however, that impulses, and for every commodities, all converge to zero in the long term after the first five periods, and that steel does not seem to cause any response in the GEPUI.

Based on all these observations, we notice the same results as for hypothesis four. Indeed, it seems that there is a clear effect of the commodities on the macroeconomic variables, but no common trend or direction in the responses to the impulses. For example, an impulse in all commodities always leads to a short term reaction in GEPUI, and most of the time leads to long term effects for BDI and EIR, but not for the GEPUI. But these effects go in both directions for each of the three macro-economic variables. Once again the three categories of commodities (agricultural, energy, and metal) do not seem to be relevant in finding common trends in the responses of the variables. We again observe radically opposite response for impulses in commodities sharing the same category. For example, an impulse in crude oil leads to a short term increase in the response of the GEPUI, whereas for impulses in refined oil we observe the exact opposite effect. In the end, our results allow us to confirm clear effects of the commodities on the economy in general, but do not allow us to determine a clear direction for the effects. Indeed, the impulse response function shows clear responses of the macroeconomic variables to impulses in commodities for which Russia and Ukraine are main exporters, but the effects are mitigated and go in both directions, namely they both lead to increases and decreases in the value of the macroeconomic variables.

Thus, we cannot reject our fifth hypothesis as we have evidence for clear impacts of the commodities on the economic variables, even if we cannot determine the overall direction of the effects. Similarly as for hypothesis four, since we previously reached the conclusion that the Russian war in Ukraine in 2022 had a clear impact on the commodities for which Russia and Ukraine are major exporters, and that now we come to the conclusion that these same commodities affect the macroeconomic variables, by transition we conclude that the Russian annexation of the Crimean peninsula in 2014 has an impact on the economy in general. This supports our fifth hypothesis which we therefore cannot reject.

5.6 Hypothesis 6

In this section we describe the results obtained for the sixth hypothesis, namely whether the impact on the economy in general of the Russian invasion of Ukraine in February 2022 was more significant than the impact on the economy of the annexation of Crimea in 2014. We test this hypothesis by comparing the two models obtained for the previous two hypothesis.

Firstly, we notice from Table 24 and 25 in Appendix A4 that the coefficients are overall more significant for the first SVAR model (corresponding to the period between 2020 and 2022) then for the second SVAR model (corresponding to the period between 2013 and 2015). Indeed, for the first model three coefficients are significant for the BDI in contrast to the only one in the second model. For EIR it is the same, six coefficients are significant at 1% in the first SVAR as opposed to four significant coefficients at 5% and 1% for the second SVAR. For the GEPUI however, we do not observe a difference in the significance of the coefficients.

Secondly, we look at model adequacy with various statistics. For example we compare the Akaike information criteria (AIC) of the two models. We notice that the first SVAR has a considerably higher AIC statistic then the second SVAR, leading us to believe that the second model is of greater quality. Indeed, the first model has an AIC of 24.597 as opposed to the AIC of 2.310 of the second model. Moreover, we compare the models based on their stability, the tests of the stability conditions of the two models are displayed in Figure 58 in Appendix A5. We observe on this figure that for both SVAR models the stability condition is met and even share the same observable bias. Thus this does not help us in the comparison. Additionally, we perform tests for Granger causality on the three macroeconomic variables of interest for both SVAR models. The results can be observed in Table 26 (Appendix A4). We notice on this table that for the 2022 SVAR model we reject the null hypothesis at 5% that the prices of platinum and steel do not granger cause the BDI, but we cannot reject the null hypothesis that all variables jointly do not granger cause the BDI. This last hypothesis is however rejected at 1% for the SVAR model of 2014, and this same hypothesis is also rejected at 1% for both the EIR and GEPUI. Since there are more proof of granger causality in the 2014 SVAR model, we conclude that this model is more relevant.

Based on these observations, we should find the 2014 SVAR model more relevant and accurate than the 2022 SVAR models. Indeed, even if there seem to be more significant coefficients in the 2022 model, we note through the AIC that the 2014 model is more accurate and with the granger causality tests we know it as more relevant. Thus, we reject our sixth hypothesis as we do not have evidence for more significant impacts of the commodities on the economic variables in 2022 as opposed to 2014. Indeed, we came to the conclusion that the SVAR model for 2014 has more significance, is more adequate, and is more relevant, thus the results obtained with this model are more significant than those obtained with the SVAR model of 2022. We therefore reject our sixth hypothesis.

5.7 Hypothesis 7

In this section we describe the results obtained for the seventh hypothesis, namely what are the impacts of the Russian invasion of Ukraine in 2022 on the Dutch economy. We test this hypothesis mainly with two-sample t-tests to determine whether the exports are significantly larger than the imports for each of the twelve commodities investigated in this paper.

We thus perform a two-sample t-test between the imports and exports of the Netherlands for each of the twelve commodities investigated in this research for the years 2010 to 2020. The results are displayed in Table 27 (Appendix A4). We observe that for corn, seed oils, wheat, crude oil, petroleum gas, aluminum, and platinum, the Dutch imports are significantly larger than the exports at 1 and 5%. Oppositely, for fertilizers, refined oil, steel, and titanium, the Dutch exports are significantly larger than the imports at 1 and 5%. Concerning lead, there is no significant difference between imports and exports.

We then look at Table 13 and 14 (Appendix A4), and notice that refined oil indeed is in size the largest source of income amongst the twelve commodities. But we also take into account the fact that refined oil imports are also the largest source of expenses along with crude oil amongst the twelve commodities. We thus perform another two sample t-test to determine whether the imports, which were significantly larger than the exports, are significantly larger or not than the exports which were significantly larger than the imports. The results of this test is a t stat of -1.362, indicating that exports are significantly larger than imports only at 10%. Nonetheless, in this research we consider significance only at 5%, and thus establish that there is no significant difference between the exports and imports between the exports which were significantly larger than the imports and the imports which were significantly larger than the exports, for the Netherlands.

Finally, we look at Tables 15 and 16 (Appendix A4), where we can see the percentage of the Dutch exports destinated to Ukraine or Russia and the percentage of the Dutch imports originating from Ukraine or Russia. We observe that between 2010 and 2020, only a little bit over 1% and 0.2% of the Dutch exports were destinated to Russia and Ukraine respectively. Among the twelve commodities, only the Dutch seed oils exports were destinated at more than 1% to Russia. Concerning the imports we note a rise in the importance of the imports from Ukraine (from 0.1% to 0.4%), and a decrease in the importance of the imports from Russia (from around 5% to 2.2%). The most important to consider, is the dependence in imports of the Netherlands towards Russia and Ukraine for some specific commodities. Indeed, the Netherlands imported 48% of their corn from Ukraine in 2020, and over 6% of their seed oils. The dependence towards Russia is more numerous. Indeed, 26% of the Dutch crude oil imports came from Russia in 2020, over 5% of petroleum gas, almost 10% of refined oil, and over 4% of titanium.

Considering all the previously described observations, we can expect clear impacts of the war in Ukraine in 2022 on the Netherlands. Indeed, we mentioned the significant difference in imports and exports of the Netherlands for the investigated commodities for which we already determined clear impacts from the war in the previous section 5.1. However, from our second t-test, we found that the difference in exports and imports for each commodities were not significantly different and were thus compensated by each other, leading us to believe that changes in the prices of these commodities would not have an overall positive or negative impact on the revenues or expenses of the Dutch imports and exports. This is nevertheless without considering the direct dependence of the Netherlands on Ukraine and Russia for its exports and imports. We observed that the Dutch exports to Russia and Ukraine added to an insignificant part of the total Dutch exports, thereby not affecting them. Yet this cannot be said of the Dutch imports from Ukraine and Russia. Indeed, the Netherlands have an important dependence on Ukraine for corn and seed oils, and have an important dependence on Russia for crude oil, petroleum gas, refined oil and titanium.

Considering all the impediments caused by the war, such as the blockade of Odessa limiting the exports of Ukrainian corn, the destruction of fields and silos to store grain, the Russian use of oil and gas as a tool for blackmail, the supply of the Netherlands for commodities coming from Ukraine and Russia are severely threatened by hurdles and disruptions. Therefore, if we cannot consider a significant impact on the revenues and expenses of exports and imports due to changing commodity prices caused by the war in Ukraine started in February 2022, we can consider a significant threat and potential disruptions of supplies especially for corn, seed oils, crude oil, refined oil, petroleum gas, and titanium. However it is established that refined petroleum is the most lucrative exports of the Netherlands, and refined petroleum requires crude oil for its manufacturing. Therefore, if the Netherlands see their imports of crude oil from Russia significantly reduced, their production of refined oil will also be severely impacted, and ipso facto the exports of refined oil will be considerably reduced leading to an important decrease of the Netherlands' single most important revenues.

Thus, we do not reject the seventh hypothesis as we found clear impacts of the Russian invasion of Ukraine in 2022 on the economy of the Netherlands. Indeed, if the overall impact on the imports and exports seems nullified, it is clear that the supply of the Netherlands for key commodities in the energy and agricultural sectors are threatened to be considerably reduced. And this would have the largest consequences concerning refined petroleum, as such decreases in supply would hinder the production capacity of refined oil and therefore significantly reduce the revenues of the Dutch exports.

6. Discussion

Throughout this research we have investigated the economic consequences of the Russian invasion of Ukraine in February 2022. Indeed, we have asked what are the impacts of the war on the commodities for which Russia and Ukraine are major exporters. We also have studied the impacts of the war on the economy in general, and specifically on the economic activity, the inflation, and the economic policy uncertainty. For both these impacts we have tried to determine whether those were comparable to the similar effects caused in 2014 by the annexation of the Crimean peninsula. Finally, we have investigated the impacts of the war in Ukraine in 2022 on the economy of the Netherlands through the imports and exports.

In this study we have found that the Russian invasion of Ukraine in February 2022 had a clear impact on the agricultural and energy commodities for which Russia and Ukraine are major exporters, namely corn, wheat, fertilizers, seed oils, crude oil, refined oil, and petroleum gas. We however could not observe such impact for the metal commodities. On the other hand, for the annexation of the Crimean peninsula, we rejected the hypothesis or similar effects on the commodities as we did not observe any impact on the prices of the commodities for which Russia and Ukraine are major exporters. We do however observe high parameter instability and multiple breaks around the period of the annexation, but those breaks and impacts seemed related to other factors. That is why we were constrained to reject our third hypothesis stating that the impacts in 2022 were more important than those of 2014. Indeed, the comparison of the Wald, LR, and CUSUM tests were inconclusive due to the high parameter instability around 2014.

Concerning the impacts of the war on the economy in general, we established clear effects on the economic activity, expected inflation rate, and economic policy uncertainty. However, we were not able to determine an overall direction for this effects as we saw both decreases and increases, in all of the three macroeconomic indicators, as a result of the invasion of Ukraine in February 2022. We have arrived to the same conclusion for the impacts of the annexation of Crimea on the same macroeconomic variables. Nonetheless, although similar results were obtained for the two periods, we were able to distinguish their significance and quality. Indeed, we found the results of the model for the period of 2014 to be more accurate and more relevant than the model of 2022, via the Akaike information criteria (AIC) and granger causality tests.

Finally, with regards to the impact of the war in Ukraine in 2022 on the economy of the Netherlands, we have reached interesting and significant results. Indeed, we were not able to establish an overall impact on the imports and exports of the Netherlands, but we were able to point at the commodities for which the Netherlands have a considerable dependence to Russia and Ukraine, namely corn, seed oils, crude oil, refined oil, petroleum gas, and titanium. We have also come to the conclusion that since on one hand refined oil was the most lucrative export for the Netherlands and on the other hand the imports of crude oil (necessary in the production of refined oil) and refined oil are largely originated from Russia, the Netherlands face a serious threat of considerable decrease in the production of refined oil and therefore an important decrease in the exports of its most lucrative product.

To answer our research question briefly, the Russian invasion of Ukraine in 2022 had an impact on the prices of commodities for which Russia and Ukraine are major exporters. On the other hand, the annexation of Crimea in 2014 could not be associated with changes in the prices of these same commodities. However, the price changes for these commodities were not more important in 2022 than in 2014. Next, both the war in 2022 and the annexation in 2014 had observable effects on the economic activity, inflation, and economic policy uncertainty, but those effects go in various directions and therefore do not allow to tell us whether overall these events lead to decreases or increases in the three macroeconomic variables. It is nonetheless evident that the effects in 2014 are more accurately observed and are more relevant than the effects in 2022. Lastly, the impact of the war in 2022 have serious impacts on the Netherlands because of the supply of certain commodities, and especially the supply of crude and refined oil. These disruptions of supply will inevitably lead to considerable decreases in revenues in the exports of refined oil.

The results obtained in this research were not always those expected based on our expectations and based on previous literature. In general however, our results confirm that of previous researchers. Indeed, the results of our commodities regression show clear significance of the economic activity and expected inflation rate coefficients as was expected and previously found in (Gargano & Timmermann, 2014) (Piesse & Thirtle, 2009) (Stuermer, 2018). The impact of the war in 2022 on the prices of commodities was also expected to be significant (Canuto, 2022) (Costola & Lorusso, 2022) (Guenette, Kenworthy, & Wheeler, 2022), and our results confirm their findings. Concerning the impacts of the war on the economy, our results differ from the previously established findings. Indeed, our results did not allow us to confirm the decrease in economic activity due to the war in 2022 as found in previous literature (Ozili, 2022) (Astrov, Grieveson, Kochnev, Landesmann, & Pindyuk, 2022) (Neely, 2022). We also cannot confirm that the war in 2022 lead to increased inflation as some researchers found in the scientific community (Dräger, Gründer, & Potrafke) (Yeoman, 2022) (Canuto, 2022). We have however found the same significance of the impact commodities on the economic activity (He, Wang, & Lai, 2010) (Rafiq, Salim, & Bloch, 2009) (Cunado & De Gracia, 2005) (Oviedo-Gómez, Viafara, & Candelo, 2022), and the same significance of the effect of commodities on inflation rates (Bhattacharya & Bhattacharyya, 2001) (Moreira, 2014) (Moessner, 2022) (Binti Mohd Shafie, Tan, & Sek, 2022) (Iqbal, Nadim, & Akbar, 2022). And like the previous literature we did not establish a clear effect of the commodities on the economic policy uncertainty, except for petroleum gas. Lastly, with regards to the impact of the war in 2022 on the Dutch economy, previous literature suggested that countries exporting wheat, corn or oil were benefiting due to price increases, and oppositely, countries importing wheat, corn or oil would suffer increased costs (Ali, Azaroual, Bourhriba, & Dadush, 2022) (Mammadov, 2022) (Dole, 2022). We found however that the Netherlands were importing more than exporting large quantities of corn (especially from Ukraine) and were exporting considerably more than importing refined oil, and we found the effects of the prices changes to therefore compensate each other. Nevertheless, our findings show potential decreases in revenues due to disruptions of supply as expected by the literature (Mbah & Wasum, 2022) (Liadze, Macchiarelli, Mortimer-Lee, & Juanino, 2022), and especially concerning crude and refined oil (Astrov, Grieveson, Kochnev, Landesmann, & Pindyuk, 2022). These disruptions were found to lead to considerable decreases in revenues due to decreases in production, thus decreases in GDP, and these results are in line with the academic literature (Astrov, Grieveson, Kochnev, Landesmann, & Pindyuk, 2022) (Pestova, Mamonov, & Ongena, 2022). Our results are thus overall confirming the previously established findings.

Nonetheless, this research comes with limitations. The most evident drawback of this study is the data range used. Indeed, this research was made shortly after the beginning of the invasion of Ukraine in February 2022, leading us to have fewer data and to decide to use a daily frequency. This frequency, even if it allows us to catch shorter term effects, also brings noise in the analysis of these same effects. Moreover, a shorter data range can constraint us from capturing longer term and wider effects of the war in Ukraine on the commodities or the economy in general. Another limitation of this paper can be the too large set of commodities selected. Indeed, even if for each of these commodities Russia and Ukraine together represent more than 10% of their exports, the list of selected commodities could be narrowed down to only the most important commodities, or only commodities of the same category such as agricultural, energy, or metals. This broad choice of commodities might be one of the reasons why we could not determine a unique direction for the effects of the war in Ukraine on the economic activity, inflation, and economic policy uncertainty.

Lastly, we hope our research opens the way for further research. We provide several suggestions for future research in this section, also in response to the limitations of our paper. Indeed, any research done at a later point on the same topic will have enhance value as more data would be available allowing for the use of a monthly frequency which we recommend as we believe it would yield more accurate and broader observable effects of the Russian invasion of Ukraine. We also suggest analyzing the impacts of the war on specific sectors of commodities to establish which category is affected the most. Another interesting field of study would be the investigation of the impact of the sanctions imposed on Russia as a result of its invasion, as those results would be useful in the preparation of potential future sanctions.

7. Conclusion

To conclude this research, we have found that the Russian invasion of Ukraine in February 2022 had a clear impact on the agricultural and energy commodities (but not on the metal commodities) for which Russia and Ukraine are major exporters. We have not found similar effects due to the annexation of the Crimean peninsula in 2014, although we noticed high parameter instability and multiple breaks around the period of the annexation, but those breaks and impacts seemed related to other factors. Therefore we did not establish larger effects on the prices of commodities in 2022 compared to 2014. We also found clear signs of impact of the war in 2022 on the economic activity, expected inflation rate, and economic policy uncertainty. However, we could not determine a direction for these effects as both decreases and increases, in all of the three macroeconomic indicators, were observed. The results were similar for the impacts of the annexation of Crimea, however more significant, accurate, and relevant. Finally, we have established that overall the impacts on the imports and exports of the Netherlands compensate each other, but we pointed out that for some commodities the Netherlands have a considerable dependence to Russia and Ukraine. The most serious threat for the Netherlands concerns the refined oil, most lucrative export of the country, for which the supply of crude oil from Russia (26% in 2020) is endangered of disruption leading to decreases in the production of refined oil and hence decreased exports and revenues.

The findings of this research therefore imply that the Russian invasion of Ukraine in 2022 is an important factor for the increased prices and increased volatility of key commodities such as oil and gas, or corn and wheat. The study also implies that this war is a major event as it is responsible for changed levels of production, expected inflation rate, and economic policy uncertainty, which all could lead to severe economic recessions worldwide. Lastly, this paper shows the importance of the consequences of the war for each country, especially those exporting or importing the investigated commodities, and in particular when those imports are originating from Ukraine or Russia.

References

Ahmed, M., & Sarkodie, S. (2021). Counterfactual shock in energy commodities affects stock market dynamics: Evidence from the United States. *Resources Policy, 72*, 102083.

Alchian, A., & Klein, B. (1973). On a correct measure of inflation. *Journal of Money, Credit and Banking, 5(1)*, 173-191.

Ali, A., Azaroual, F., Bourhriba, O., & Dadush, U. (2022). The Economic Implications of the War in Ukraine for Africa and Morocco. *Policy Center for the New South, PB-11/22*.

Alquist, R., Bhattarai, S., & Coibion, O. (2014). Commodity-price comovement and global economic activity. *National Bureau of Economic Research*.

Alquist, R., Bhattarai, S., & Coibion, O. (2020). Commodity-price comovement and global economic activity. *Journal of Monetary Economics*, 112, 41-56.

Andreou, E., & Ghysels, E. (2006a). Monitoring disruptions in financial markets. *Journal of Econometrics, 135(1-2)*, 77-124.

Andreou, E., & Ghysels, E. (2009). Structural breaks in financial time series. *Handbook of financial time series*, 839-870.

Astrov, V., Grieveson, R., Kochnev, A., Landesmann, M., & Pindyuk, O. (2022). Possible Russian invasion of Ukraine, scenarios for sanctions, and likely economic impact on Russia, Ukraine and the EU. *Policy Notes and Reports, (No. 55)*.

Aue, A., & Horváth, L. (2013). Structural breaks in time series. *Journal of Time Series Analysis, 34(1)*, 1-16.

Baker, S., Bloom, N., & Davis, S. (2016). Measuring economic policy uncertainty. *The quarterly journal of economics, 131(4)*, 1593-1636.

Baker, S., Bloom, N., & Davis, S. (2022, May 28). *Global Economic Policy Uncertainty Index*. Retrieved from Economic Policy Uncertainty Index: https://www.policyuncertainty.com/global_monthly.html

Bakshi, G., Panayotov, G., & Skoulakis, G. (2011). The Baltic Dry Index as a predictor of global stock returns, commodity returns, and global economic activity. *In AFA 2012 Chicago Meetings Paper*.

BBC . (2022, March 07). *Ukraine conflict: Petrol at fresh record as oil and gas prices soar.* Retrieved from BBC News: https://www.bbc.com/news/business-60642786

BBC. (2022, April 27). *Ukraine war: Russia halts gas exports to Poland and Bulgaria.* Retrieved from BBC: https://www.bbc.com/news/business-61237519

Beale, E. (1960). Confidence regions in non-linear estimation. *Journal of the Royal Statistical Society: Series B (Methodological), 22(1)*, 41-76.

Bebier, A. (2015). Crimea and the Russian-Ukrainian conflict. *Romanian J. Eur. Aff., 15* , 35.

Bebier, A. (2015). Crimea and the Russian-Ukrainian conflict. *Romanian J. Eur. Aff., 15*, 35.

Bella, T. (2022, May 24). *Kissinger says Ukraine should cede territory to Russia to end war*. Retrieved from https://www.washingtonpost.com/world/2022/05/24/henry-kissinger-ukraine-russia-territory-davos/: https://www.washingtonpost.com/world/2022/05/24/henry-kissinger-ukraine-russia-territory-davos/

Bhattacharya, K., & Bhattacharyya, I. (2001). Impact of increase in oil prices on inflation and output in India. *Economic and Political weekly*, 4735-4741.

Bildirici, M., Kayikçi, F., & Onat, I. (2015). Baltic Dry Index as a major economic policy indicator: the relationship with economic growth. *Procedia-Social and Behavioral Sciences, 210*, 416-424.

Binti Mohd Shafie, N., Tan, P., & Sek, S. (2022). Determinants of Inflation in Malaysia: Monetary or Real Factor? *International Conference on Mathematics and its Applications in Science and Engineering*, 113-124.

Bloomberg. (2022, May 28). *Commodities*. Retrieved from Bloomberg: https://www.bloomberg.com/markets/commodities

Boubaker, S., Goodell, J., Pandey, D., & Kumari, V. (2022). Heterogeneous impacts of wars on global equity markets: Evidence from the invasion of Ukraine. *Finance Research Letters*, 102934.

Breitung, J., & Eickmeier, S. (2011). Testing for structural breaks in dynamic factor models. *Journal of Econometrics, 163(1)*, 71-84.

Brown, R., Durbin, J., & Evans, J. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society: Series B (Methodological), 37(2)*, 149-163.

Canette, I. (2022, March 04). *Using gsem to combine estimation results*. Retrieved from The Stata Blog: https://blog. stata. com/2014/08/18/using-gsem-to-combine-estimation-results

Canuto, O. (2022). War in Ukraine and Risks of Stagflation. *Policy Center for the New South*.

Cheung, C., & Morin, S. (2007). The impact of emerging Asia on commodity prices. *Bank of Canada Working Paper*, (No. 2007, 55).

Ciner, C. (2011). Commodity prices and inflation: Testing in the frequency domain. *Research in International Business and Finance, 25(3)*, 229-237.

Clarke, D., Romano, J., & Wolf, M. (2020). The Romano–Wolf multiple-hypothesis correction in Stata. *The Stata Journal, 20(4)*, 812-843.

Corporate Finance Institute. (2022, May 28). *Baltic Dry Index*. Retrieved from CFI: https://corporatefinanceinstitute.com/resources/knowledge/other/baltic-dry-index/

Costola, M., & Lorusso, M. (2022). Spillovers among energy commodities and the Russian stock market. *Journal of Commodity Markets*, 100249.

Crawford, G., Liew, J., & Marks, A. (2013). Spot commodities as inflation protection. *The Journal of Wealth Management, 16(3)*, 87-111.

Cró, S., & Martins, A. (2017). Structural breaks in international tourism demand: Are they caused by crises or disasters? *Tourism management*, 63, 3-9.

Cunado, J., & De Gracia, F. (2005). Oil prices, economic activity and inflation: evidence for some Asian countries. *The Quarterly Review of Economics and Finance, 45(1)*, 65-83.

Dietz, T., & Kalof, L. (2009). *Introduction to social statistics: the logic of statistical reasoning.* John Wiley & Sons.

Diewert, W. (1998). High inflation, seasonal commodities, and annual index numbers. *Macroeconomic Dynamics, 2(4)*, 456-471.

Dole, M. (2022). Russia-Ukraine war: Impact on Indian Economy. *IJNRD-International Journal of Novel Research and Development (IJNRD), 7(4)*, 303-309.

Dräger, L., Gründer, K., & Potrafke, N. (n.d.). Political Shocks and Inflation Expectations: Evidence from the 2022 Russian Invasion of Ukraine. *2022*.

Economic Intelligence. (2022, March 03). *Global economic implications of the Russia-Ukraine war*. Retrieved from Economic Intelligence Unit: https://www.eiu.com/n/global-economic-implications-of-the-russia-ukraine-war/

Enders, W. (2004). Applied econometric time series 2nd edition. *Technometrics, 46(2)*, 264-264.

Energy Intel. (2022, February 25). *How Will New Russia Sanctions Affect Energy?* Retrieved from Energy Intel: https://www.energyintel.com/0000017f-323e-dca3-a77f-f6bf644e0000

European Commision. (2020, December 22). *Glossary:Economic activity*. Retrieved from Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Main_Page

Federal Reserve Bank of St. Louis. (2022, May 28). *10-Year Breakeven Inflation Rate*. Retrieved from FRED Economic Data St. Louis FED: https://fred.stlouisfed.org/series/T10YIE

Federal Reserve Bank of St. Louis. (2022, May 28). *Economic Research*. Retrieved from FRED Economic Data St. Louis FED: https://fred.stlouisfed.org/#

Fernando, J. (2022, May 13). *What Is Inflation?* Retrieved from Investopedia: https://www.investopedia.com/terms/i/inflation.asp

Finanzen.net. (2022, May 28). *https://www.finanzennet.gmbh/*. Retrieved from Wer wir sind: https://www.finanzennet.gmbh/

Furlong, F., & Ingenito, R. (1996). Commodity prices and inflation. *Economic Review-Federal Reserve Bank of San Francisco*, 27-47.

Galesi, A., & Lombardi, M. (2009). External shocks and international inflation linkages: a global VAR analysis.

Gargano, A., & Timmermann, A. (2014). Forecasting commodity price indexes using macroeconomic and financial predictors. *International Journal of Forecasting*, 30(3), 825-843.

Geman, H., & Smith, W. (2012). Shipping markets and freight rates: an analysis of the Baltic Dry Index. *The Journal of Alternative Investments, 15(1)*, 98-109.

Gevorkyan, V., & Gevorkyan, A. (2012). Derivatives, commodities, and social costs: exploring correlation in economic uncertainty. *Derivative Securities Pricing and Modelling*, Emerald Group Publishing Limited.

Glynn, J., Perera, N., & Verma, R. (2007). Unit root tests and structural breaks: A survey with applications.

Gourieroux, C., & Monfort, A. (1995). *Statistics and econometric models (Vol. 1).* Cambridge: Cambridge University Press.

Greene, W. (2003). *Econometric analysis.* Pearson Education.

Griffiths, W., Judge, G., Hill, R., Lütkepohl, H., & Lee, T. (1985). *The theory and practice of econometrics.* Wiley.

Guenette, J., Kenworthy, P., & Wheeler, C. (2022). Implications of the War in Ukraine for the Global Economy.

Gulen, H., & Ion, M. (2016). Policy uncertainty and corporate investment. *The Review of Financial Studies, 29(3)*, 523-564.

Gutierrez, R., Carter, S., & Drukker, D. (2001). On boundary-value likelihood-ratio tests. *Stata Technical Bulletin, 10(60)*.

Hanna, S. (2022, March 14). *Russia-Ukraine War Could Cause Aerospace Supply Shortages.* Retrieved from Mexico Business News: https://mexicobusiness.news/aerospace/news/russia-ukraine-war-could-cause-aerospace-supply-shortages

Hansen, W. (2022, May 28). *Understanding the Baltic Dry Index*. Retrieved from Learning Markets: https://www.learningmarkets.com/understanding-the-baltic-dry-index/

Havlik, P. (2014). Economic consequences of the Ukraine conflict. *Policy Notes and Reports*, No. 14.

Hayes, A. (2021, October 30). *Commodity Market*. Retrieved from Investopedia: https://www.investopedia.com/terms/c/commodity-market.asp

He, Y., Wang, S., & Lai, K. (2010). Global economic activity and crude oil prices: A cointegration analysis. *Energy Economics*, 32(4), 868-876.

Herrera, A., Lagalo, L., & Wada, T. (2011). Oil price shocks and industrial production: Is the relationship linear? *Macroeconomic dynamics*, 15(S3), 472-497.

Hodge, Lister, Kottasova, & Helen. (2022, February 24). *Russia launches military attack on Ukraine with reports of explosions and troops crossing border.* Retrieved from CNN: https://edition.cnn.com/2022/02/23/europe/russia-ukraine-putin-military-operation-donbas-intl-hnk/index.html

Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian journal of statistics*, 65-70.

Hosmer, D., Lemeshow, S., & Sturdivant, R. (2013). *Applied logistic regression (Vol. 398).* John Wiley & Sons.

Hotten, R. (2022, May 04). *Ukraine conflict: What is Swift and why is banning Russia so significant?* Retrieved from BBC: https://www.bbc.com/news/business-60521822

Hsiao, C. (2022). *Analysis of panel data.* Cambridge university press.

International Trade Center. (2022, May 28). *Trade Map*. Retrieved from International Trade Center: https://www.trademap.org/Index.aspx

Investing.com. (2022, May 28). *About Investing.com*. Retrieved from Investing.com: https://www.investing.com/about-us/

Iqbal, M., Nadim, N., & Akbar, Z. (2022). Determinants of Recent Inflation in Pakistan and its Relation with Economic Growth: An Econometric Analysis. *Pakistan Journal of Humanities and Social Sciences, 10(1)*, 345-353.

Isserlis, L. (1938). Tramp shipping cargoes, and freights. *Journal of the Royal Statistical Society, 101(1)*, 53-146.

Jurado, K., Ludvigson, S., & Ng, S. (2015). Measuring uncertainty. *American Economic Review, 105(3)*, 1177-1216.

Karanasos, M., & Yfanti, S. (2021). On the Economic fundamentals behind the Dynamic Equicorrelations among Asset classes: Global evidence from Equities, Real estate, and Commodities. *Journal of International Financial Markets, Institutions and Money, 74*, 101292.

Khalifa, A., Otranto, E., Hammoudeh, S., & Ramchander, S. (2016). Volatility transmission across currencies and commodities with US uncertainty measures. *The North American Journal of Economics and Finance, 37*, 63-83.

Kholodilin, K. A., & Netsunajev, A. (2016). Crimea and punishment: The impact of sanctions on Russian and European economies. *Working Paper*.

Kirby, P. (2022, May 09). *Why has Russia invaded Ukraine and what does Putin want?* Retrieved from BBC: https://www.bbc.com/news/world-europe-56720589

Kirchene, N. (2008). Recent inflationary trends in world commodities markets. *IMF Working Papers, 2008(130)*.

Kopp, C. (2021, October 31). *Baltic Dry Index (BDI)*. Retrieved from Investopedia: https://www.investopedia.com/terms/b/baltic_dry_index.asp

Korn, E., & Graubard, B. (1990). Simultaneous testing of regression coefficients with complex survey data: Use of Bonferroni t statistics. *The American Statistician, 44(4)*, 270-276.

Köse, N., & Ünal, E. (2021). The effects of the oil price and oil price volatility on inflation in Turkey. *Energy*, 226.

Labson, B., & Crompton, P. (1993). Common trends in economic activity and metals demand: Cointegration and the intensity of use debate. *Journal of Environmental Economics and Management*, 25(2), 147-161.

Lamoureux, C., & Lastrapes, W. (1990a). Heteroskedasticity in stock return data: Volume versus GARCH effects. *The journal of finance*, 45(1), 221-229.

Lamoureux, C., & Lastrapes, W. (1990b). Persistence in variance, structural change, and the GARCH model. *Journal of Business & Economic Statistics*, 8(2), 225-234.

Liadze, I., Macchiarelli, C., Mortimer-Lee, P., & Juanino, P. (2022). The economic costs of the Russia-Ukraine conflict. *NIESR Policy Paper, 32*.

Lin, F., & Sim, N. (2013). Trade, income and the baltic dry index. *European Economic Review, 59*, 1-18.

Liste, T., & Fylyppov, S. (2022, May 05). *Russians steal vast amounts of Ukrainian grain and equipment, threatening this year's harvest.* Retrieved from CNN: https://edition.cnn.com/2022/05/05/europe/russia-ukraine-grain-theft-cmd-intl/index.html

Liu, J., & Serletis, A. (2021). World Commodity Prices and Economic Activity in Advanced and Emerging Economies. *Open Economies Review*, 1-28.

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

Lutz, E. (2022, May 13). *Maps: Tracking the Russian Invasion of Ukraine*. Retrieved from The New York Times: https://www.nytimes.com/interactive/2022/world/europe/ukraine-maps.html

MacFarlane, S. (2022, May 06). *Bakers warn of summer surge in bread prices due to war in Ukraine.* Retrieved from CBS News: https://www.cbsnews.com/news/ukraine-russia-war-bread-price-surge/

MacKinnon, J., & White, H. (1985). Some heteroskedasticity-consistent covariance matrix estimators with improved finite sample properties. *Journal of econometrics, 29(3)*, 305-325.

Mammadov, E. (2022). The Economic Consequences of Russia-Ukraine War for Azerbaijan. *Available at SSRN 4058963*.

Markets Insider. (2022, May 28). *Commodities*. Retrieved from Markets Insider: https://markets.businessinsider.com/commodities

Massachusetts Institute of Technology. (2022, May 28). *The Observatory of Economic Complexity (OEC)*. Retrieved from MIT Media Lab: https://www.media.mit.edu/projects/oec-new/overview/

Mbah, R., & Wasum, D. (2022). Russian-Ukraine 2022 War: A review of the economic impact of Russian-Ukraine crisis on the USA, UK, Canada, and Europe. *Adv. Soc. Sci. Res. J, 9*, 144-153.

Mehmetoglu, M., & Jakobsen, T. (2022). *Applied statistics using Stata: a guide for the social sciences.* Sage.

Meijering, E. (2002). A chronology of interpolation: from ancient astronomy to modern signal and image processing. *Proceedings of the IEEE, 90(3)*, 319-342.

Moessner, R. (2022). Determinants of Inflation Expectations in the Euro Area.

Moreira, R. (2014). Commodities prices volatility, expected inflation and GDP levels: an application for a net-exporting economy. *Procedia Economics and Finance, 14*, 435-444.

Morris, M., Kaplinsky, R., & Kaplan, D. (2012). “One thing leads to another”—Commodities, linkages and industrial development. *Resources Policy, 37(4)*, 408-416.

Mowry, B., & Pescatori, A. (2008). Industrial Production, Commodity Prices, and the Baltic Dry Index. *Economic Trends*.

Neely, C. (2022). The Russian Invasion, Oil and Gasoline Prices, and Recession. *Economic Synopses, (10)*.

NPR. (2022, May 27). *Russia-Ukraine war: What happened today (May 27)*. Retrieved from Non Profit Journalism: https://www.npr.org/2022/05/27/1101750622/russia-ukraine-war-what-happened-today-may-27

Offshore Technology. (2022, April 25). *Netherlands looking to end dependence on Russian oil and gas by year-end*. Retrieved from Offshore Technology: https://www.offshore-technology.com/news/netherlands-russian-oil-2022/#:~:text=The%20Netherlands%20is%20planning%20to,the%20share%20of%20Russian%20gas.

Oviedo-Gómez, A., Viafara, J., & Candelo, M. (2022). Economic growth without welfare. The case of the impact of commodities on the Colombian economy. *Brazilian Journal of Political Economy, 42*, 71-87.

Ozili, P. (2022). Global economic consequence of Russian invasion of Ukraine. *Available at SSRN*.

Pástor, L., & Stambough, R. (2001). The equity premium and structural breaks. *The Journal of Finance, 56(4)*, 1207-1239.

Perron, P. (2006). Dealing with structural breaks. *Palgrave handbook of econometrics, 1(2)*, 278-352.

Perron, P., & Zhu, X. (2005). Structural breaks with deterministic and stochastic trends. *Journal of Econometrics, 129(1-2)*, 65-119.

Pestova, A., Mamonov, M., & Ongena, S. (2022). The price of war: Macroeconomic effects of the 2022 sanctions on Russia.

Piesse, J., & Thirtle, C. (2009). Three bubbles and a panic: An explanatory review of recent food commodity price events. *Food policy*, 34(2), 119-129.

Ploberger, W., & Krämer, W. (1992). The CUSUM test with OLS residuals. *Econometrica: Journal of the Econometric Society*, 271-285.

Rafiq, S., Salim, R., & Bloch, H. (2009). Impact of crude oil price volatility on economic activities: An empirical investigation in the Thai economy. *Resources policy, 34(3)*, 121-132.

Rapach, D., & Strauss, J. (2008). Structural breaks and GARCH models of exchange rate volatility. *Journal of Applied Econometrics, 23(1)*, 65-90.

Reuters. (2022, March 31). *Putin says Russian gas must be paid for in rubles from Friday.* Retrieved from CNBC: https://www.cnbc.com/2022/03/31/putin-says-russian-gas-must-be-paid-for-in-rubles-from-friday.html

Robinson, S., Mason-D'Croz, D., Sulser, T., Islam, S., Robertson, R., Zhu, T., & Rosegrant, M. (2015). The international model for policy analysis of agricultural commodities and trade (IMPACT): model description for version 3.

Rumelt, R. (2009). Strategy in a ‘structural break’. *McKinsey Quarterly, 1*, 35-42.

Seddon, M., Reed, J., Olearchyk, R., Ivanova, P., & Foy, H. (2022, February 25). *Russia mobilises for assault on Kyiv as its troops storm Ukraine*. Retrieved from Financial Times: https://www.ft.com/content/07bbc5c7-e620-4734-83b5-7bb261363c35

Shahzad, S., Raza, N., Balcilar, M., Ali, S., & Shahbaz, M. (2017). Can economic policy uncertainty and investors sentiment predict commodities returns and volatility? *Resources Policy, 53*, 208-218.

STATA. (2022, May 28). *dipolate.* Retrieved from Stata: https://www.stata.com/manuals/dipolate.pdf

STATA. (2022, May 28). *rlrtest*. Retrieved from STATA: https://www.stata.com/manuals/rlrtest.pdf#rlrtest

STATA. (2022, May 28). *rtest*. Retrieved from STATA: https://www.stata.com/manuals/rtest.pdf

STATA. (2022, May 28). *tsestatsbcusum*. Retrieved from STATA: https://www.stata.com/manuals/tsestatsbcusum.pdf

STATA. (2022, May 28). *tsvarsvar*. Retrieved from STATA: https://www.stata.com/manuals/tsvarsvar.pdf

Stock, J. (1994). Unit roots, structural breaks and trends. *Handbook of econometrics, 4*, 2739-2841.

Stuermer, M. (2018). 150 years of boom and bust: what drives mineral commodity prices? *Macroeconomic Dynamics*, 22(3), 702-717.

Tapiero, C. (2008). Orders and inventory commodities with price and demand uncertainty in complete markets. *International Journal of Production Economics, 115(1)*, 12-18.

The Observatory of Economic Complexity. (2022). *Netherlands*. Retrieved from OEC: https://oec.world/en/profile/country/nld

The Observatory of Economic Complexity. (2022). *Russia.* Retrieved from OEC: https://oec.world/en/profile/country/rus

The Observatory of Economic Complexity. (2022). *Ukraine.* Retrieved from OEC: https://oec.world/en/profile/country/ukr

Tierney, J. (2022, March 23). *How the Baltic Dry Index Impacts Markets*. Retrieved from Macro Hive: https://macrohive.com/hive-explainers/how-the-baltic-dry-index-impacts-markets/

Tinbergen. (1959). Tonnage and freight. *Jan Tinbergen Selected Papers*, 93-111.

U.S. Department of the Treasury. (2022, February 24). *U.S. Treasury Announces Unprecedented & Expansive Sanctions Against Russia, Imposing Swift and Severe Economic Costs.* Retrieved from Press Releases: https://home.treasury.gov/news/press-releases/jy0608

Umar, Z., Polat, O., Choi, S., & Teplova, T. (2022). The impact of the Russia-Ukraine conflict on the connectedness of financial markets. *Finance Research Letters*, 102976.

Vasylkovska, K., Andriienko, O., Vasylkovskyi, O., Andriienko, A., Volodymyr, P., & Malakhovska, V. (2021). Dynamics of export potential of sunflower oil in Ukraine. *Helia, 44(74)*, 115-123.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica: journal of the Econometric Society*, 817-838.

Wikipedia. (2022, May 28). *International Trade Centre*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/International_Trade_Centre

Wikipedia. (2022, May 28). *Policy uncertainty*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Policy_uncertainty#:~:text=Policy%20uncertainty%20(also%20called%20regime,this%20uncertainty%20has%20been%20resolved.

Wintour, P. (2022, May 12). *G7 to discuss action to break Russian blockade of Ukraine grain exports.* Retrieved from The Guardian: https://www.theguardian.com/world/2022/may/12/russian-blockade-grain-exports-ukraine-ports-g7

Ye, X., & Sun, Y. (2018). Heteroskedasticity-and autocorrelation-robust F and t tests in Stata. *The Stata Journal, 18(4)*, 951-980.

Yeoman, I. (2022). Ukraine, price and inflation. *Journal of Revenue and Pricing Management*, 1-2.

Zaremba, A., Umar, Z., & Mikutowski, M. (2019). Inflation hedging with commodities: A wavelet analysis of seven centuries worth of data. *Economics Letters, 181*, 90-94.

Appendix

A1. List of Tables

A2. List of Figures

A3. List of Equations

A4. Tables

Table 1: *Russia and Ukraine's Major Commodities Share of Exports*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Corn	3.35	6.06	12.16	12.03	11.68	11.79	11.40	12.01	12.13	15.82	13.85
Fertilizers	15.63	15.97	17.32	15.03	14.28	14.33	16.65	16.16	13.24	13.76	12.71
Seed Oils	41.05	38.46	48.90	45.80	48.90	47.10	51.20	52.80	51.50	55.30	57.40
Wheat	11.38	12.14	17.87	11.46	18.69	16.98	24.24	24.68	33.34	27.84	28.47
Crude Oil	12.00	11.20	10.90	9.63	10.30	11.80	11.10	11.30	12.10	12.40	11.60
Oil Gas	12.40	11.80	11.10	10.50	7.63	8.39	7.73	7.25	8.26	8.98	9.08
Refined Oil	10.50	9.13	8.73	9.63	10.70	12.20	11.80	11.40	10.80	10.40	10.60
Aluminum	12.40	12.70	13.20	13.30	12.00	13.70	11.10	10.40	9.67	9.86	9.02
Lead Ore	3.71	6.66	5.63	7.11	6.84	5.63	8.17	10.20	10.40	9.56	7.84
Platinum	10.20	11.20	9.28	8.60	5.62	5.92	12.40	15.30	13.30	16.40	16.60
Steel	9.71	8.32	7.95	10.06	11.69	9.58	8.78	11.42	11.22	11.01	10.79
Titanium	14.20	11.57	13.15	13.54	11.98	11.71	10.60	11.88	12.25	11.93	11.20

Notes: (i) This table shows the evolution of the sum of the share of exports of Russia and Ukraine in agricultural, energy, and metal commodities between 2010 and 2020 included. (ii) The numbers are displayed with two decimals and are percentages.

Table 2: *Russia's Major Commodities Share of Exports*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Corn	0.24	0.46	1.56	1.73	2.07	2.02	2.84	2.68	2.39	1.72	1.05
Fertilizers	13.50	13.30	14.70	13.30	13.20	13.40	16.00	15.90	13.10	13.40	12.10
Seed Oils	6.05	7.06	14.50	14.10	14.40	13.40	14.40	15.40	14.50	18.80	18.20
Wheat	8.22	9.76	12.10	7.51	12.80	10.60	16.60	18.10	26.50	17.90	19.50
Crude Oil	12.00	11.20	10.90	9.63	10.30	11.80	11.10	11.30	12.10	12.40	11.60
Oil Gas	12.40	11.80	11.10	10.50	7.63	8.39	7.73	7.25	8.26	8.98	9.08
Refined Oil	10.50	9.13	8.73	9.63	10.70	12.20	11.80	11.40	10.80	10.40	10.60
Aluminum	12.40	12.70	13.20	13.30	12.00	13.70	11.10	10.40	9.67	9.86	9.02
Lead Ore	3.71	6.66	5.63	7.11	6.84	5.63	8.17	10.20	10.40	9.56	7.84
Platinum	10.20	11.20	9.28	8.60	5.62	5.92	12.40	15.30	13.30	16.40	16.60
Steel	6.50	5.98	6.71	8.60	9.49	7.89	7.84	10.30	9.74	9.43	7.71
Titanium	11.90	9.29	10.70	11.40	9.89	10.10	9.39	10.50	10.90	10.50	10.00

Notes: (i) This table shows the evolution of the share of exports of Russia in agricultural, energy, and metal commodities between 2010 and 2020 included. (ii) The numbers are displayed with two decimals and are percentages.

Table 3: *Ukraine's Major Commodities Share of Exports*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Corn	3.11	5.60	10.60	10.30	9.61	9.77	8.56	9.33	9.74	14.10	12.80
Fertilizers	2.13	2.67	2.62	1.73	1.08	0.93	0.65	0.26	0.14	0.36	0.61
Seed Oils	35.00	31.40	34.40	31.70	34.50	33.70	36.80	37.40	37.00	36.50	39.20
Wheat	3.16	2.38	5.77	3.95	5.89	6.38	7.64	6.58	6.84	9.94	8.97
Steel	3.21	2.34	1.24	1.46	2.20	1.69	0.94	1.12	1.48	1.58	3.08
Titanium	2.30	2.28	2.45	2.14	2.09	1.61	1.21	1.38	1.35	1.43	1.20

Notes: (i) This table shows the evolution of the share of exports of Ukraine in agricultural and metal commodities between 2010 and 2020 included. (ii) The numbers are displayed with two decimals and are percentages.

Table 4: *List of Commodities Investigated and their Corresponding Market Instrument*

	Instrument type	Instrument	Currency	Source
Corn	Future	US Corn Futures	Dollars	Investing.com
Fertilizers	Stock	Nutrien	Dollars	Investing.com
Seed Oils	Future	US Soybean Oil Futures	Dollars	Investing.com
Wheat	Future	London Wheat Futures	Pound Sterling	Investing.com
Crude Oil	Future	Crude Oil WTI Futures	Dollars	Investing.com
Oil Gas	Future	Natural Gas Futures	Dollars	Investing.com
Refined Oil	Future	Heating Oil Futures	Dollars	Investing.com
Aluminum	Future	Aluminum Futures	Dollars	Finanzen.net
Lead Ore	Future	Lead Futures	Dollars	Investing.com
Platinum	Future	Platinum Futures	Dollars	Investing.com
Steel	Future	Steel Futures	Indian Rupee	Investing.com
Titanium	Stock	BaoJi Titanium Industry	Renminbi	Investing.com

Notes: (i) This table shows which type of market instrument was selected to represent the investigated commodities. (ii) The table also indicates precisely which item represent the commodities and in which currency this data was obtained.

Table 5: *Results of the interpolation and extrapolation applied on our commodity time-series*

	Interpolation	Extrapolation	Selected Data
Corn	1360	0	Interpolated
Fertilizers	500	2924	Interpolated
Seed Oils	1346	0	Interpolated
Wheat	1350	2	Extrapolated
Crude Oil	1304	3	Extrapolated
Oil Gas	1305	3	Extrapolated
Refined Oil	1281	0	Interpolated
Aluminum	1395	3	Extrapolated
Lead Ore	1455	5	Extrapolated
Platinum	676	0	Interpolated
Steel	909	1278	Interpolated
Titanium	1256	782	Interpolated
Renminbi	1296	0	Interpolated
Sterling	1296	0	Interpolated
Rupee	941	0	Interpolated
Dollar	1296	0	Interpolated

Notes: (i) This table shows the results of the interpolation and extrapolation applied to our time-series. (ii) The Interpolation column indicates the number of additional observations obtained through interpolation. (iii) The extrapolation column indicates the number of additional observations obtained through extrapolation.

Table 6: *Descriptive Statistics of Commodity Time-Series between 2010 and 2022*

	Obs.	Mean	Std. dev.	Median	Skewness	Kurtosis
Corn	4535	388.073	105.221	341.715	1.147	3.683
Fertilizers	1611	47.475	14.344	45.352	1.918	7.387
Seed Oils	4535	33.528	9.809	29.625	1.954	7.749
Wheat	4535	189.183	44.989	181.222	1.546	7.611
Crude Oil	4535	57.094	15.560	56.782	0.090	3.277
Oil Gas	4535	2.726	0.817	2.585	2.436	14.336
Refined Oil	4535	1.744	0.486	1.744	0.786	5.644
Aluminum	4535	1673.897	316.496	1618.504	2.334	10.101
Lead Ore	4535	1735.568	198.455	1690.069	0.645	2.520
Platinum	4535	976.147	183.856	945.578	0.269	1.880
Steel	3257	435.970	70.672	433.760	1.024	5.718
Titanium	3753	3.122	1.645	2.621	1.829	5.967

Notes: (i) This table shows descriptive statistics for our commodity time-series between 2010 and 2022. (ii) Obs. represents the number of observations. (iii) Std. dev. represents the standard deviation of the time-series. (iv) All numbers are rounded to three decimal places.

Table 7: *Descriptive Statistics of Commodity Time-Series between 2021 and 2022*

	Obs.	Mean	Std. dev.	Median	Skewness	Kurtosis
Corn	517	539.287	97.260	518.468	0.937	2.847
Fertilizers	517	60.912	17.124	53.689	1.169	3.144
Seed Oils	517	54.198	10.969	52.836	0.672	3.335
Wheat	517	262.659	56.309	239.166	1.432	3.715
Crude Oil	517	67.268	17.783	61.752	0.846	2.737
Oil Gas	517	3.772	1.507	3.465	1.188	4.035
Refined Oil	517	2.144	0.732	1.852	1.273	3.737
Aluminum	517	2333.067	441.561	2301.744	0.368	2.349
Lead Ore	517	1922.192	167.705	1951.064	-0.130	2.059
Platinum	517	917.615	64.404	908.037	0.377	2.419
Steel	500	538.496	78.515	517.820	0.895	3.171
Titanium	517	6.682	1.261	6.604	0.609	2.922

Notes: (i) This table shows descriptive statistics for our commodity time-series between 2021 and 2022. (ii) Obs. represents the number of observations. (iii) Std. dev. represents the standard deviation of the time-series. (iv) All numbers are rounded to three decimal places.

Table 8: *Descriptive Statistics of Commodity Time-Series between 2013 and 2015*

	Obs.	Mean	Std. dev.	Median	Skewness	Kurtosis
Corn	731	374.377	95.333	336.204	0.794	2.127
Fertilizers	0	-	-	-	-	-
Seed Oils	731	31.103	4.557	29.841	0.470	1.910
Wheat	731	190.842	28.339	188.948	0.324	2.624
Crude Oil	731	71.703	6.820	72.312	-1.995	8.467
Oil Gas	731	3.007	0.342	3.017	0.537	3.939
Refined Oil	731	2.168	0.157	2.185	-1.901	7.772
Aluminum	731	1425.752	110.843	1403.866	0.292	1.944
Lead Ore	731	1606.189	74.013	1592.584	0.838	3.357
Platinum	731	1080.737	77.022	1068.905	0.810	3.083
Steel	731	421.772	27.387	424.281	-0.121	2.205
Titanium	731	1.825	0.351	1.721	0.404	1.809

Notes: (i) This table shows descriptive statistics for our commodity time-series between 2013 and 2015. (ii) Obs. represents the number of observations. (iii) Std. dev. represents the standard deviation of the time-series. (iv) All numbers are rounded to three decimal places.

Table 9: *Results of the interpolation and extrapolation applied on our economic time-series*

	Interpolation	Extrapolation	Selected Data
GEPUI	0	0	Original
Inflation	1425	3	Extrapolated
BDI	1143	915	Interpolated

Notes: (i) This table shows the results of the interpolation and extrapolation applied to our time-series. (ii) The Interpolation column indicates the number of additional observations obtained through interpolation. (iii) The extrapolation column indicates the number of additional observations obtained through extrapolation. (iv) GEPUI represents the Global Economic Policy Uncertainty Index. (v) BDI represents the Baltic Dry index.

Table 10: *Descriptive Statistics of the Economic Indicator Time-Series between 2010 and 2022*

	Obs.	Mean	Std. dev.	Median	Skewness	Kurtosis
GEPUI	4535	128.984	92.813	104.550	2.473	12.088
Inflation	4535	2.002	0.357	2.040	-0.221	3.040
BDI	3620	1106.112	679.217	909.200	2.054	8.336

Notes: (i) This table shows descriptive statistics for our economic indicator time-series between 2010 and 2022. (ii) Obs. represents the number of observations. (iii) Std. dev. represents the standard deviation of the time-series. (iv) GEPUI represents the Global Economic Policy Uncertainty Index. (v) BDI represents the Baltic Dry index. (vi) All numbers are rounded to three decimal places.

Table 11: *Descriptive Statistics of the Economic Indicator Time-Series between 2021 and 2022*

	Obs.	Mean	Std. dev.	Median	Skewness	Kurtosis
GEPUI	517	141.348	64.817	126.890	1.477	6.419
Inflation	517	2.451	0.218	2.410	0.580	2.921
BDI	517	2357.272	807.697	2304.323	0.761	3.520

Notes: (i) This table shows descriptive statistics for our economic indicator time-series between 2021 and 2022. (ii) Obs. represents the number of observations. (iii) Std. dev. represents the standard deviation of the time-series. (iv) GEPUI represents the Global Economic Policy Uncertainty Index. (v) BDI represents the Baltic Dry index. (vi) All numbers are rounded to three decimal places.

Table 12: *Descriptive Statistics of the Economic Indicator Time-Series between 2013 and 2015*

	Obs.	Mean	Std. dev.	Median	Skewness	Kurtosis
GEPUI	731	92.453	57.427	77.940	2.275	11.971
Inflation	731	2.186	0.199	2.180	-0.232	3.620
BDI	731	870.329	282.619	800.539	1.182	3.634

Notes: (i) This table shows descriptive statistics for our economic indicator time-series between 2013 and 2015. (ii) Obs. represents the number of observations. (iii) Std. dev. represents the standard deviation of the time-series. (iv) GEPUI represents the Global Economic Policy Uncertainty Index. (v) BDI represents the Baltic Dry index. (vi) All numbers are rounded to three decimal places.

Table 13: *Exports of the Netherlands and their Trade Value in Millions of Dollars*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Corn	51	122	166	190	249	171	134	203	224	261	207
Fertilizers	1961	2762	3028	2964	2837	2477	2039	2042	2013	2158	2023
Seed Oils	2404	2804	3764	3614	3437	2813	3181	3519	3647	3601	4335
Wheat	119	215	187	220	215	132	113	105	104	89	67
Crude Oil	180	63	332	306	370	184	77	65	119	75	68
Oil Gas	1315	1790	1619	1484	1927	1106	759	909	1237	1098	2572
Refined Oil	44928	65308	71436	74480	64887	41944	37646	43937	53679	53869	34735
Aluminum	4031	4827	4063	4019	4887	4235	4344	4847	5489	4683	4276
Lead Ore	99	165	58	59	78	84	54	125	287	344	312
Platinum	34	26	23	20	21	19	17	14	10	17	39
Steel	13470	17090	14595	12959	14103	10985	10148	12643	13859	11837	10464
Titanium	55	101	79	97	68	58	99	129	59	54	36
Total	492646	569358	552502	575112	575677	464697	468697	527908	587893	576784	551353

Notes: (i) This table shows the evolution of the exports of the Netherlands in agricultural, energy, and metal commodities between 2010 and 2020 included. (ii) The numbers are displayed in millions of dollars.

Table 14: *Imports of the Netherlands and their Trade Value in Millions of Dollars*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Corn	656	1148	1249	1466	1311	1058	938	1102	1317	1355	1290
Fertilizers	703	1059	1081	1040	1208	952	826	799	760	739	695
Seed Oils	3421	4890	4562	5024	4642	4131	4089	4258	4293	4339	5032
Wheat	1076	1298	1196	1232	1050	1173	919	1021	1183	1142	955
Crude Oil	35933	45425	53293	52157	46632	25209	21568	28398	35849	34063	21980
Oil Gas	1039	4440	2152	2984	3334	2219	1481	1602	3585	3766	1652
Refined Oil	27859	45545	49620	50567	40168	26599	23716	27977	32012	29365	17866
Aluminum	4082	5469	4869	4865	5819	4874	4474	5165	6002	5314	5014
Lead Ore	3	21	34	12	90	35	30	207	195	248	341
Platinum	59	80	68	35	24	29	18	12	70	18	28
Steel	10116	13851	11769	10757	11054	8633	8193	9627	10902	9756	8585
Titanium	56	72	67	66	52	46	64	65	54	43	28
Total	439987	507677	500607	513063	508158	412644	408053	461903	521035	514858	484088

Notes: (i) This table shows the evolution of the imports of the Netherlands in agricultural, energy, and metal commodities between 2010 and 2020 included. (ii) The numbers are displayed in millions of dollars.

Table 15: *Percentage of the Dutch Exports Destinated to Ukraine and Russia*

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Corn	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fertilizers	Ukraine	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.4	1.1	0.6
	Russia	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1
Seed Oils	Ukraine	0.5	0.8	0.6	0.6	0.6	0.6	0.5	0.4	0.5	0.6	0.5
	Russia	1.8	3.0	3.5	2.0	1.7	1.9	1.5	1.7	1.8	2.2	2.1
Wheat	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crude Oil	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil Gas	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Refined Oil	Ukraine	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Russia	0.0	0.2	0.2	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.2
Aluminum	Ukraine	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1
	Russia	0.6	0.5	0.9	0.8	0.7	0.5	0.3	0.3	0.3	0.4	0.4
Lead Ore	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	0.0	0.0	0.0	0.0	0.0	0.9	0.7	0.0	0.0	0.0	0.0
Platinum	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Steel	Ukraine	0.2	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Russia	0.3	0.2	0.3	0.3	0.3	0.3	0.2	0.1	0.1	0.1	0.1
Titanium	Ukraine	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	0.2	0.0	0.1	0.0	0.0	0.3	1.8	7.2	0.5	0.5	0.3
Total	Ukraine	0.3	0.3	0.3	0.3	0.2	0.1	0.2	0.2	0.2	0.2	0.2
	Russia	1.5	1.6	1.7	1.6	1.5	1.0	1.0	1.2	1.1	1.3	1.3

Notes: (i) This table shows the evolution of the percentage of Dutch exports destinated to Ukraine and Russia in agricultural, energy, and metal commodities between 2010 and 2020 included. (ii) The numbers are displayed in percentage and rounded to one decimal.

Table 16: *Percentage of the Dutch Imports Originating from Ukraine and Russia*

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Corn	Ukraine	0.1	9.2	9.6	16.3	26.2	34.1	23.9	45.5	46.0	58.2	48.0
	Russia	0.1	0.8	2.5	0.6	7.4	2.5	8.8	3.3	0.5	0.0	0.1
Fertilizers	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	2.7	3.3	2.3	3.3	4.8	1.6	0.4	0.6	3.9	1.7	0.5
Seed Oils	Ukraine	3.8	3.4	3.5	7.0	1.8	1.2	1.5	7.0	5.2	9.7	6.4
	Russia	0.3	0.1	0.5	0.1	0.2	0.3	0.6	0.4	0.1	0.1	0.1
Wheat	Ukraine	0.1	2.0	2.4	0.5	1.6	2.4	1.4	0.9	0	3.0	1.0
	Russia	0.1	1.1	0.4	0.0	0.0	0.5	1.3	2.1	1.6	0.1	0.1
Crude Oil	Ukraine	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	29.3	28.2	26.9	26.9	23.0	27.0	36.7	25.8	29.8	25.5	26.0
Oil Gas	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	0.1	0.4	1.5	2.0	2.4	5.4	4.7	4.0	5.3	4.0	5.4
Refined Oil	Ukraine	0.0	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	16.3	16.1	13.4	18.6	19.9	10.9	11.9	10.8	8.8	12.1	9.8
Aluminum	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	2.7	1.8	2.1	2.9	14.9	10.3	12.3	11.3	9.2	3.8	1.2
Lead Ore	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Platinum	Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Russia	3.7	4.3	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Steel	Ukraine	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Russia	6.5	5.5	5.3	3.8	3.7	2.4	2.5	2.9	2.3	2.0	2.4
Titanium	Ukraine	2.8	1.4	7.9	9.9	2.5	3.3	2.6	2.0	3.2	0.2	2.2
	Russia	6.5	5.7	11.6	10.9	19.5	5.1	1.7	9.0	7.7	4.6	4.7
Total	Ukraine	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4
	Russia	4.2	4.7	5.2	5.3	4.8	3.8	3.7	3.7	3.9	3.4	2.2

Notes: (i) This table shows the evolution of the percentage of Dutch imports originating from Ukraine and Russia in agricultural, energy, and metal commodities between 2010 and 2020 included. (ii) The numbers are displayed in percentage and rounded to one decimal.

Table 17: *Results from the twelve linear regressions for the commodities between the 1st of January 2020 and the 1th of June 2022*

	Constant	BDI	Inflation
Corn	-304.135*** [24.658]	-0.024*** [0.003]	366.938*** [10.445]
Fertilizers	-107.844*** [3.761]	-0.002*** [0.000]	70.738*** [1.541]
Seed Oils	-48.331*** [2.900]	0.001*** [0.000]	41.115*** [1.221]
Wheat	-238.164*** [15.795]	-0.015*** [0.001]	218.384*** [6.249]
Crude Oil	-101.270*** [3.650]	-0.001* [0.000]	69.427*** [1.569]
Gas Oil	-8.803*** [0.503]	0.000*** [0.000]	4.731*** [0.214]
Refined Oil	-4.790*** [0.196]	-0.000*** [0.000]	2.887*** [0.085]
Aluminum	-1801.270*** [90.920]	0.036** [0.013]	1652.116*** [40.145]
Lead Ore	418.428*** [39.044]	0.017*** [0.005]	597.529*** [15.851]
Platinum	1005.111*** [26.761]	-0.036*** [0.002]	-1.414 [10.399]
Steel	-301.145*** [16.958]	0.003* [0.002]	337.782*** [7.190]
Titanium	1.318** [0.419]	-0.000 [0.000]	2.209*** [0.172]

Notes: (i) ***, ** and * means significance at 1%, 5% and 10%, (ii) BDI stands for Baltic Dry Index which represents the global economic activity, (iii) Inflation refers to the expected inflation rate, (iv) the robust standard errors are reported in the squared brackets, (v) all numbers are rounded to three decimals.

Table 18: *Test statistics and estimated break dates of both the Wald and LR tests on the commodities regression between the 1st of January 2020 and the 1th of June 2022*

	Wald estimated break date	LR estimated break date	Wald test statistic	LR test statistic
Corn	04 April 2022	19 January 2022	1400.627***	343.910***
Wheat	27 February 2022	01 March 2022	2136.065***	801.383***
Fertilizers	26 May 2021	14 December 2021	1550.950***	709.977***
Seed Oils	19 January 2022	19 January 2022	797.235***	404.734***
Crude Oil	14 January 2022	12 January 2022	1660.507***	765.313***
Refined Oil	13 January 2022	13 January 2022	1516.384***	692.586***
Gas Oil	11 April 2022	07 April 2022	1768.707***	543.475***
Aluminum	19 November 2022	12 December 2021	1827.266***	749.288***
Steel	14 January 2022	12 January 2022	1170.342***	650.538***
Lead Ore	15 April 2021	29 June 2021	1709.042***	694.437***
Platinum	10 May 2021	23 July 2021	1141.369***	443.105***
Titanium	05 May 2021	03 November 2021	1251.088***	521.844***

Notes: (i) This table shows the estimated break dates and the Wald and LR test statistics performed on the outcome of the twelve commodity regressions between the 1st of January 2020 and the 1st of June 2022. (ii) ***, ** and * means significance at 1%, 5% and 10% *, (vi) All numbers are rounded to three decimal places.*

Table 19: *Wald test with known break and CUSUM test for parameter stability*

	Wald test statistic	CUSUM test statistic
Corn	997.025***	2.522***
Wheat	2046.731***	4.269***
Fertilizers	1038.031***	5.923***
Seed Oils	444.557***	1.731***
Crude Oil	1073.584***	4.011***
Refined Oil	885.300***	4.782***
Gas Oil	405.861***	5.233***
Aluminum	90.683***	4.487***
Steel	176.888***	3.295***
Lead Ore	176.984***	3.838***
Platinum	3.031	4.308***
Titanium	297.183***	4.477***

Notes: (i) This table shows the test statistics of the Wald test and the cumulative sum test for parameter stability on the twelve commodity linear regressions between 2020 and 2022 when the break date is assumed to be the 24th of February 2022 (ii) ***, ** and * means significance at 1%, 5% and 10% *, (vi) All numbers are rounded to three decimal places.*

Table 20: *Results from the eleven linear regressions for the commodities between the 1st of January 2013 and the 1th of January 2015*

	Constant	BDI	Inflation
Corn	-88.035** [30.490]	-0.097*** [0.007]	250.136*** [12.417]
Seed Oils	1.981* [1.199]	-0.003*** [0.000]	14.416*** [0.472]
Wheat	-37.762*** [10.653]	-0.001 [0.002]	104.872*** [4.326]
Crude Oil	26.561*** [4.562]	0.004*** [0.001]	19.030*** [1.844]
Gas Oil	3.786*** [0.167]	-0.000 [0.000]	4.731*** [0.214]
Refined Oil	-4.790*** [0.196]	-0.000*** [0.000]	-0.343*** [0.069]
Aluminum	1783.650*** [43.423]	-0.173*** [0.008]	-94.799*** [19.720]
Lead Ore	1365.046*** [28.526]	-0.069*** [0.007]	137.876*** [13.010]
Platinum	531.949*** [15.452]	-0.092*** [0.004]	287.609*** [6.557]
Steel	407.470*** [6.361]	-0.061*** [0.002]	30.661*** [2.748]
Titanium	3.246*** [0.153]	-0.001*** [0.000]	-0.431*** [0.067]

Notes: (i) ***, ** and * means significance at 1%, 5% and 10%, (ii) BDI stands for Baltic Dry Index which represents the global economic activity, (iii) Inflation refers to the expected inflation rate, (iv) the robust standard errors are reported in the squared brackets, (v) all numbers are rounded to three decimals.

Table 21: *Test statistics and estimated break dates of both the Wald and LR tests on the commodities regression between the 1st of January 2013 and the 1th of January 2015*

	Wald estimated break date	LR estimated break date	Wald test statistic	LR test statistic
Corn	14 July 2013	15 July 2013	4148.283***	1229.999***
Wheat	14 July 2014	27 May 2014	3933.499***	902.571***
Seed Oils	12 July 2013	24 October 2013	4434.453***	1052.757***
Crude Oil	08 October 2014	18 September 2014	2719.974***	906.493***
Refined Oil	02 April 2014	12 March 2014	1028.018***	685.347***
Gas Oil	02 May 2013	05 December 2013	1839.209***	355.113***
Aluminum	19 August 2014	16 July 2014	3628.812***	1074.614***
Steel	03 April 2013	20 March 2014	717.387***	259.395***
Lead Ore	17 May 2013	17 May 2013	1181.249***	357.552***
Platinum	18 November 2013	18 November 2013	694.769***	448.526***
Titanium	01 August 2014	13 July 2014	2705.794***	1111.266***

Notes: (i) This table shows the estimated break dates and the Wald and LR test statistics performed on the outcome of the twelve commodity regressions between the 1st of January 2013 and the 1st of January 2015. (ii) ***, ** and * means significance at 1%, 5% and 10% *, (vi) All numbers are rounded to three decimal places.*

Table 22: *Wald test with known break and CUSUM test for parameter stability*

	Wald test statistic	CUSUM test statistic
Corn	1383.822***	6.409***
Wheat	392.594***	4.007***
Seed Oils	1184.813***	7.283***
Crude Oil	1882.668***	4.165***
Refined Oil	868.239***	4.323***
Gas Oil	294.492***	2.267***
Aluminum	673,442***	2.107***
Steel	273.982***	4.027***
Lead Ore	147.044***	3.179***
Platinum	430.038***	3.092***
Titanium	1002.625***	2.753***

Notes: (i) This table shows the test statistics of the Wald test and the cumulative sum test for parameter stability on the twelve commodity linear regressions between 2013 and 2015 when the break date is assumed to be the 27th of February 2014 (ii) ***, ** and * means significance at 1%, 5% and 10% *, (vi) All numbers are rounded to three decimal places.*

Table 23: *Two-sample t-tests of the Wald, LR, and CUSUM tests*

	Wald Unknown	LR Unknown	CUSUM	Wald Known
T-test	-1.658	-0.712	0.679	-0.316
P-value	0.112	0.484	0.504	0.755

Notes: (i) This table shows the results of the Two-sample t-tests of the Wald, LR, and CUSUM tests for structural breaks and parameter stability. *(ii)* ***, ** and * means significance at 1%, 5% and 10%. (iii) *All numbers are rounded to three decimal places.*

Table 24: *Results from the first short run SVAR model for the macroeconomic variables*

	BDI	EIR	GEPUI
BDI	1 (constrained)	0 (constrained)	0 (constrained)
EIR	-53.589 [83.578]	1 (constrained)	0 (constrained)
GEPUI	0.022 [0.038]	0.000 [0.000]	1 (constrained)
Corn	-0.497* [0.263]	0.001 [0.001]	0.269 [0.314]
Wheat	1.075 [0.727]	0.001 [0.001]	-1.020 [0.866]
Fertilizers	-0.004 [2.354]	-0.006*** [0.001]	-0.759 [2.759]
Seed Oils	1.251 [2.731]	-0.004*** [0.001]	0.433 [3.239]
Crude Oil	3.633 [2.225]	-0.001*** [0.000]	-0.219 [2.629]
Refined Oil	-38.976 [44.357]	-0.003*** [0.001]	21.161 [52.976]
Gas Oil	7.934 [16.377]	-0.013 [0.024]	36.011** [19.489]
Aluminum	-0.184** [0.082]	0.000 [0.000]	-0.003 [0.098]
Steel	-0.273 [0.342]	0.001*** [0.000]	0.199 [0.405]
Lead Ore	0.049 [0.132]	0.001* [0.000]	0.043 [0.157]
Platinum	-0.049 [0.181]	-0.000 [0.000]	-0,112 [0.216]
Titanium	-25.394* [14.053]	-0.008 [0.007]	-16.664 [17.758]

Notes: (i) ***, ** and * means significance at 1%, 5% and 10%, (ii) BDI stands for Baltic Dry Index which represents the global economic activity, (iii) EIR refers to the expected inflation rate, (iv) GEPUI is the global economic policy uncertainty index, (v) the standard errors are reported in the squared brackets, (vi) all numbers are rounded to three decimals, (vii) the dependent variables are the columns, and each row is an independent variable.

Table 25: *Results from the second short run SVAR model for the macroeconomic variables*

	BDI	EIR	GEPUI
BDI	1 (constrained)	0 (constrained)	0 (constrained)
EIR	-29.192 [36.252]	1 (constrained)	0 (constrained)
GEPUI	-0.003 [0.014]	0.000 [0.000]	1 (constrained)
Corn	-0.063 [0.076]	-0.000 [0.000]	-0.413** [0.201]
Wheat	0.093 [0.402]	0.002*** [0.000]	-1.405 [1.055]
Seed Oils	3.177 [2.387]	-0.004* [0.002]	-8.619 [6.319]
Crude Oil	0.709 [1.182]	-0.002 [0.001]	-3.084 [3.133]
Refined Oil	-59.105 [41.345]	-0.055 [0.042]	150.174 [109.578]
Gas Oil	-7.644 [9.441]	0.021** [9.441]	-7.814 [24.996]
Aluminum	-0.059 [0.057]	0.000 [0.000]	0.073 [0.150]
Steel	-0.386** [0.162]	0.001 [0.000]	-0.465 [0.430]
Lead Ore	-0.015 [0.051]	-0.001*** [0.000]	-0.019 [0.135]
Platinum	-0.036 [0.067]	-0.000 [0.000]	0.132 [0.177]
Titanium	11.567 [17.218]	0.012 [0.018]	-5.598 [45.728]

Notes: (i) ***, ** and * means significance at 1%, 5% and 10%, (ii) BDI stands for Baltic Dry Index which represents the global economic activity, (iii) EIR refers to the expected inflation rate, (iv) GEPUI is the global economic policy uncertainty index, (v) the standard errors are reported in the squared brackets, (vi) all numbers are rounded to three decimals, (vii) the dependent variables are the columns, and each row is an independent variable.

Table 26: *Granger causality tests on the macroeconomic variables for both SVAR models*

	2022			2014		
	BDI	EIR	GEPUI	BDI	EIR	GEPUI
CP	1.118	0.605	3.214	0.057	2.172	1.318
WP	2.325	0.910	3.597	1.354	10.252***	6.571**
FP	2.174	10.047***	1.676	-	-	-
SOP	4.483	4.181	1.227	1.770	5.466*	2.045
COP	2.977	0.611	2.202	4.593	1.167	0.651
ROP	0.113	0.603	0.975	5.363*	1.509	0.500
PGP	6.355**	1.708	7.205**	4.473	5.504*	5.969*
AP	0.209	0.650	3.552	10.828***	0.362	0.207
SP	8.422**	1.430	0.308	3.109	6.158**	0.046
LP	5.523*	1.943	2.328	6.545**	0.212	1.163
PP	1.064	5.433*	2.827	2.518	1.543	0.741
TP	2.528	4.419	1.313	9.781***	3.046	0.352
ALL	31.822	66.006***	42.772**	56.819***	47.598***	45.546***

*Notes: (i) ***, ** and * means significance at 1%, 5% and 10%, (ii) BDI stands for Baltic Dry Index which represents the global economic activity, (iii) EIR refers to the expected inflation rate, (iv) GEPUI is the global economic policy uncertainty index, (v) all numbers are rounded to three decimals.*

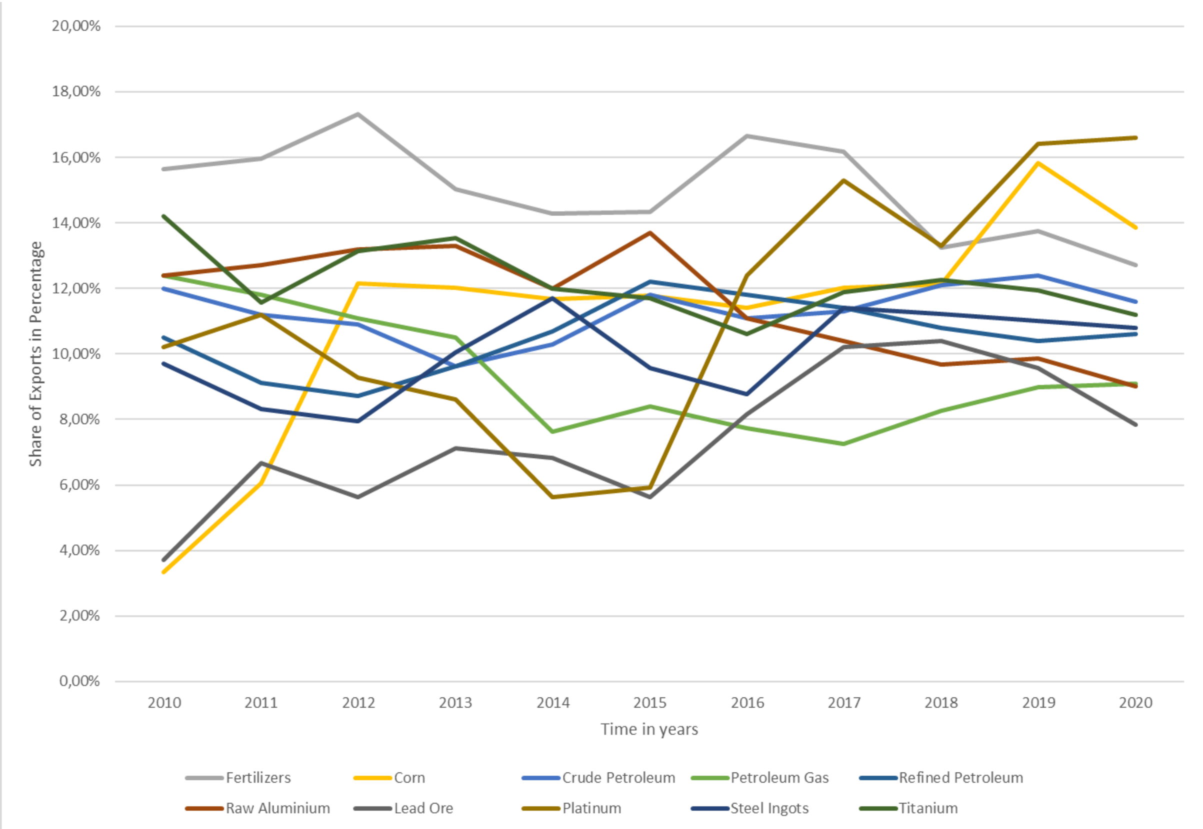
Table 27: *Two-sample t-test between imports and exports for the Netherlands of the twelve commodities investigated in this paper*

	T score	Diff<0	Diff!=0	Diff>0
Corn	13.945	Insignificant	1%	1%
Fertilizers	-10.671	1%	1%	Insignificant
Seed Oils	5.012	Insignificant	1%	1%
Wheat	24.515	Insignificant	1%	1%
Crude Oil	10.372	Insignificant	1%	1%
Oil Gas	3.059	Insignificant	1%	1%
Refined Oil	-3.666	1%	1%	Insignificant
Aluminum	2.591	Insignificant	5%	1%
Lead Ore	-0.843	Insignificant	Insignificant	Insignificant
Platinum	2.348	Insignificant	5%	5%
Steel	-3.334	1%	1%	Insignificant
Titanium	-2.194	5%	5%	Insignificant

Notes: (i) This table shows two-sample t-test between imports and exports for the Netherlands of the twelve commodities investigated in this paper between 2010 and 2020. (ii) The numbers are rounded to three decimal places.

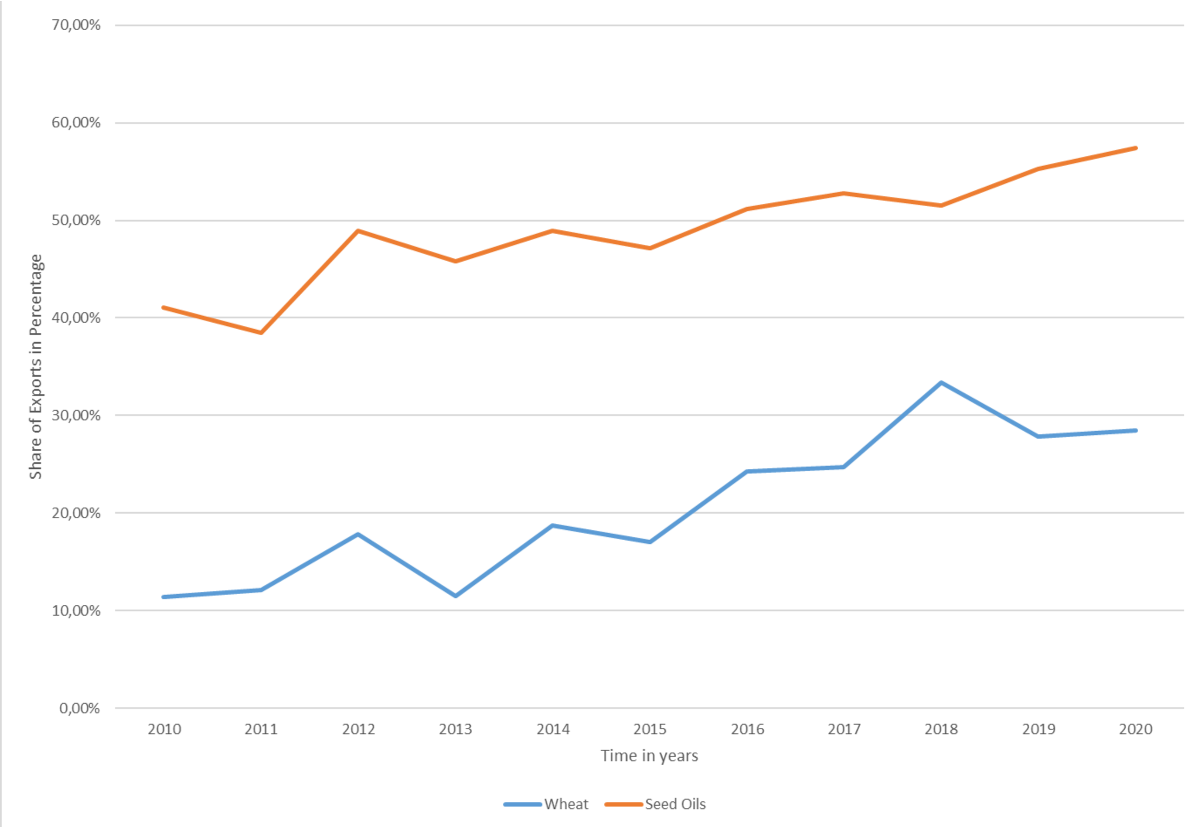
A5. Figures

Figure 1: *Russia and Ukraine's Yearly Share of Exports in Key Commodities*



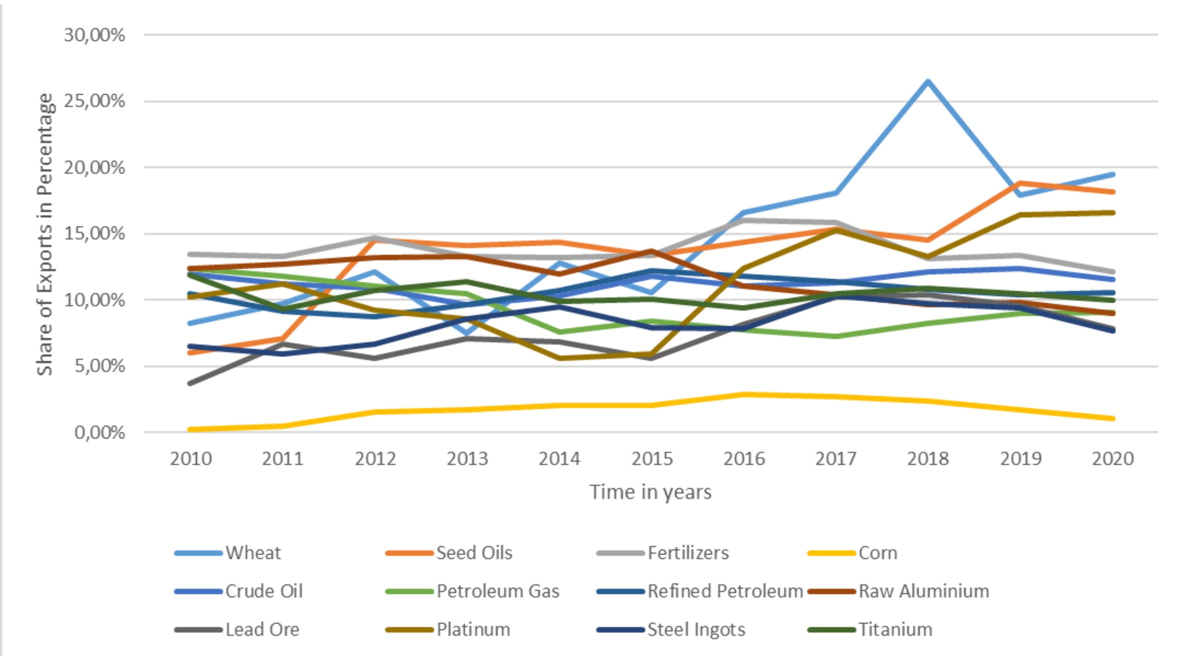
Note: This figure shows the evolution of the sum of the share of exports of Russia and Ukraine in agricultural, energy, and metal commodities between 2010 and 2020 included.

***Figure 2:** Russia and Ukraine's Yearly Share of Exports in Wheat and Seed Oils*



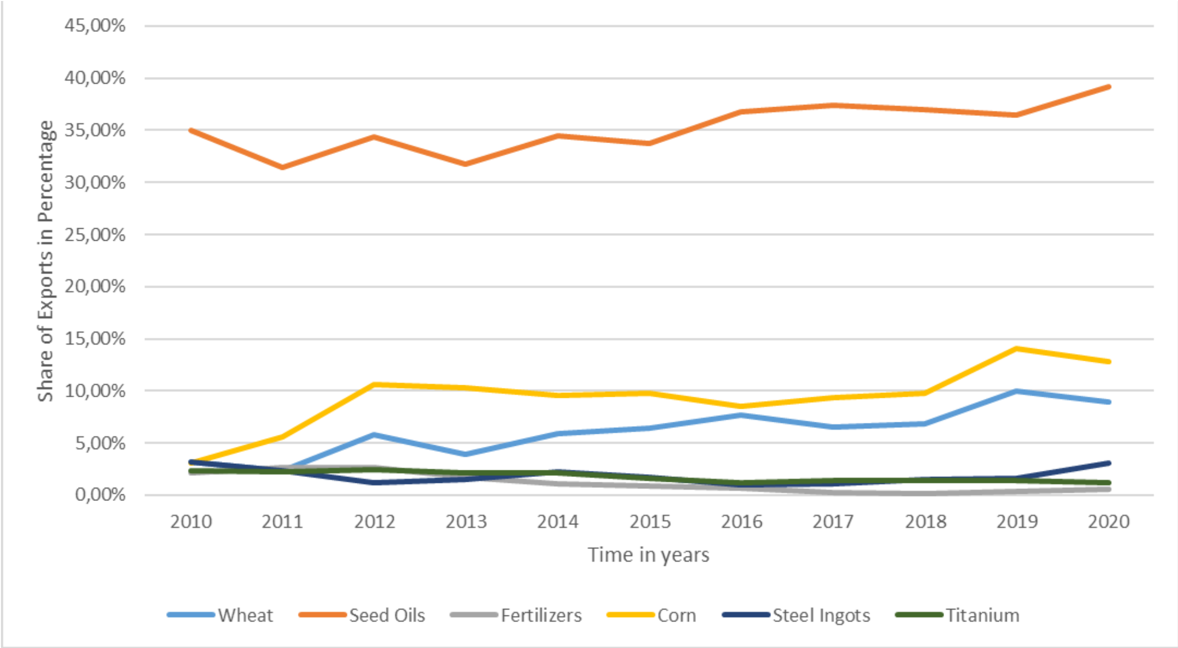
Note: This figure shows the evolution of the sum of the share of exports of Russia and Ukraine in wheat and seed oils commodities between 2010 and 2020 included.

***Figure 3:** Russia's Yearly Major Commodities Exports*



Note: This figure shows the evolution of the share of exports of Russia in agricultural, energy, and metal commodities between 2010 and 2020 included.

Figure 4: *Ukraine's Yearly Major Commodities Exports*



Note: This figure shows the evolution of the share of exports of Ukraine in agricultural and metal commodities between 2010 and 2020 included.

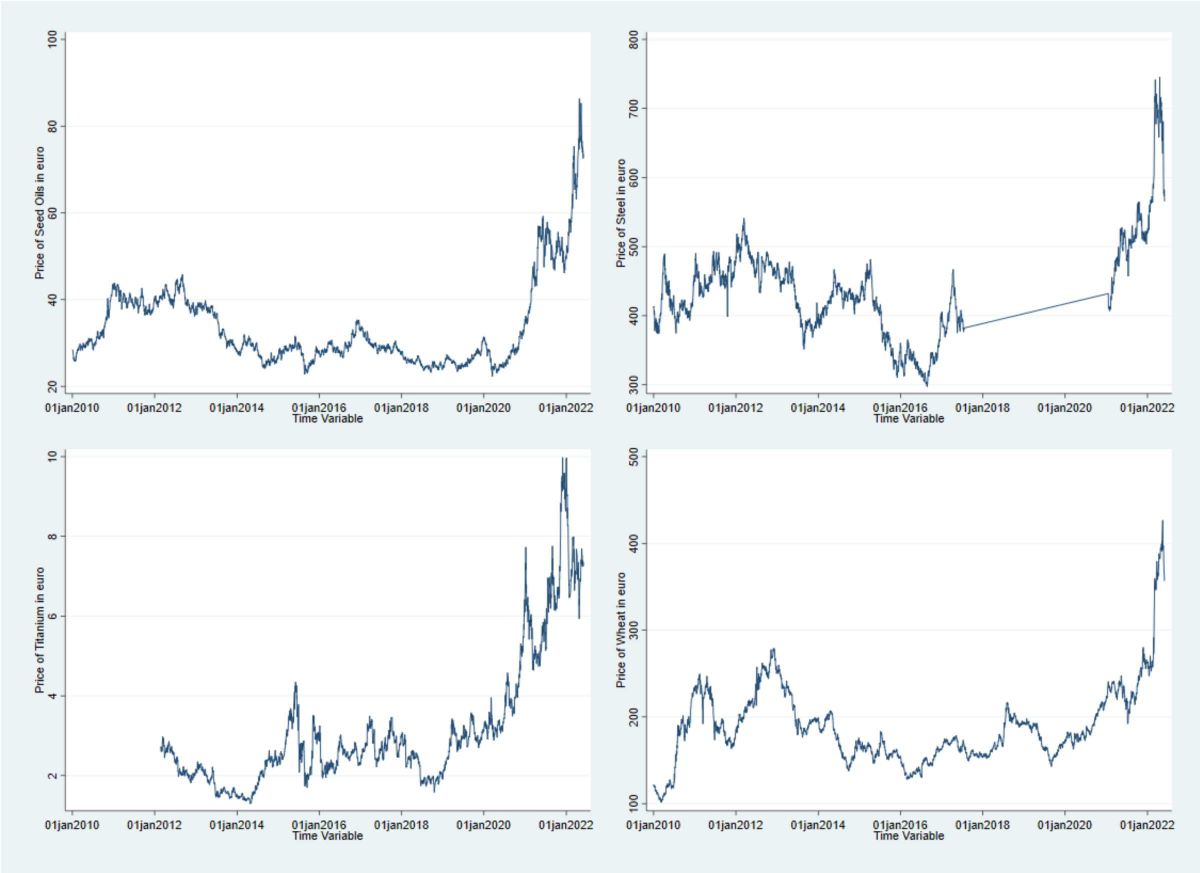
Figure 5: *Prices of Aluminum, Corn, Crude Oil, and Fertilizers between 2010 and 2022*

Note: This figure shows the evolution of the prices in aluminum, corn, crude oil, and fertilizers between the 1st of January 2010 and the 1st of June 2022. All prices are denominated in euro.

Figure 6: *Prices of Gas Oil, Lead Ore, Platinum, and Refined Oil between 2010 and 2022*

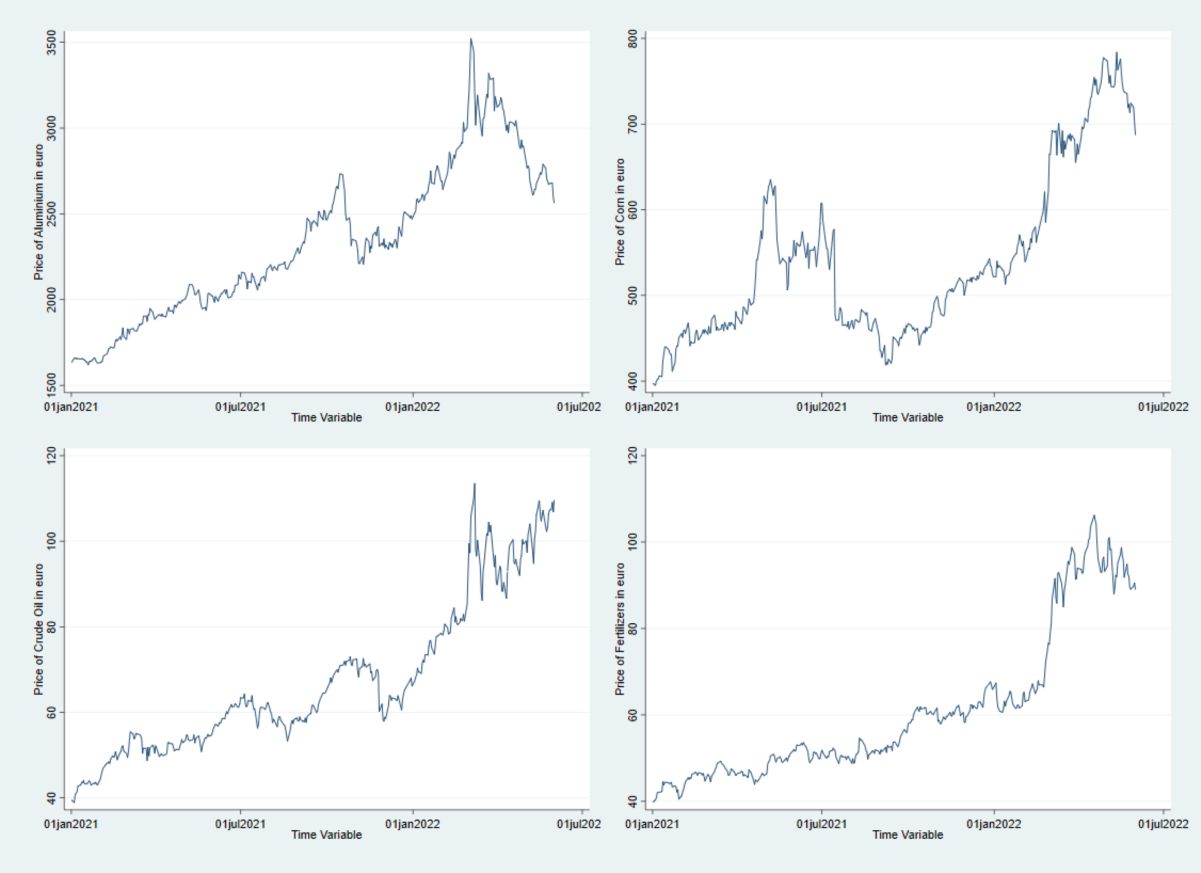
Note: This figure shows the evolution of the prices in gas oil, lead ore, platinum, and refined oil between the 1st of January 2010 and the 1st of June 2022. All prices are denominated in euro.

Figure 7: *Prices of Seed Oils, Steel, Titanium, and Wheat between 2010 and 2022*



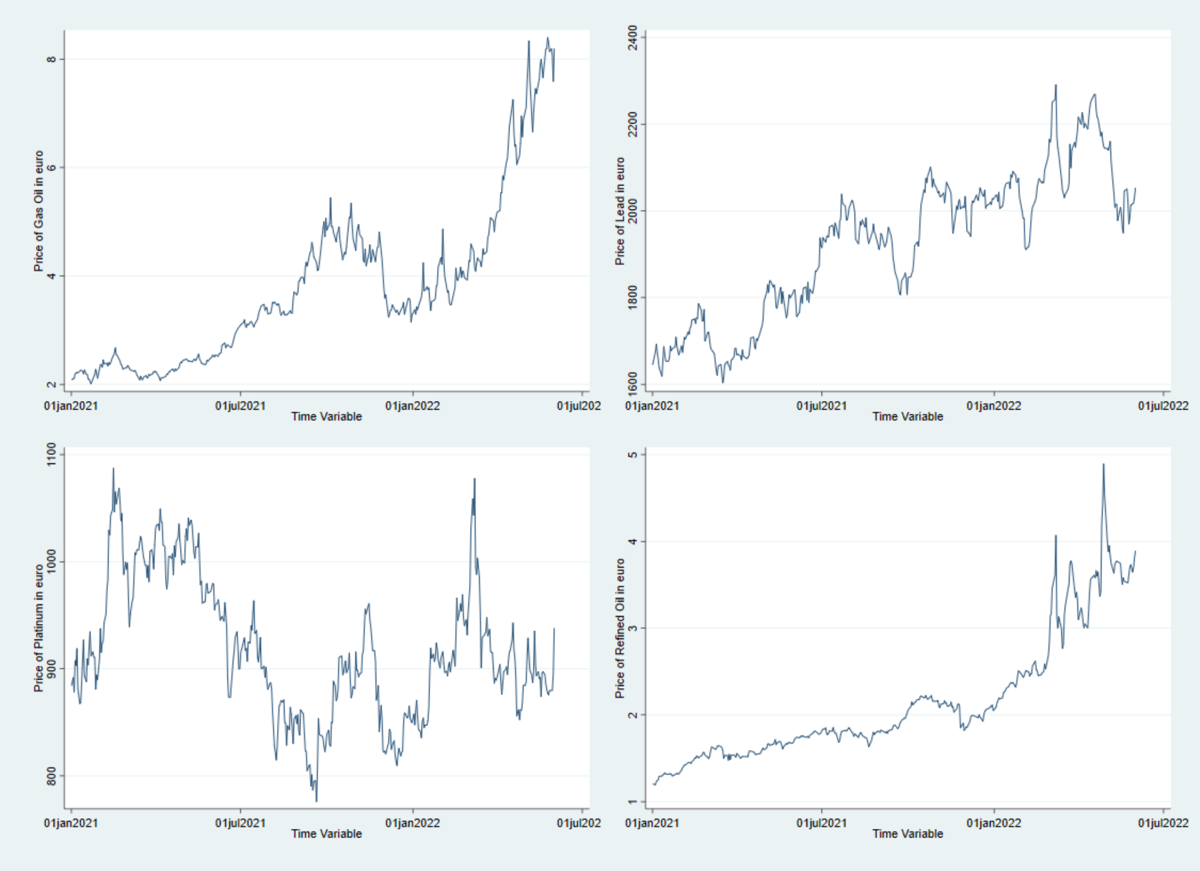
Note: This figure shows the evolution of the prices in seed oils, steel, titanium, and wheat between the 1st of January 2010 and the 1st of June 2022. All prices are denominated in euro.

Figure 8: *Prices of Aluminum, Corn, Crude Oil, and Fertilizers between 2021 and 2022*



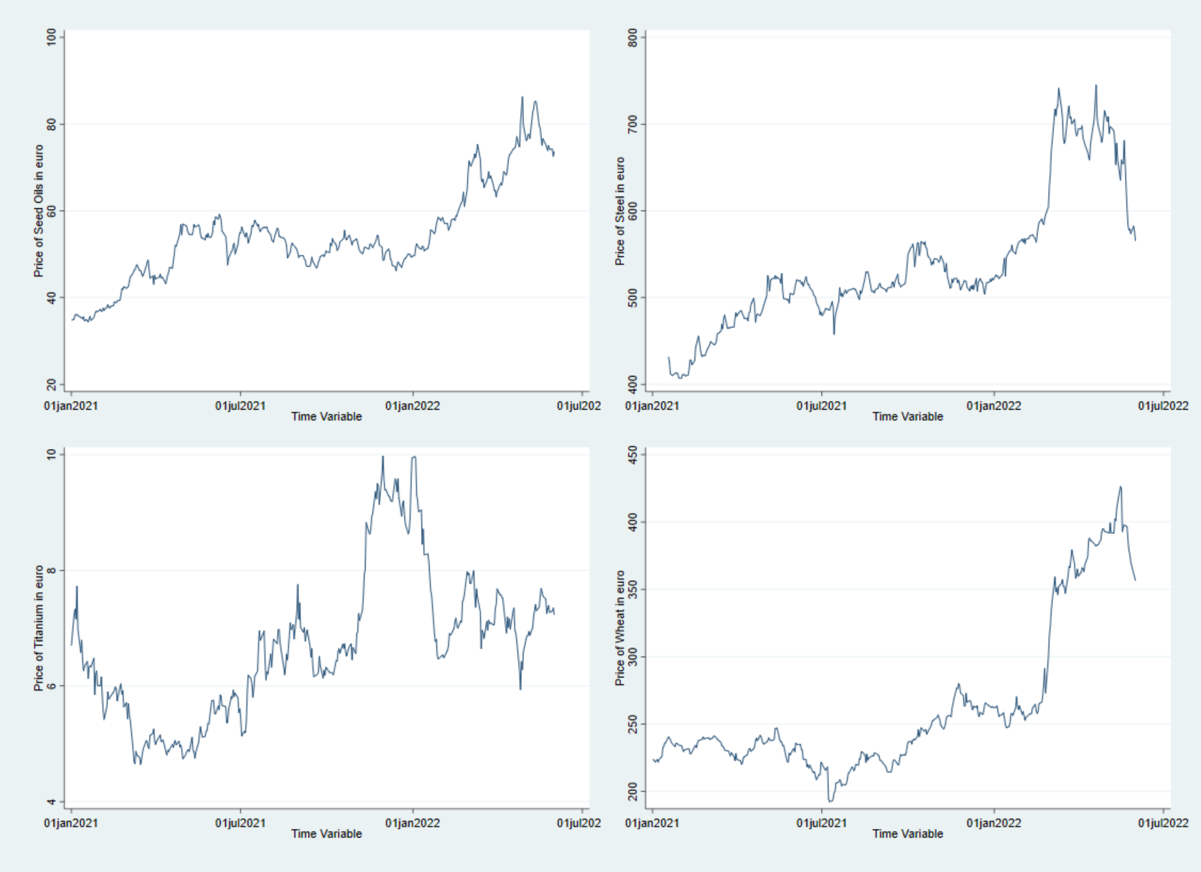
Note: This figure shows the evolution of the prices in aluminum, corn, crude oil, and fertilizers between the 1st of January 2021 and the 1st of June 2022. All prices are denominated in euro.

Figure 9: *Prices of Gas Oil, Lead Ore, Platinum, and Refined Oil between 2021 and 2022*



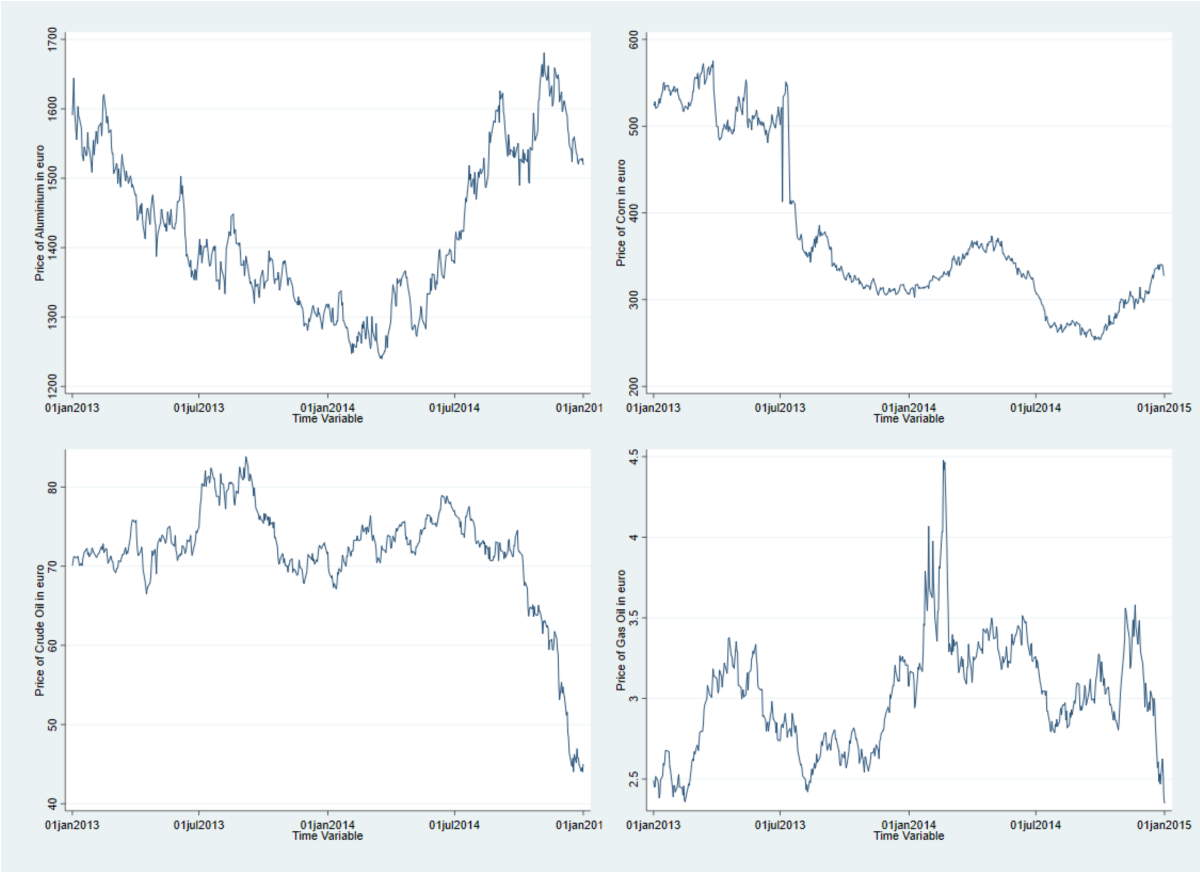
Note: This figure shows the evolution of the prices in gas oil, lead ore, platinum, and refined oil between the 1st of January 2021 and the 1st of June 2022. All prices are denominated in euro.

Figure 10: *Prices of Seed Oils, Steel, Titanium, and Wheat between 2021 and 2022*



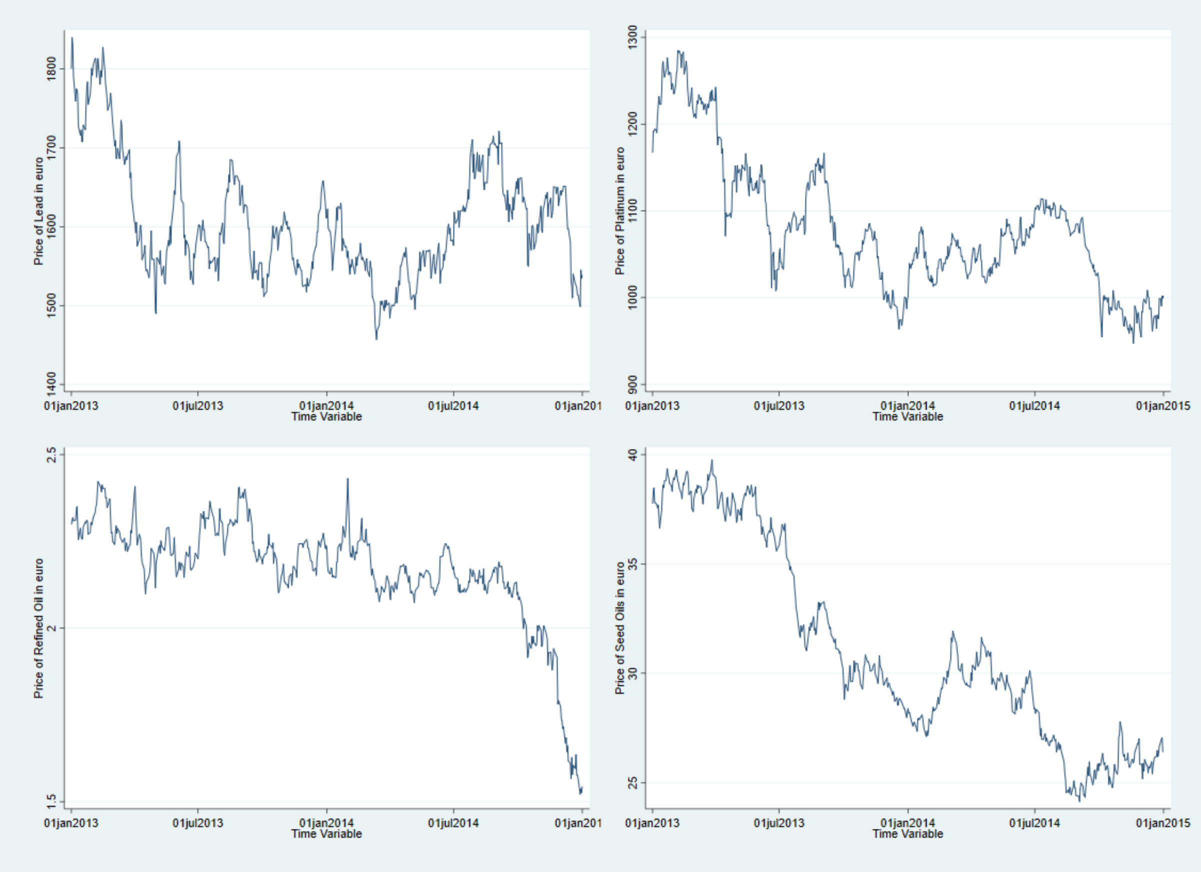
Note: This figure shows the evolution of the prices in seed oils, steel, titanium, and wheat between the 1st of January 2021 and the 1st of June 2022. All prices are denominated in euro.

Figure 11: *Prices of Aluminum, Corn, Crude Oil, and Gas Oil between 2013 and 2015*



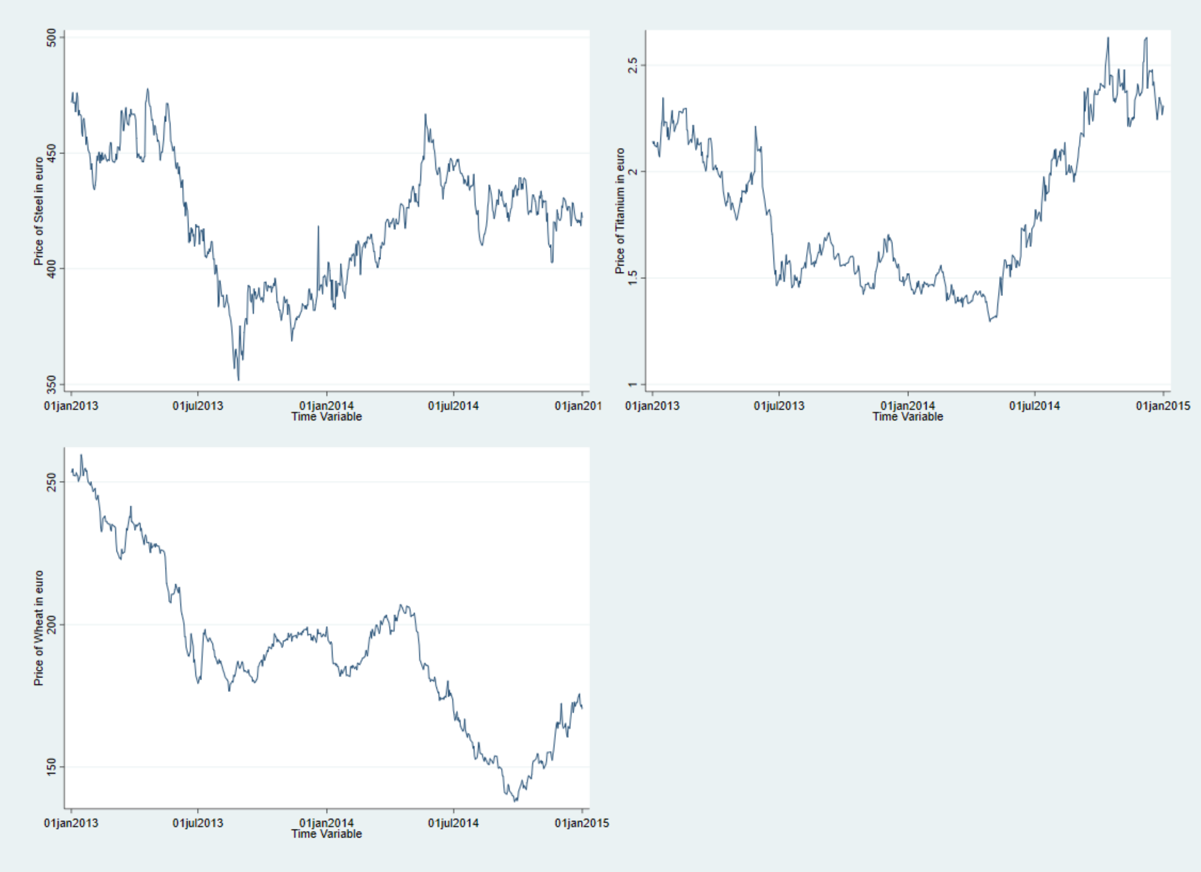
Note: This figure shows the evolution of the prices in aluminum, corn, crude oil, and gas oil between the 1st of January 2013 and the 1st of January 2015. All prices are denominated in euro.

Figure 12: *Prices of Lead Ore, Platinum, Refined Oil, and Seed Oils between 2013 and 2015*



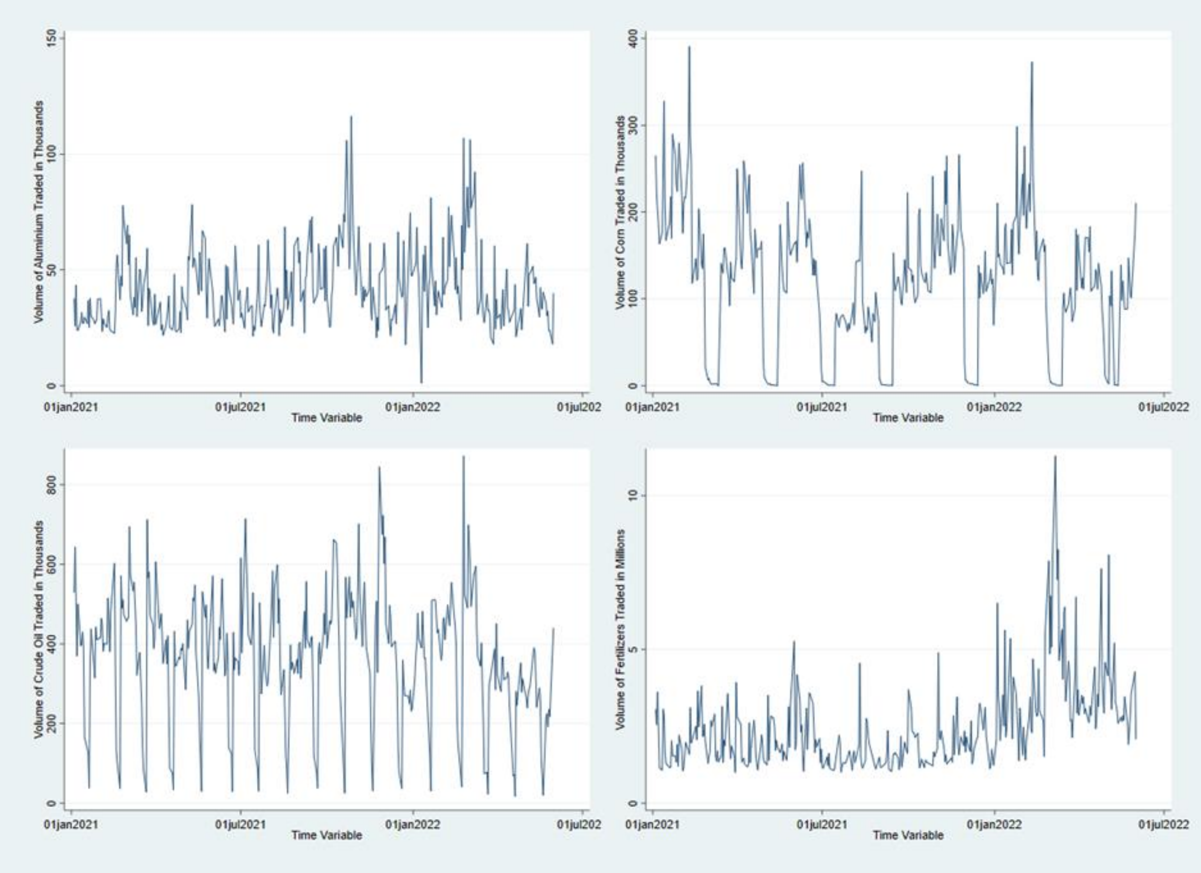
Note: This figure shows the evolution of the prices in lead ore, platinum, refined oil, and seed oils between the 1st of January 2013 and the 1st of January 2015. All prices are denominated in euro.

Figure 13: *Prices of Steel, Titanium, and Wheat between 2013 and 2015*



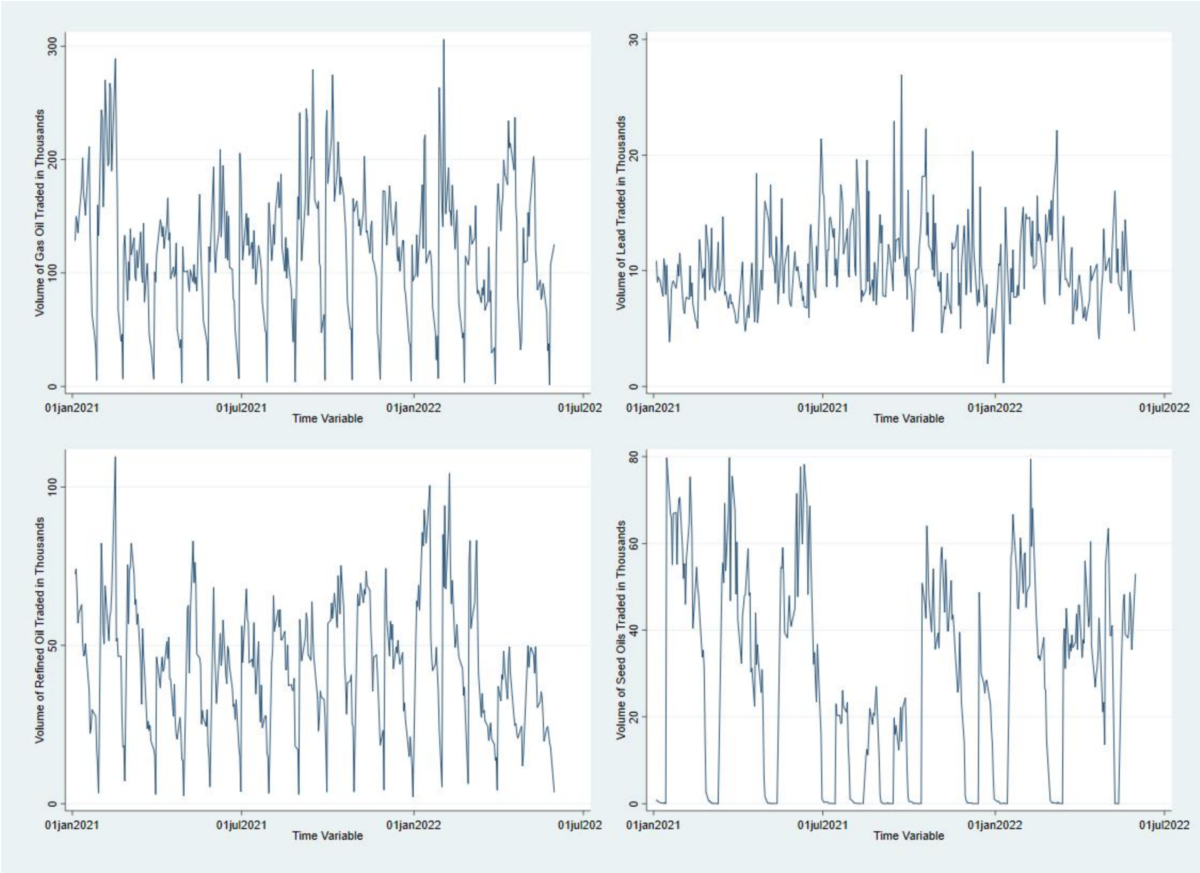
Note: This figure shows the evolution of the prices in steel, titanium, and wheat between the 1st of January 2013 and the 1st of January 2015. All prices are denominated in euro.

__Figure 14:__ Volumes Traded of Aluminum, Corn, Crude Oil, and Fertilizers between 2021 and 2022



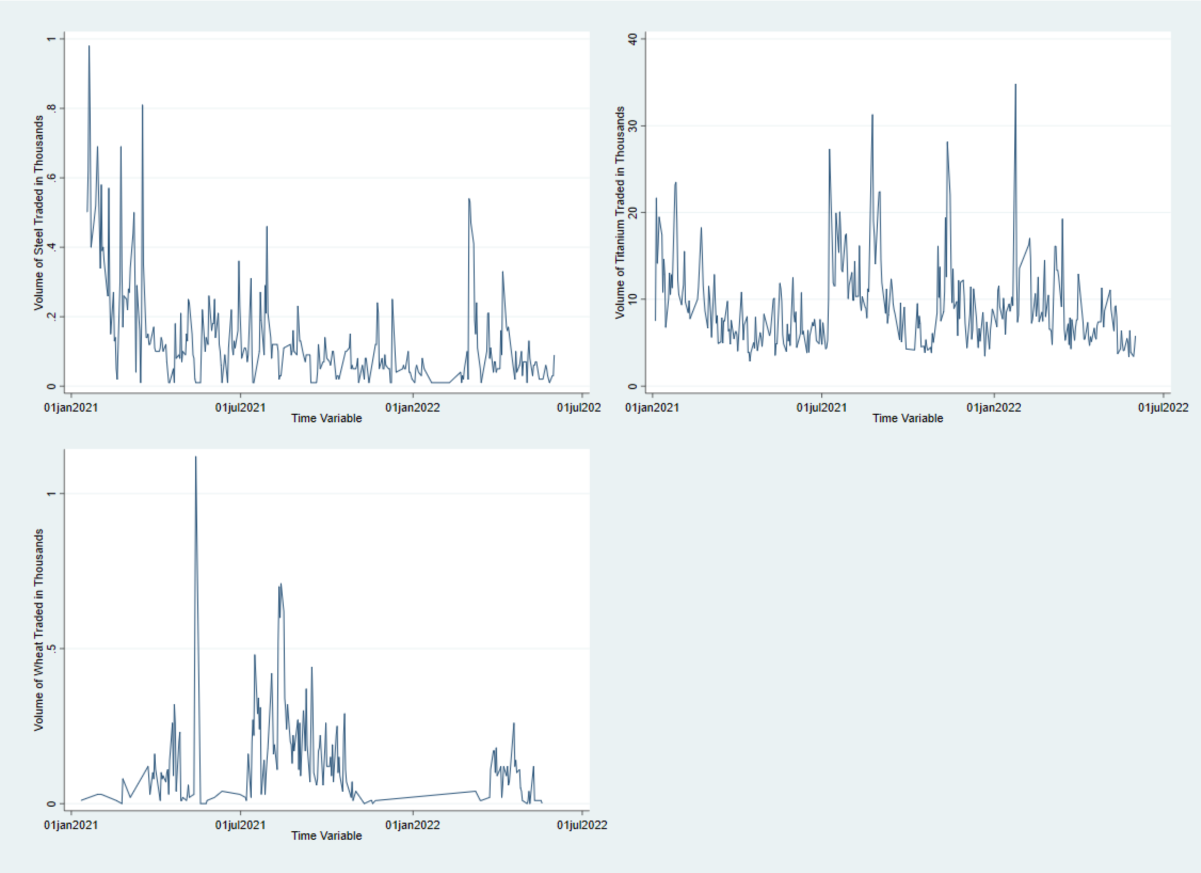
Note: This figure shows the evolution of the volumes traded in aluminum, corn, crude oil, and fertilizers between the 1st of January 2021 and the 1st of June 2022. All volumes are expressed in thousands.

Figure 15: *Volumes Traded of Gas, Lead Ore, Refined Oil, and Seed Oils between 2021 and 2022*



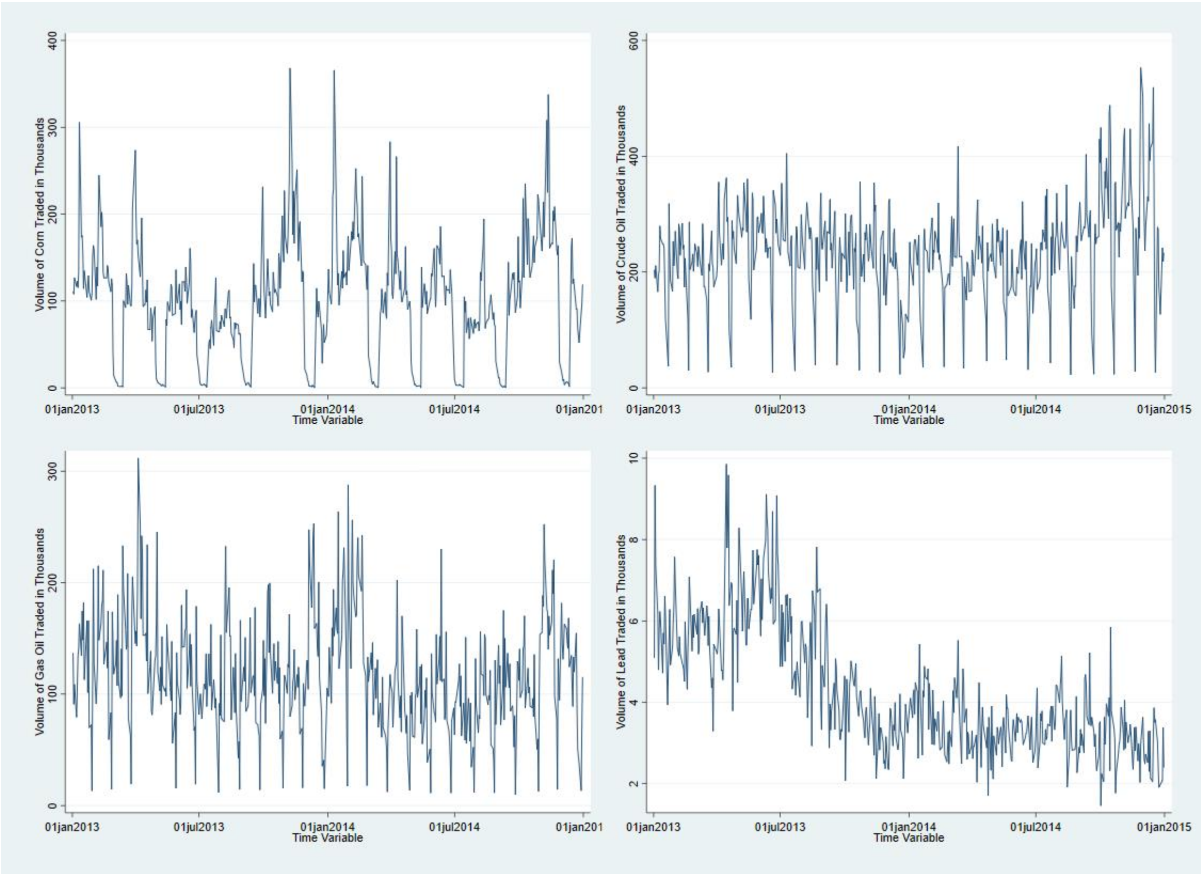
Note: This figure shows the evolution of the volumes traded in gas oil, lead ore, refined oil, seed oils between the 1st of January 2021 and the 1st of June 2022. All volumes are expressed in thousands.

Figure 16: *Volumes Traded of Steel, Titanium, and Wheat between 2021 and 2022*



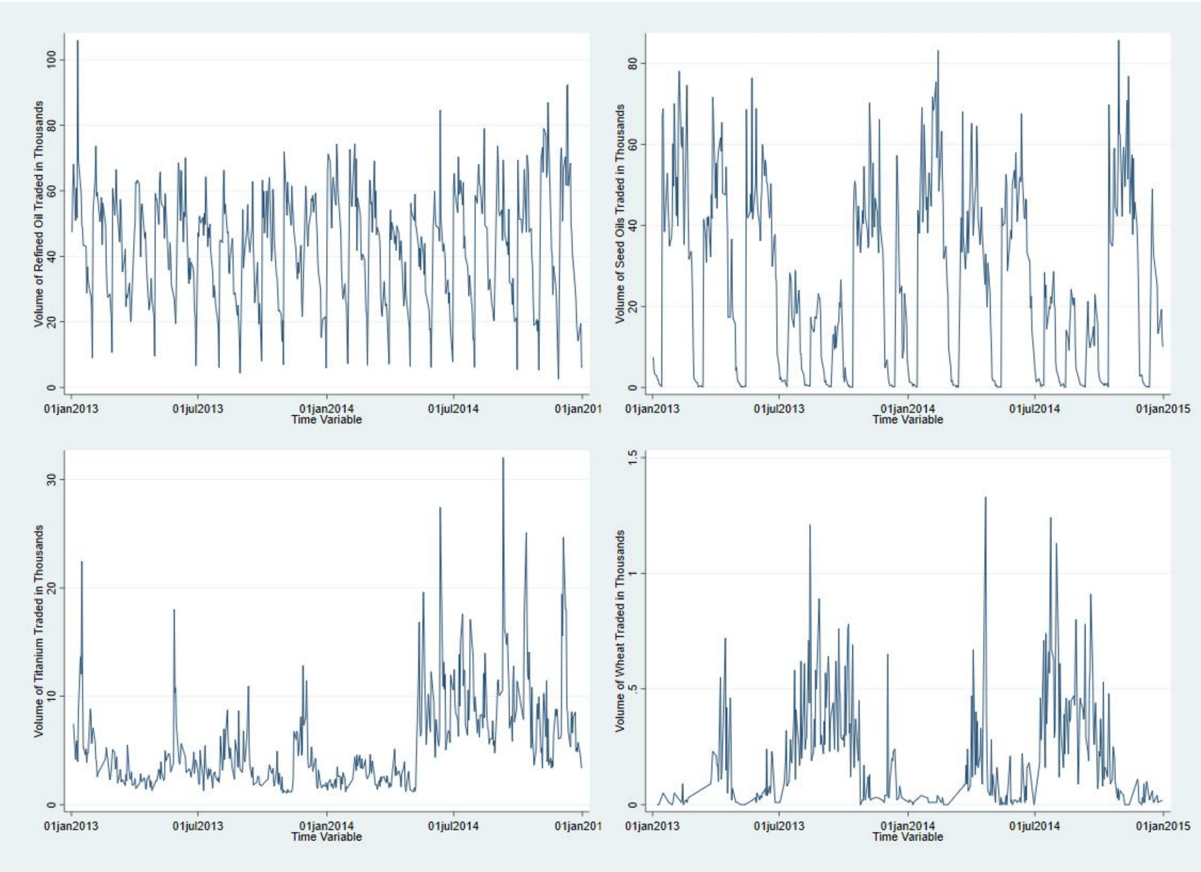
Note: This figure shows the evolution of the volumes traded in steel, titanium, and wheat between the 1st of January 2021 and the 1st of June 2022. All volumes are expressed in thousands.

Figure 17: *Volumes Traded of Corn, Crude Oil, Gas Oil, and Lead between 2013 and 2015*



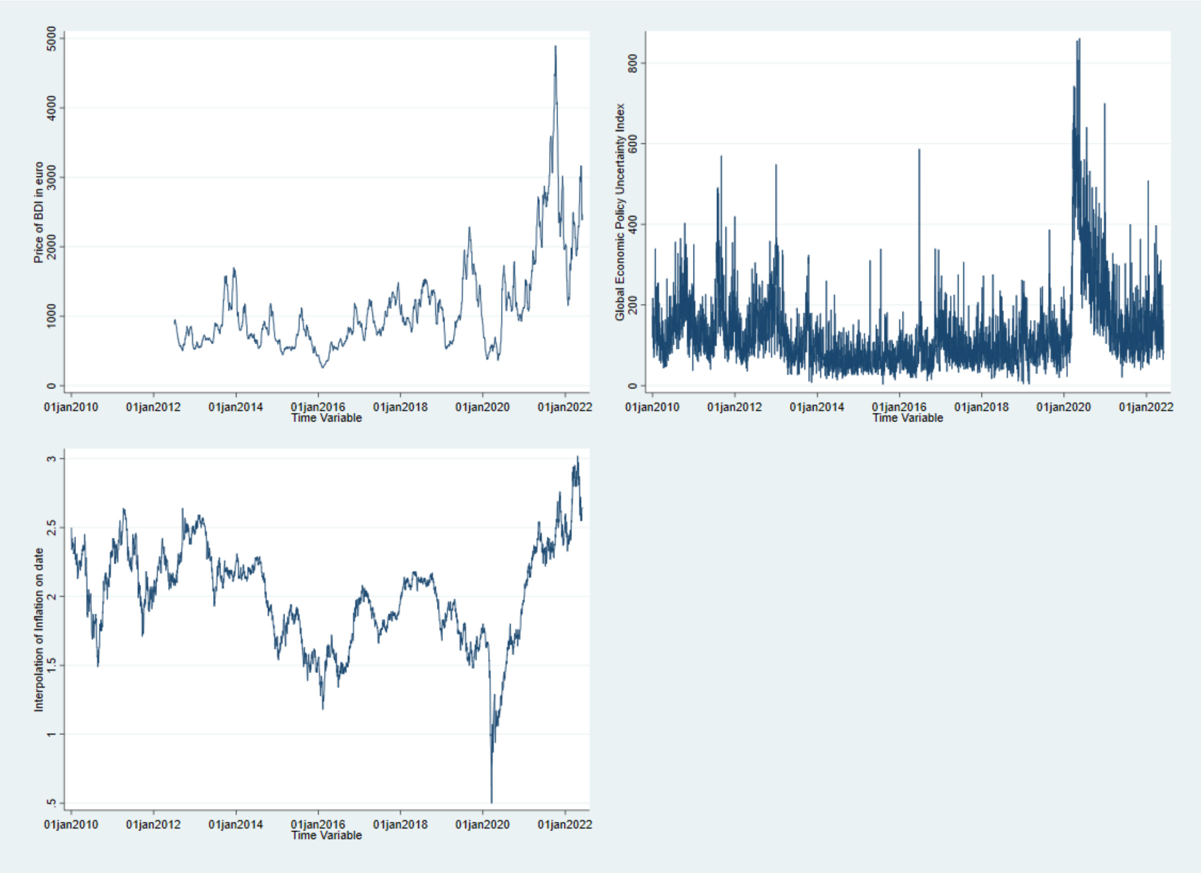
Note: This figure shows the evolution of the volumes traded in corn, crude oil, gas oil, and lead between the 1st of January 2013 and the 1st of January 2015. All volumes are expressed in thousands.

Figure 18: *Volumes Traded of Refined Oil, Seed Oils, Titanium, Wheat between 2013 and 2015*



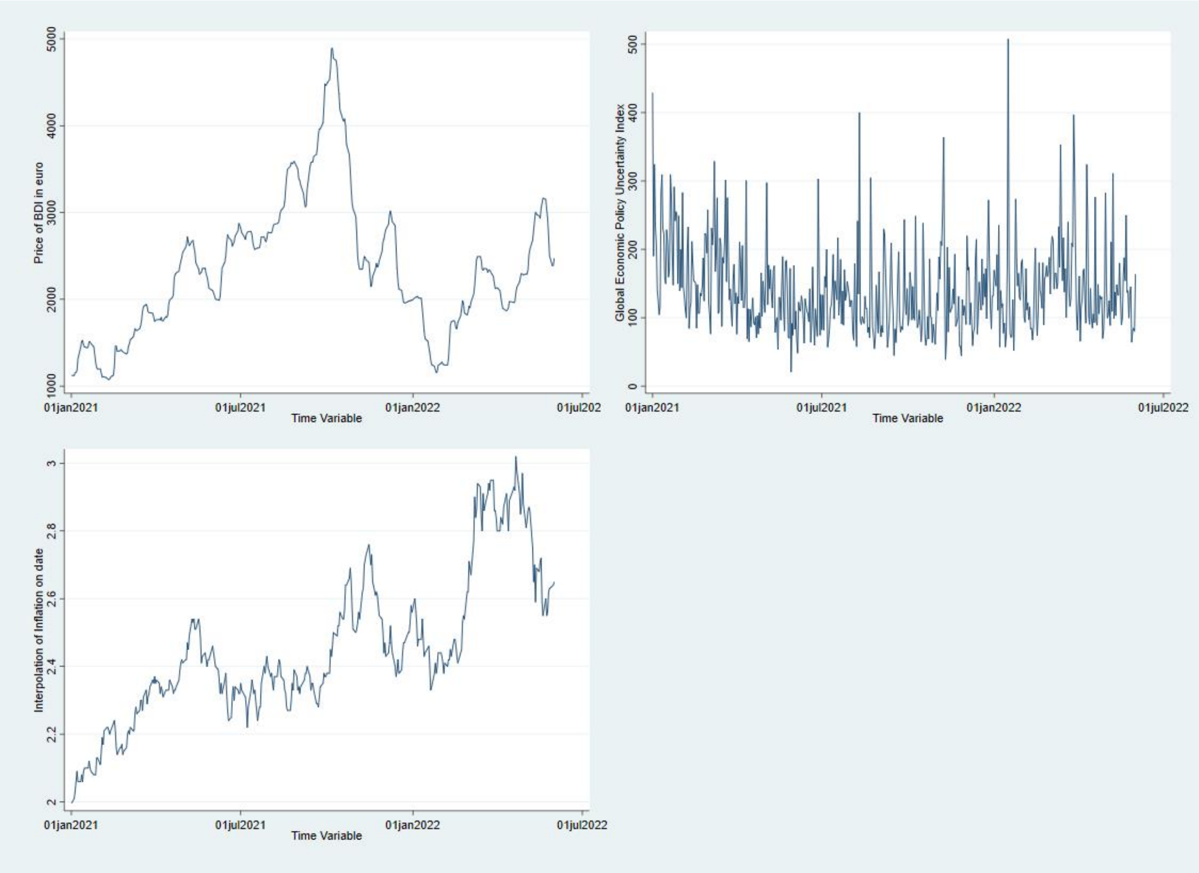
Note: This figure shows the evolution of the volumes traded in refined oil, seed oils, titanium, and wheat between the 1st of January 2013 and the 1st of January 2015. All volumes are expressed in thousands.

Figure 19: *Evolution of the BDI, EPU index, and Inflation between 2010 and 2022*



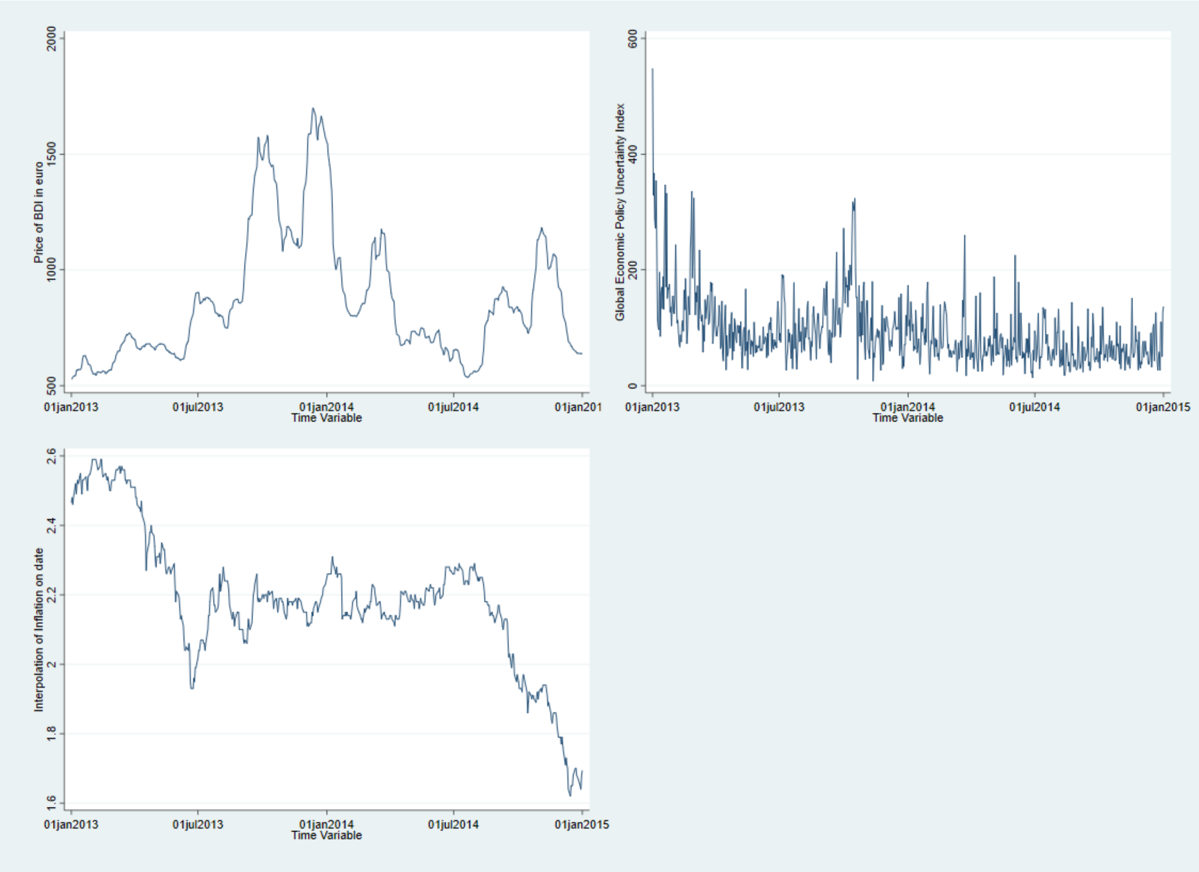
Note: This figure shows the evolution of the Baltic Dry Index, Global Economic Policy Uncertainty Index, and Inflation between 2010 and 2022.

Figure 20: *Evolution of the BDI, EPU index, and Inflation between 2021 and 2022*



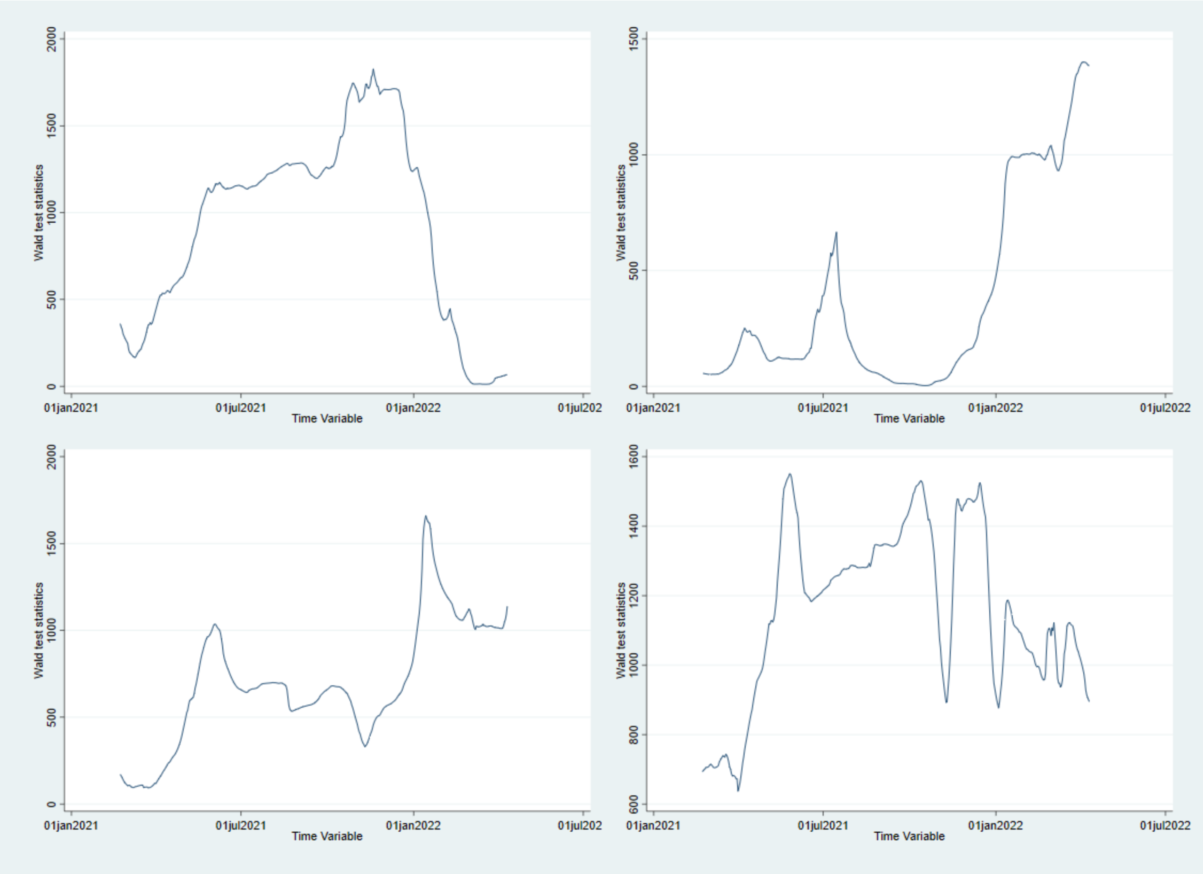
Note: This figure shows the evolution of the Baltic Dry Index, Global Economic Policy Uncertainty Index, and Inflation between 2021 and 2022.

Figure 21: *Evolution of the BDI, EPU index, and Inflation between 2013 and 2015*



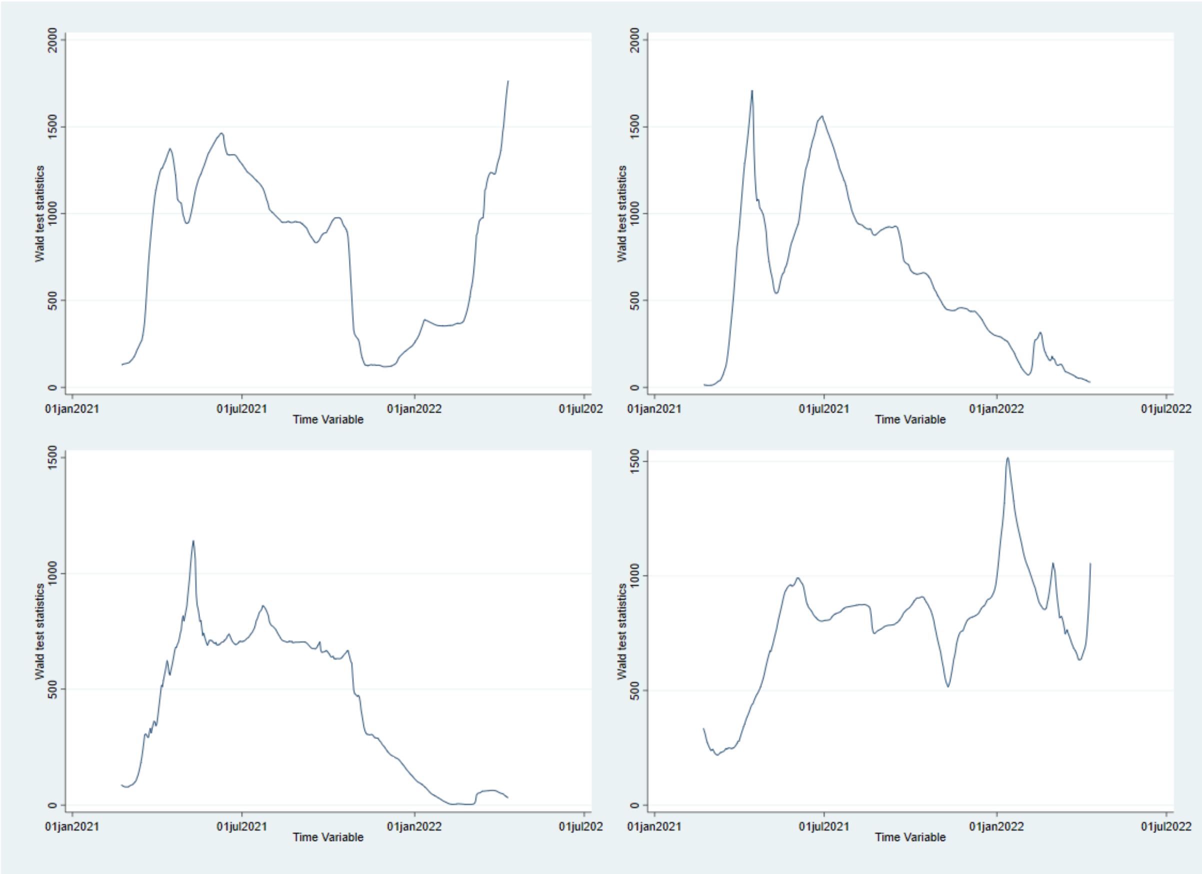
Note: This figure shows the evolution of the Baltic Dry Index, Global Economic Policy Uncertainty Index, and Inflation between 2013 and 2015.

Figure 22: *Wald tests for the regressions of Aluminum, Corn, Crude Oil, and Fertilizers between 2020 and 2022*



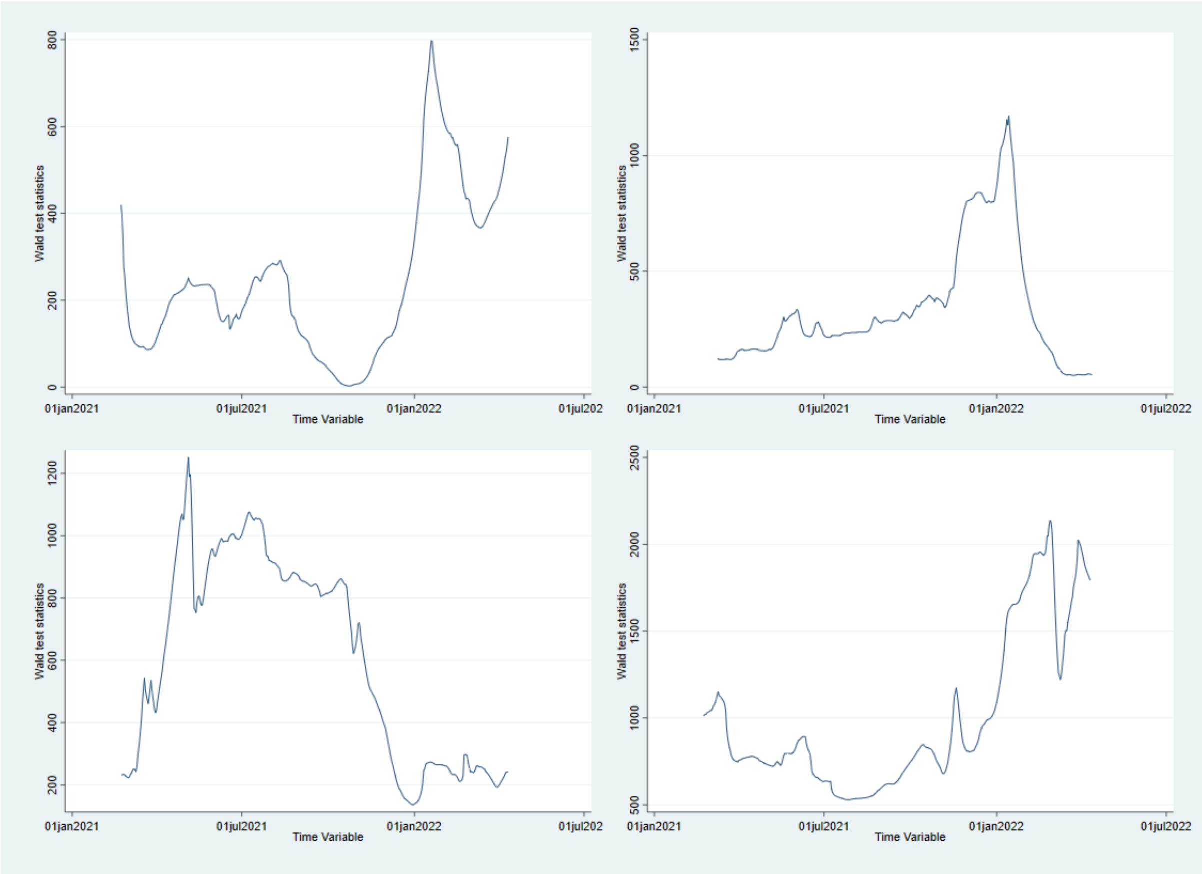
Note: This figure shows the results of the Wald tests for the regressions of Aluminum, Corn, Crude Oil, and Fertilizers between the 1st of January 2020 and the 1st of June 2022.

Figure 23: *Wald tests for the regressions of Gas Oil, Lead Ore, Platinum, and Refined Oil between 2020 and 2022*



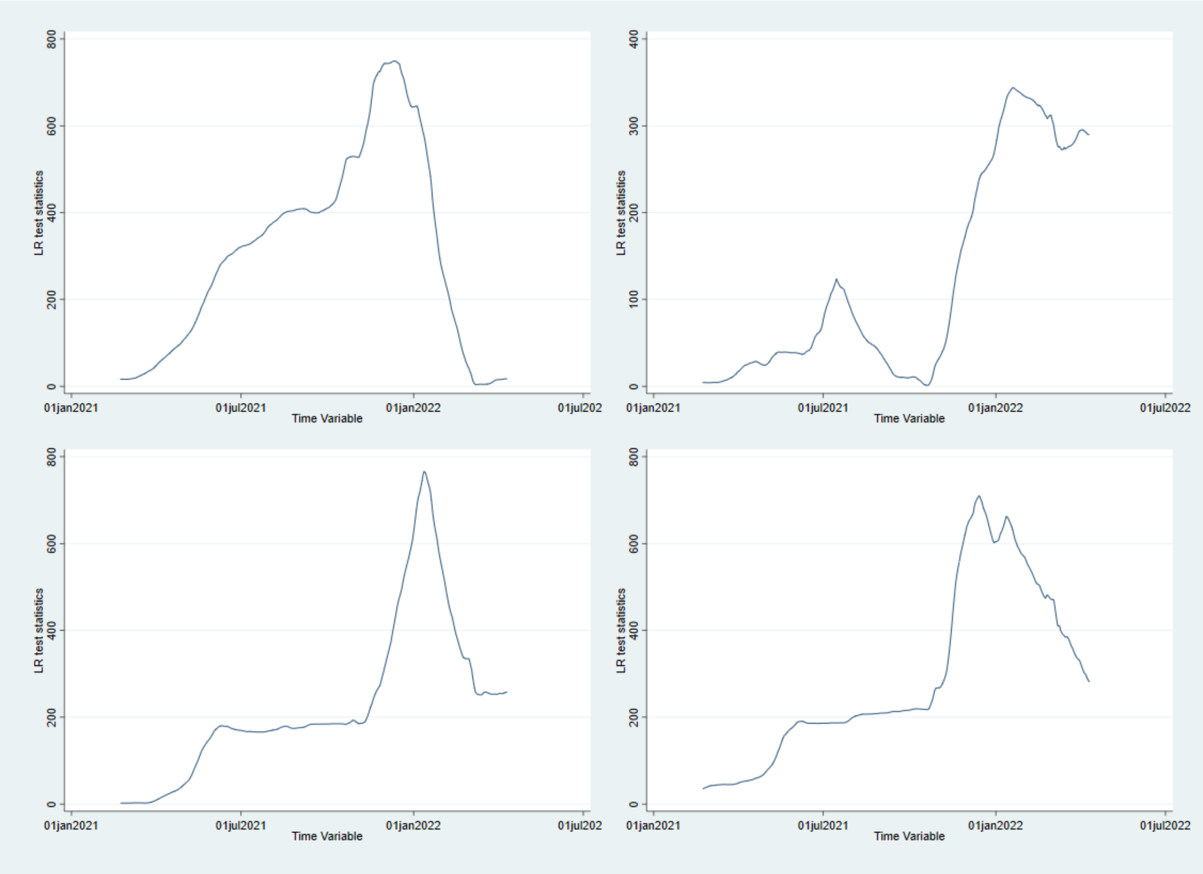
Note: This figure shows the results of the Wald tests for the regressions of Gas Oil, Lead Ore, Platinum, and Refined Oil between the 1st of January 2020 and the 1st of June 2022.

Figure 24: *Wald tests for the regressions of Seed Oils, Steel, Titanium, and Wheat between 2020 and 2022*



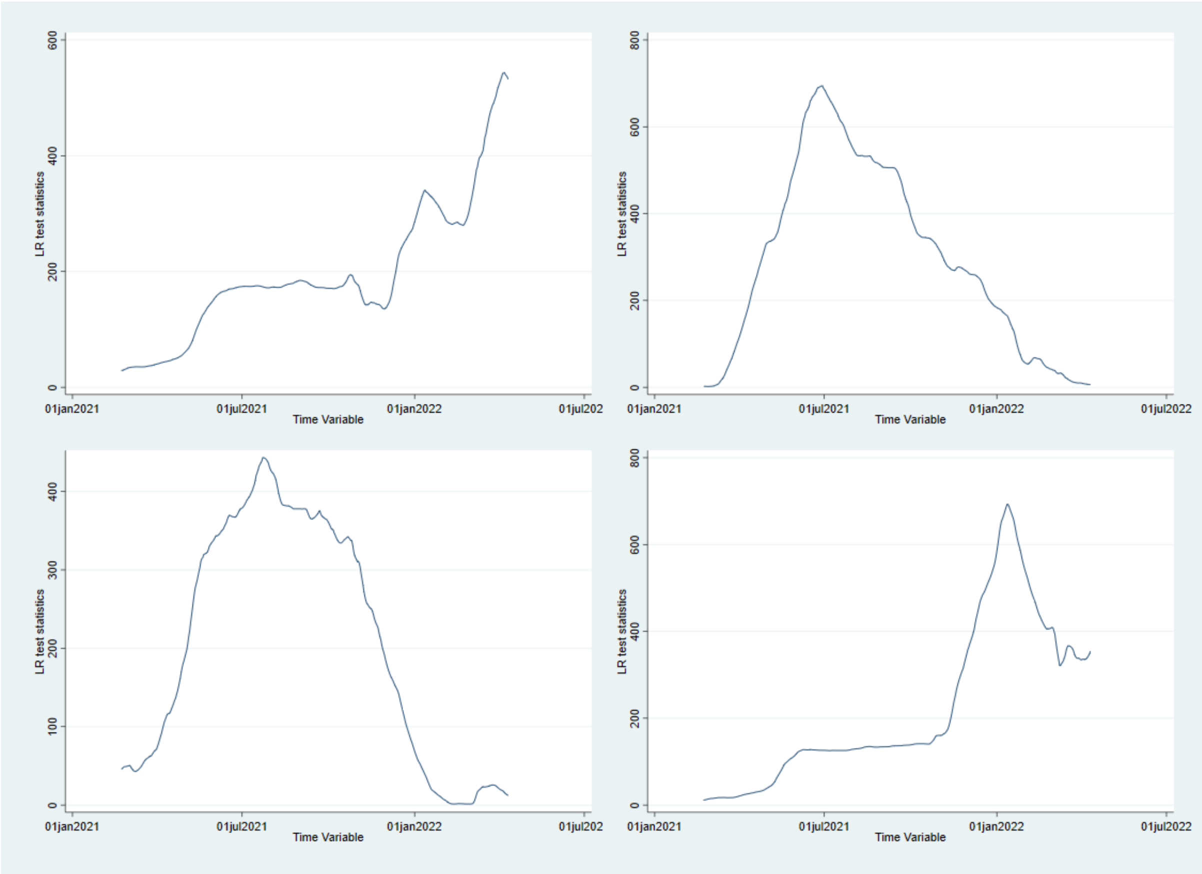
Note: This figure shows the results of the Wald tests for the regressions of Seed Oils, Steel, Titanium, and Wheat between the 1st of January 2020 and the 1st of June 2022.

Figure 25: *LR tests for the regressions of Aluminum, Corn, Crude Oil, and Fertilizers between 2020 and 2022*



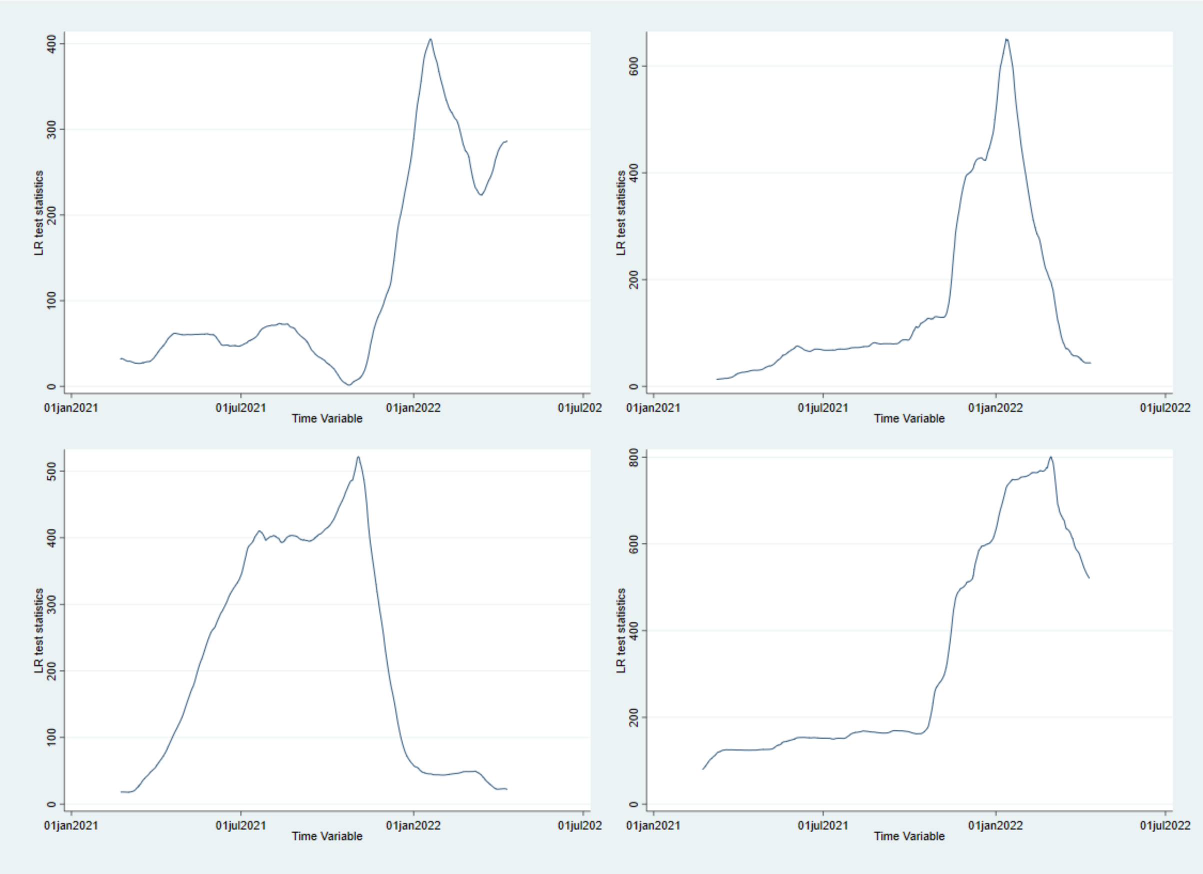
Note: This figure shows the results of the LR tests for the regressions of Aluminum, Corn, Crude Oil, and Fertilizers between the 1st of January 2020 and the 1st of June 2022.

Figure 26: *LR tests for the regressions of Gas Oil, Lead Ore, Platinum, and Refined Oil between 2020 and 2022*



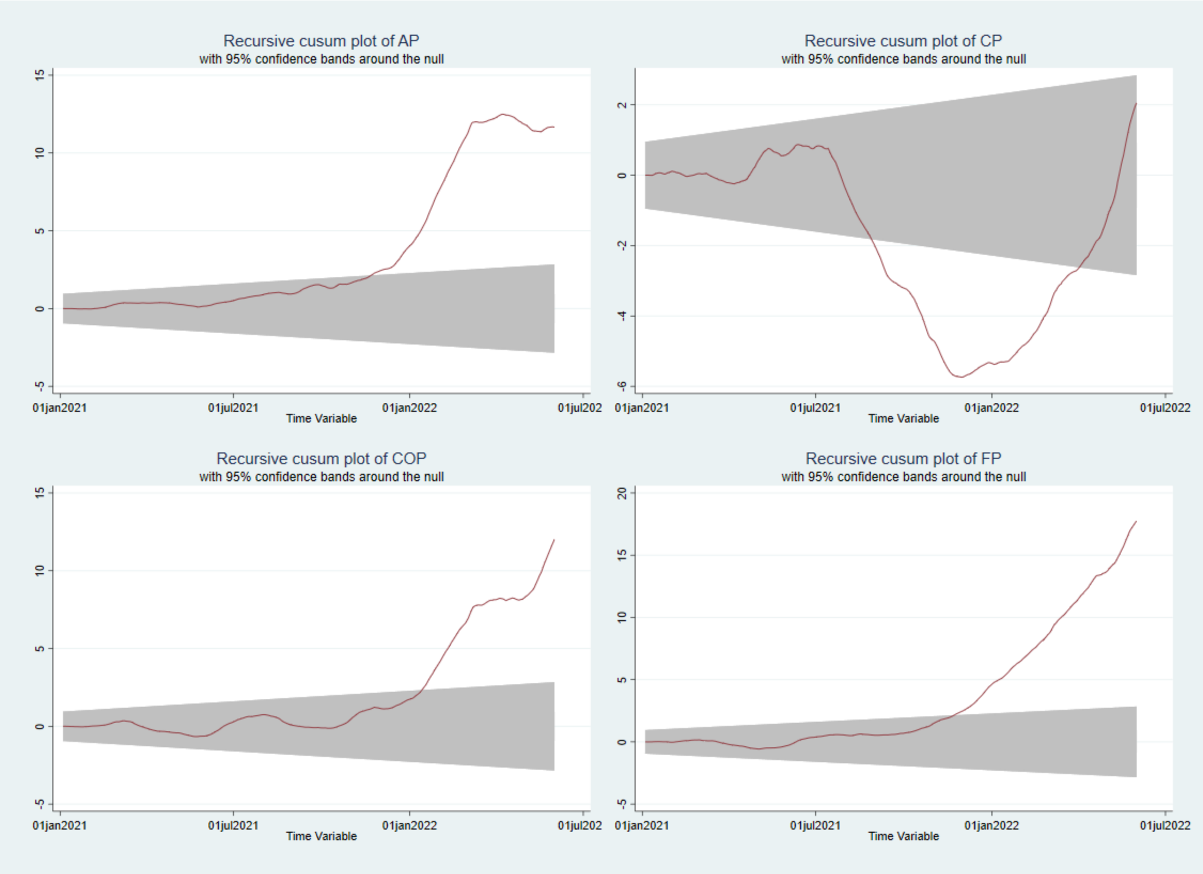
Note: This figure shows the results of the LR tests for the regressions of Gas Oil, Lead Ore, Platinum, and Refined Oil between the 1st of January 2020 and the 1st of June 2022.

Figure 27: *LR tests for the regressions of Seed Oils, Steel, Titanium, and Wheat between 2020 and 2022*



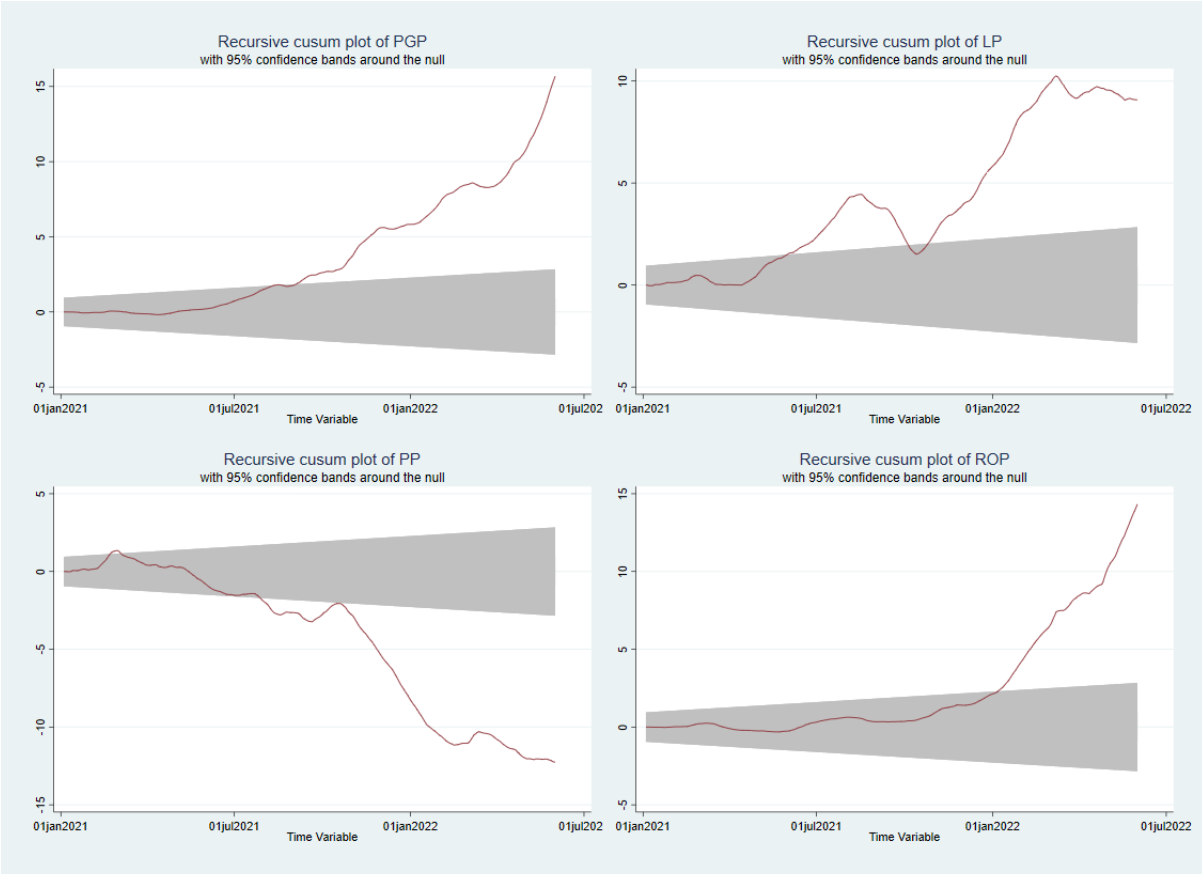
Note: This figure shows the results of the LR tests for the regressions of Seed Oils, Steel, Titanium, and Wheat between the 1st of January 2020 and the 1st of June 2022.

Figure 28: *CUSUM tests for the regressions of Aluminum, Corn, Crude Oil, and Fertilizers between 2020 and 2022*



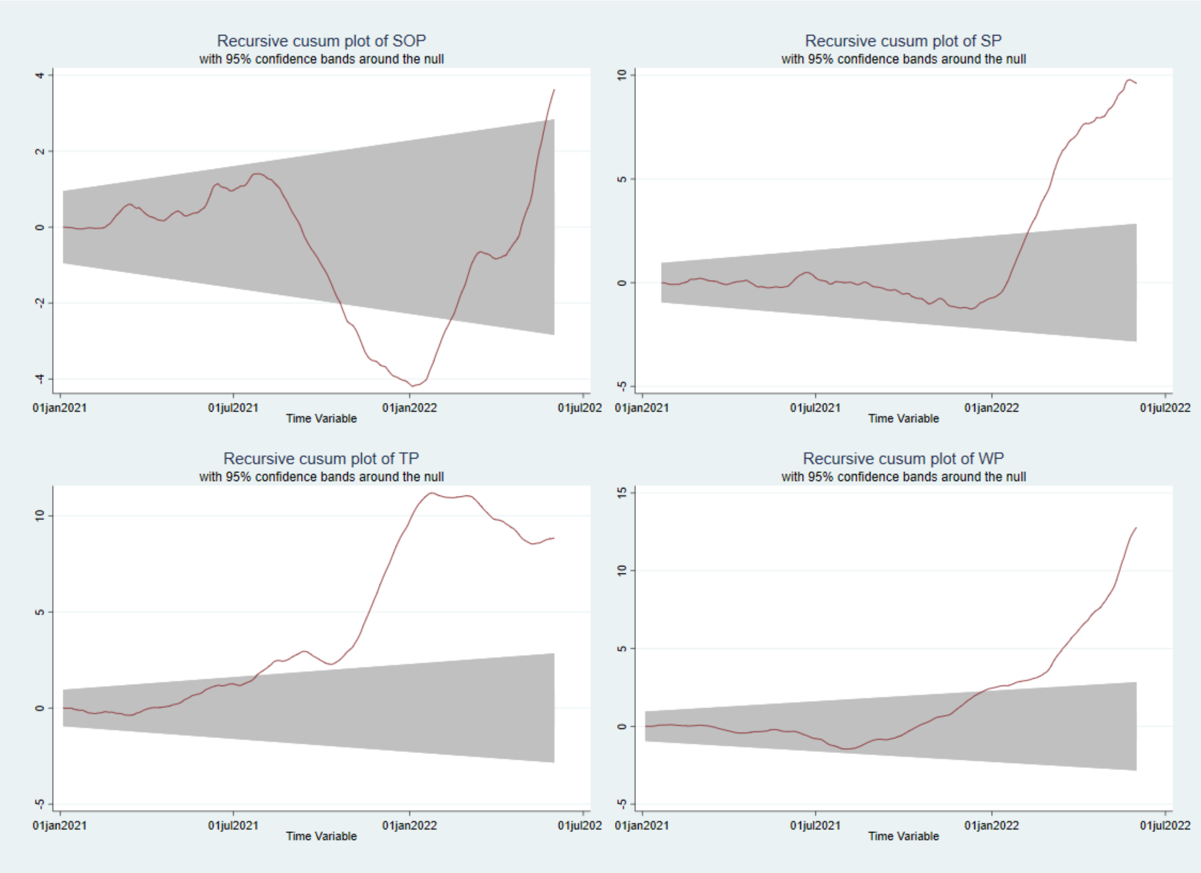
Note: This figure shows the results of the CUSUM tests for the regressions of Aluminum, Corn, Crude Oil, and Fertilizers between the 1st of January 2020 and the 1st of June 2022.

Figure 29: *CUSUM tests for the regressions of Gas Oil, Lead Ore, Platinum, and Refined Oil between 2020 and 2022*



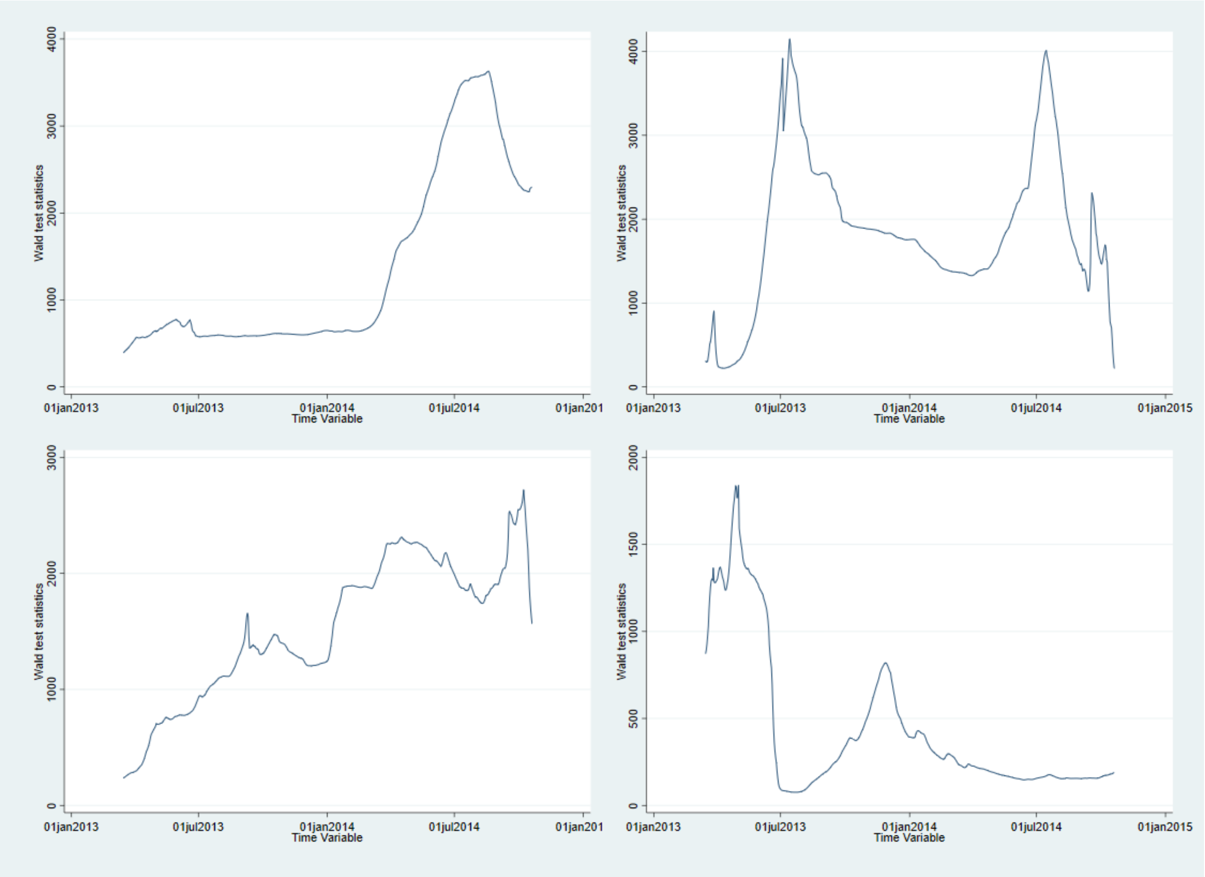
Note: This figure shows the results of the CUSUM tests for the regressions of Gas Oil, Lead Ore, Platinum, and Refined Oil between the 1st of January 2020 and the 1st of June 2022.

Figure 30: *CUSUM tests for the regressions of Seed Oils, Steel, Titanium, and Wheat between 2020 and 2022*



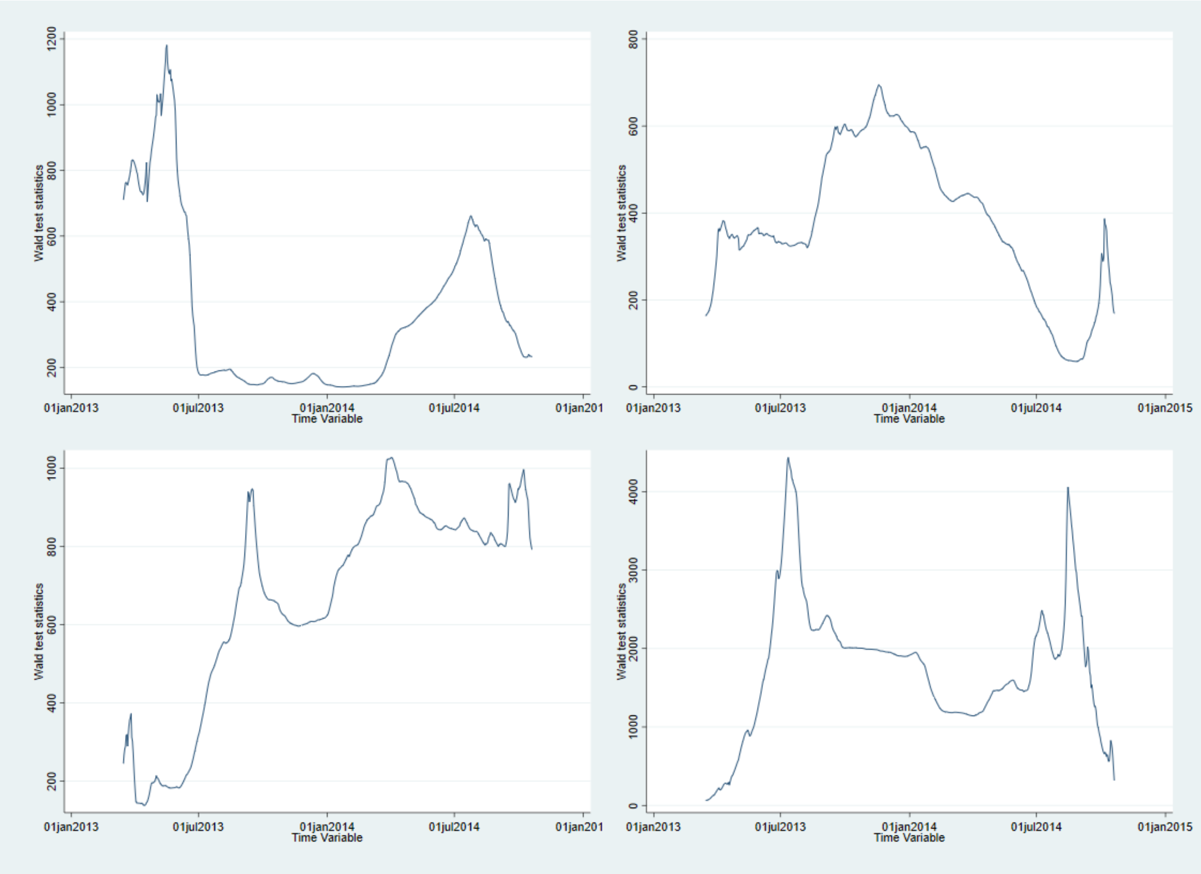
Note: This figure shows the results of the CUSUM tests for the regressions of Seed Oils, Steel, Titanium, and Wheat between the 1st of January 2020 and the 1st of June 2022.

Figure 31: *Wald tests for the regressions of Aluminum, Corn, Crude Oil, and Gas Oil between 2013 and 2015*



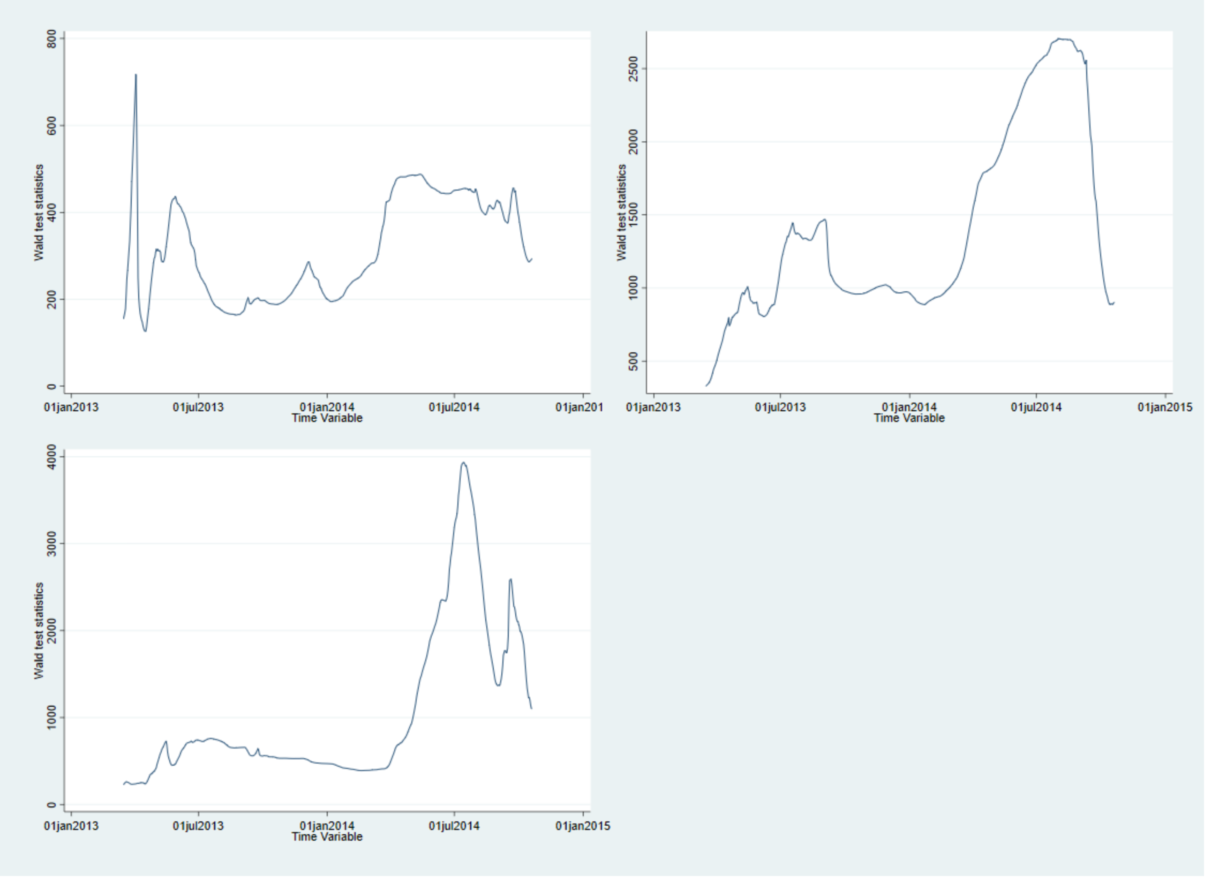
Note: This figure shows the results of the Wald tests for the regressions of Aluminum, Corn, Crude Oil, and Gas Oil between the 1st of January 2013 and the 1st of January 2015.

Figure 32: *Wald tests for the regressions of Lead Ore, Platinum, Refined Oil, and Seed Oils between 2013 and 2015*



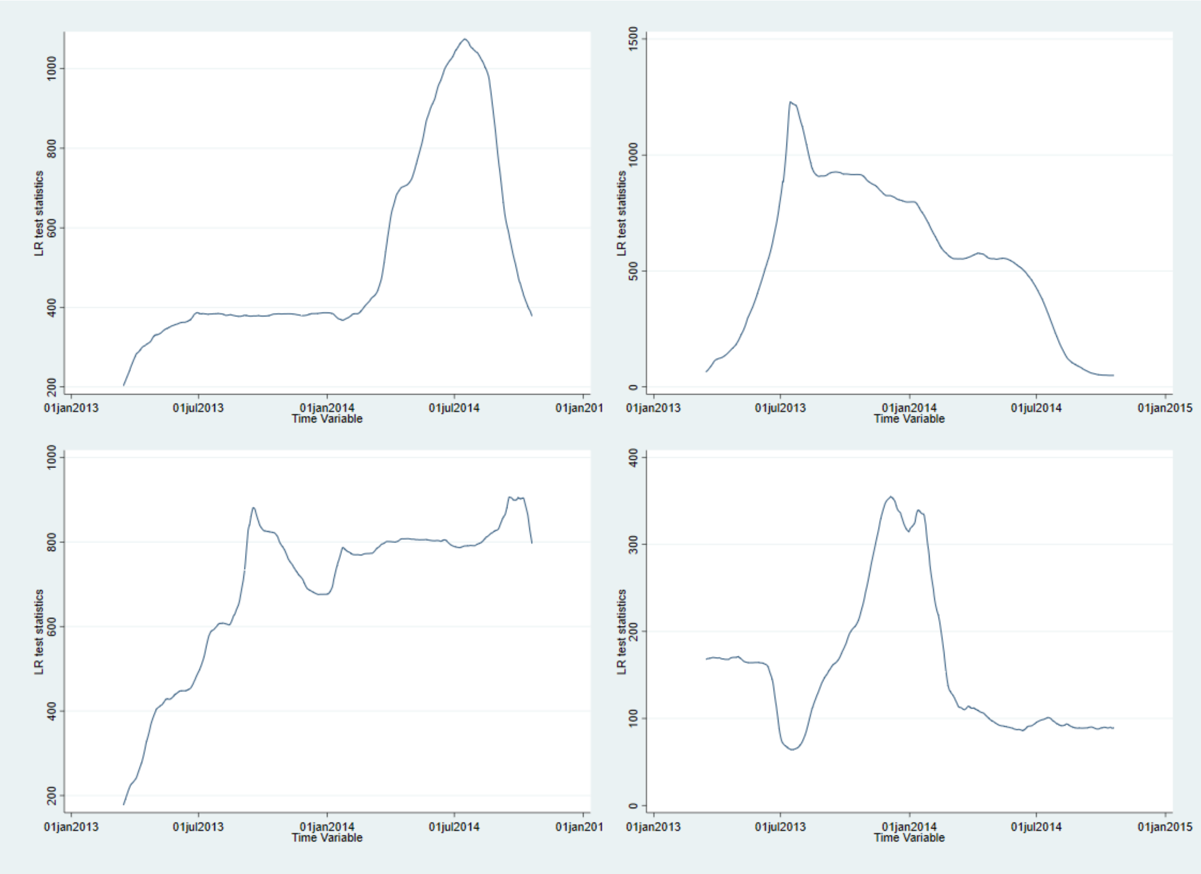
Note: This figure shows the results of the Wald tests for the regressions of Lead Ore, Platinum, Refined Oil, and Seed Oils between the 1st of January 2013 and the 1st of January 2015.

Figure 33: *Wald tests for the regressions of Steel, Titanium, and Wheat between 2013 and 2015*



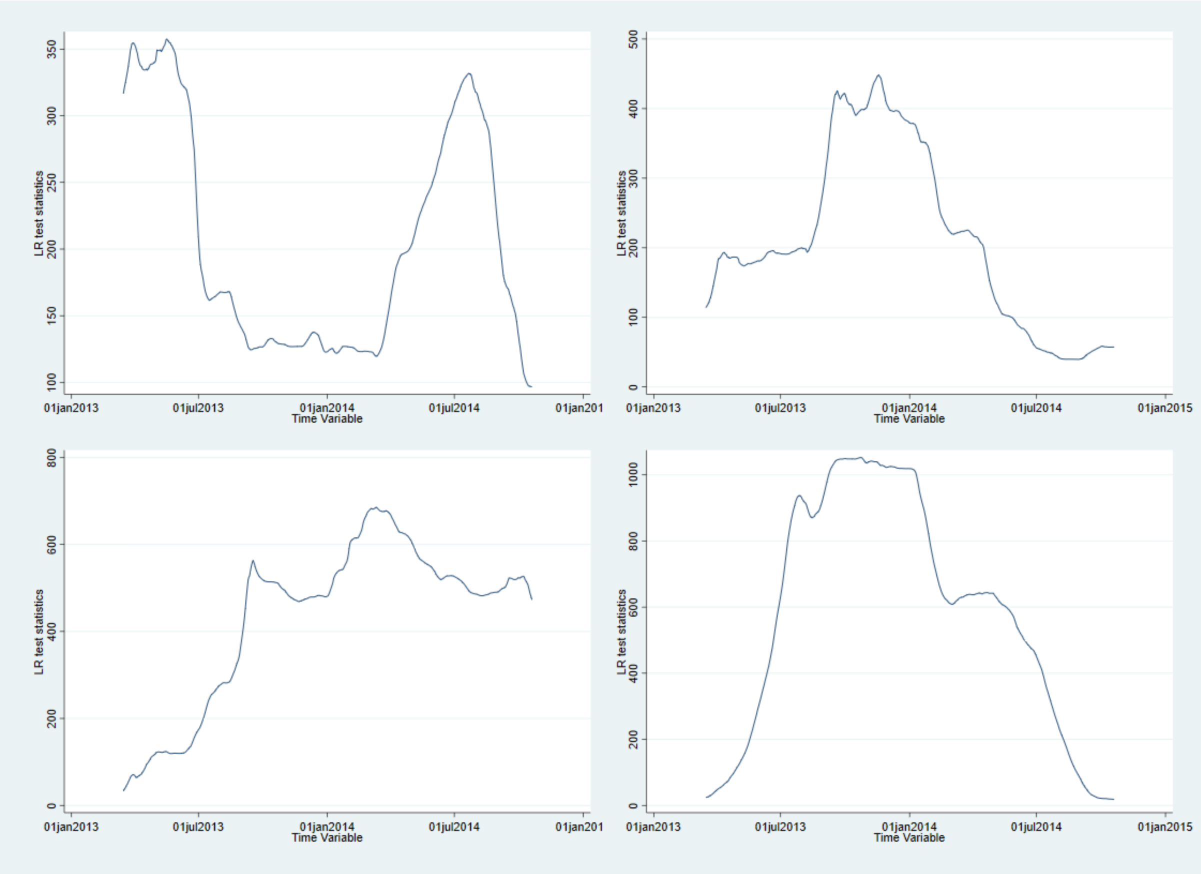
Note: This figure shows the results of the Wald tests for the regressions of Steel, Titanium, and Wheat between the 1st of January 2013 and the 1st of January 2015.

Figure 34: *LR tests for the regressions of Aluminum, Corn, Crude Oil, and Gas Oil between 2013 and 2015*



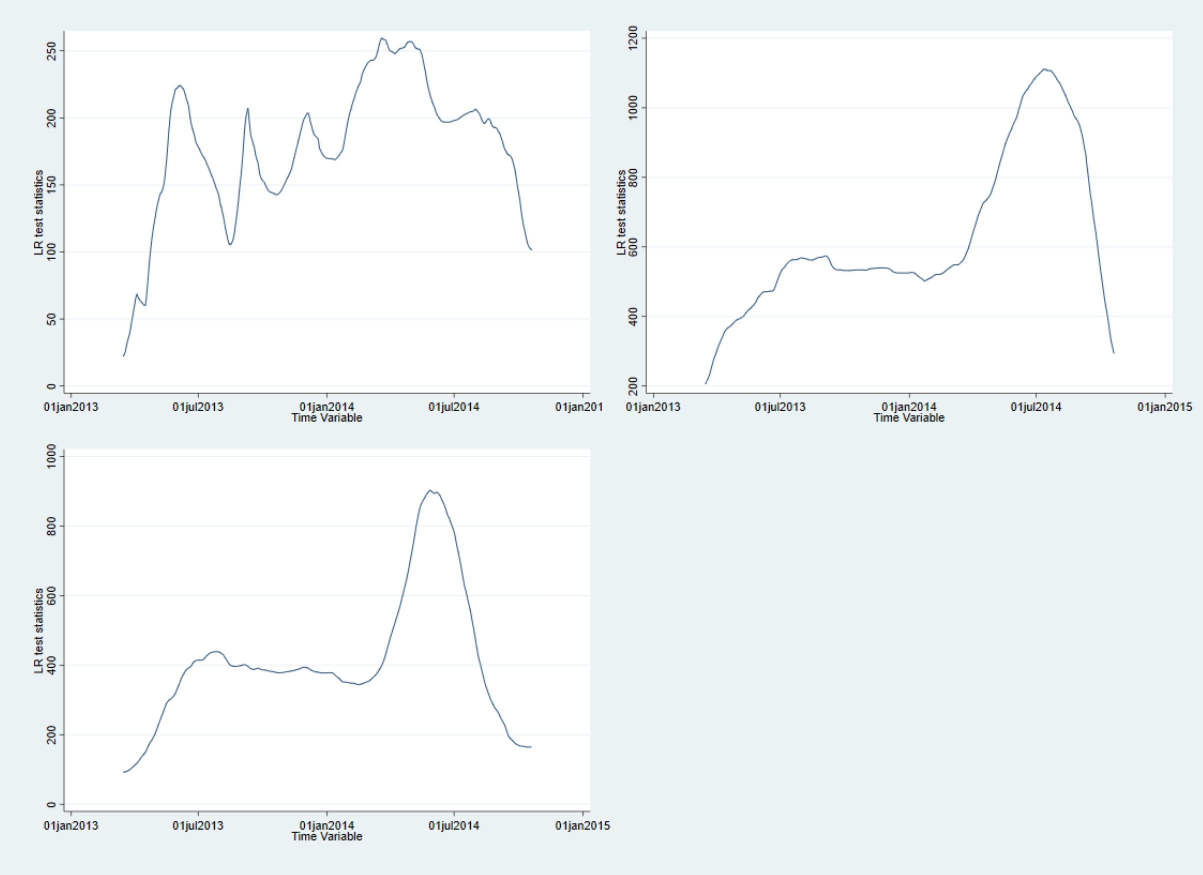
Note: This figure shows the results of the LR tests for the regressions of Aluminum, Corn, Crude Oil, and Gas Oil between the 1st of January 2013 and the 1st of January 2015.

Figure 35: *LR tests for the regressions of Lead Ore, Platinum, Refined Oil, and Seed Oils between 2013 and 2015*



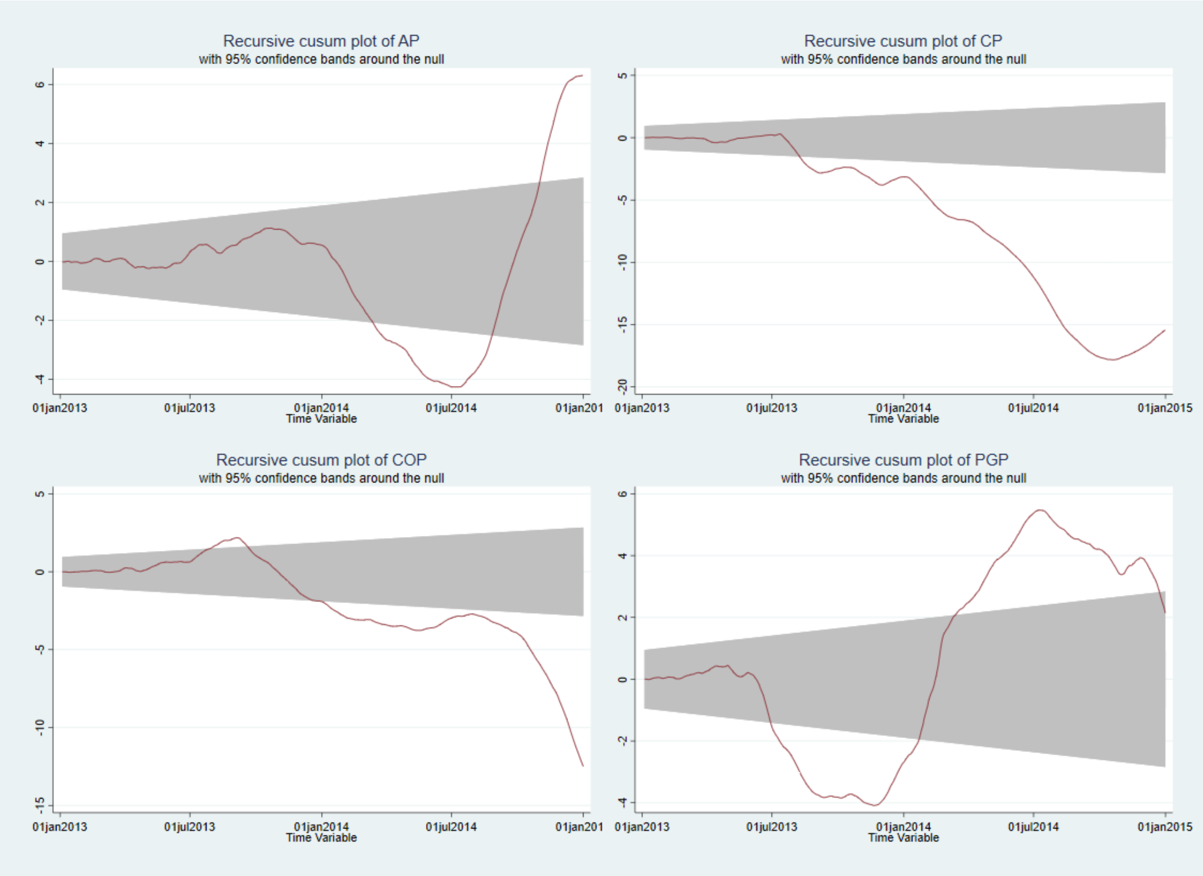
Note: This figure shows the results of the LR tests for the regressions of Lead Ore, Platinum, Refined Oil, and Seed Oils between the 1st of January 2013 and the 1st of January 2015.

Figure 36: *LR tests for the regressions of Steel, Titanium, and Wheat between 2013 and 2015*



Note: This figure shows the results of the LR tests for the regressions of Steel, Titanium, and Wheat between the 1st of January 2013 and the 1st of January 2015.

Figure 37: *CUSUM tests for the regressions of Aluminum, Corn, Crude Oil, and Gas Oil between 2013 and 2015*

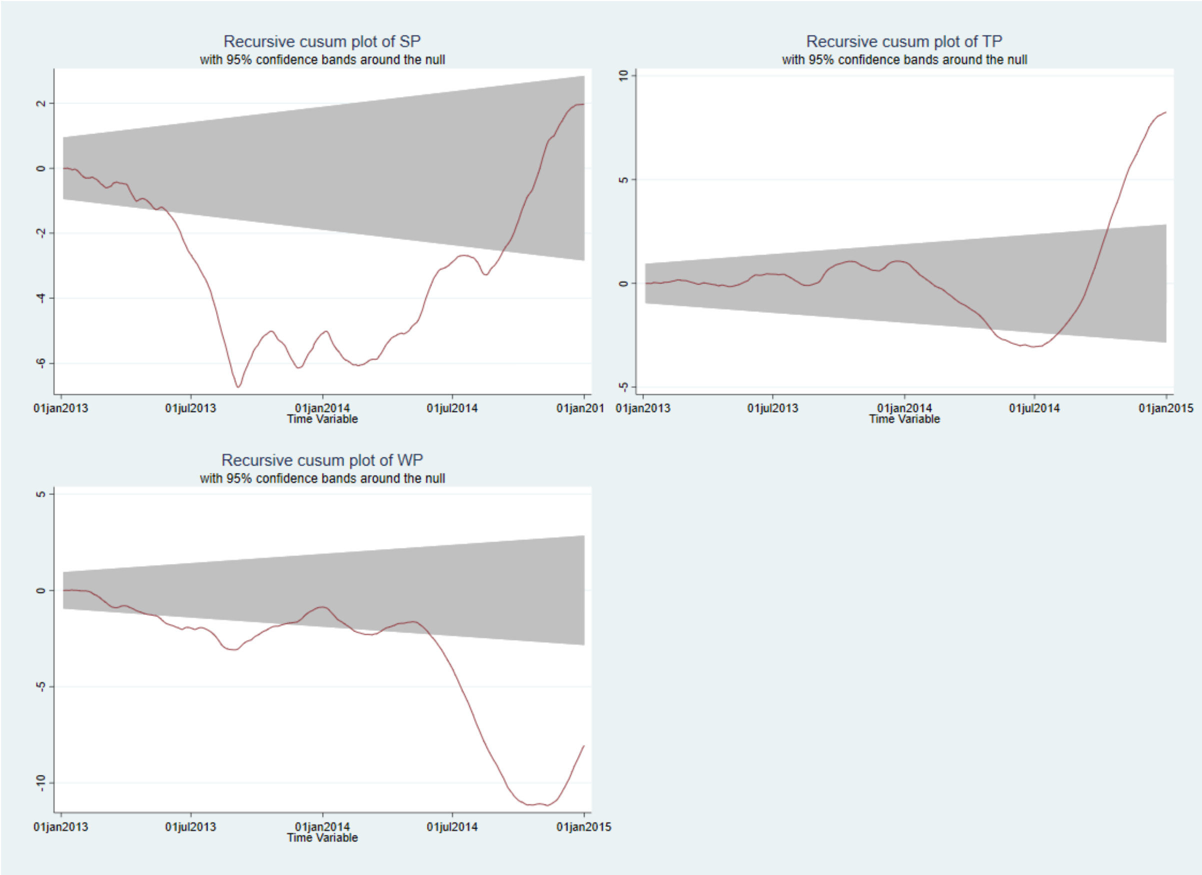


Note: This figure shows the results of the CUSUM tests for the regressions of Aluminum, Corn, Crude Oil, and Gas Oil between the 1st of January 2013 and the 1st of January 2015.

Figure 38: *CUSUM tests for the regressions of Lead Ore, Platinum, Refined Oil, and Seed Oils between 2013 and 2015*

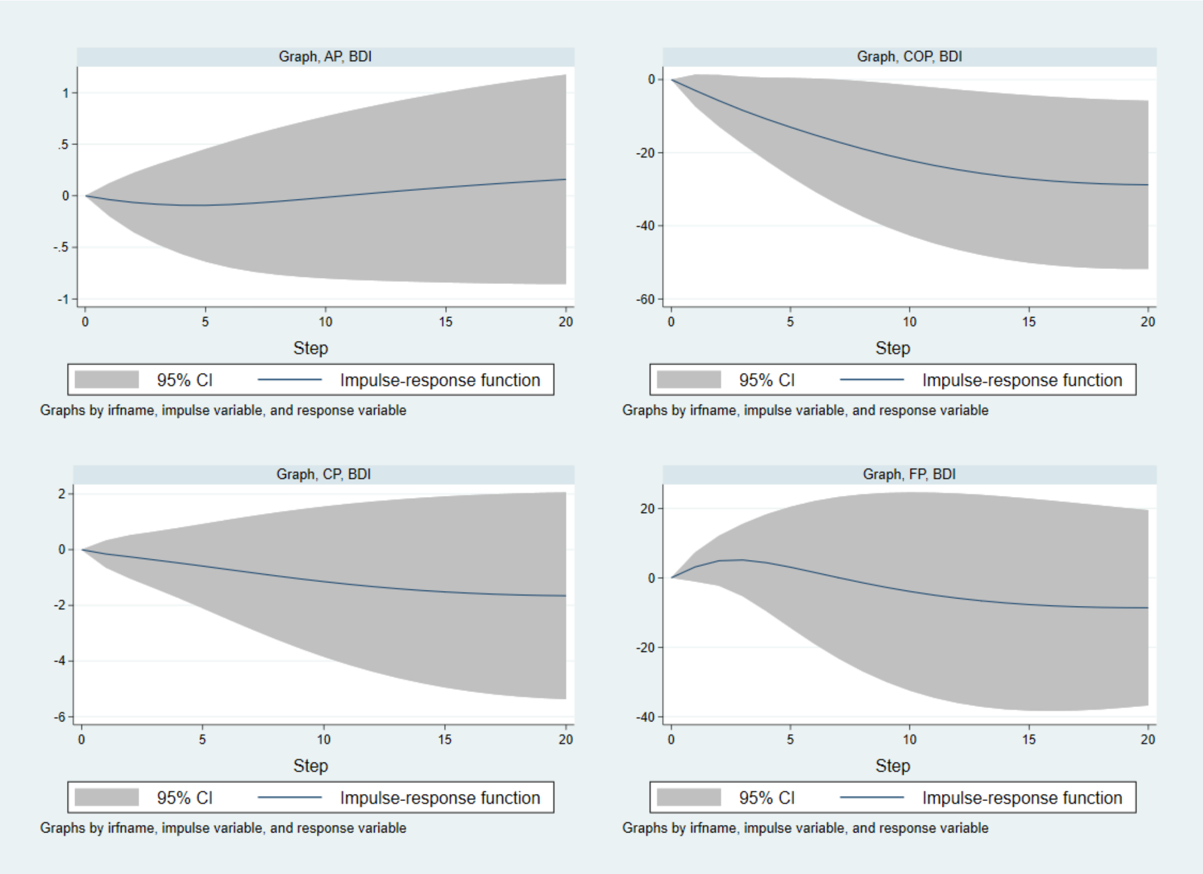
Note: This figure shows the results of the CUSUM tests for the regressions of Lead Ore, Platinum, Refined Oil, and Seed Oils between the 1st of January 2013 and the 1st of January 2015.

Figure 39: *CUSUM tests for the regressions of Steel, Titanium, and Wheat between 2013 and 2015*



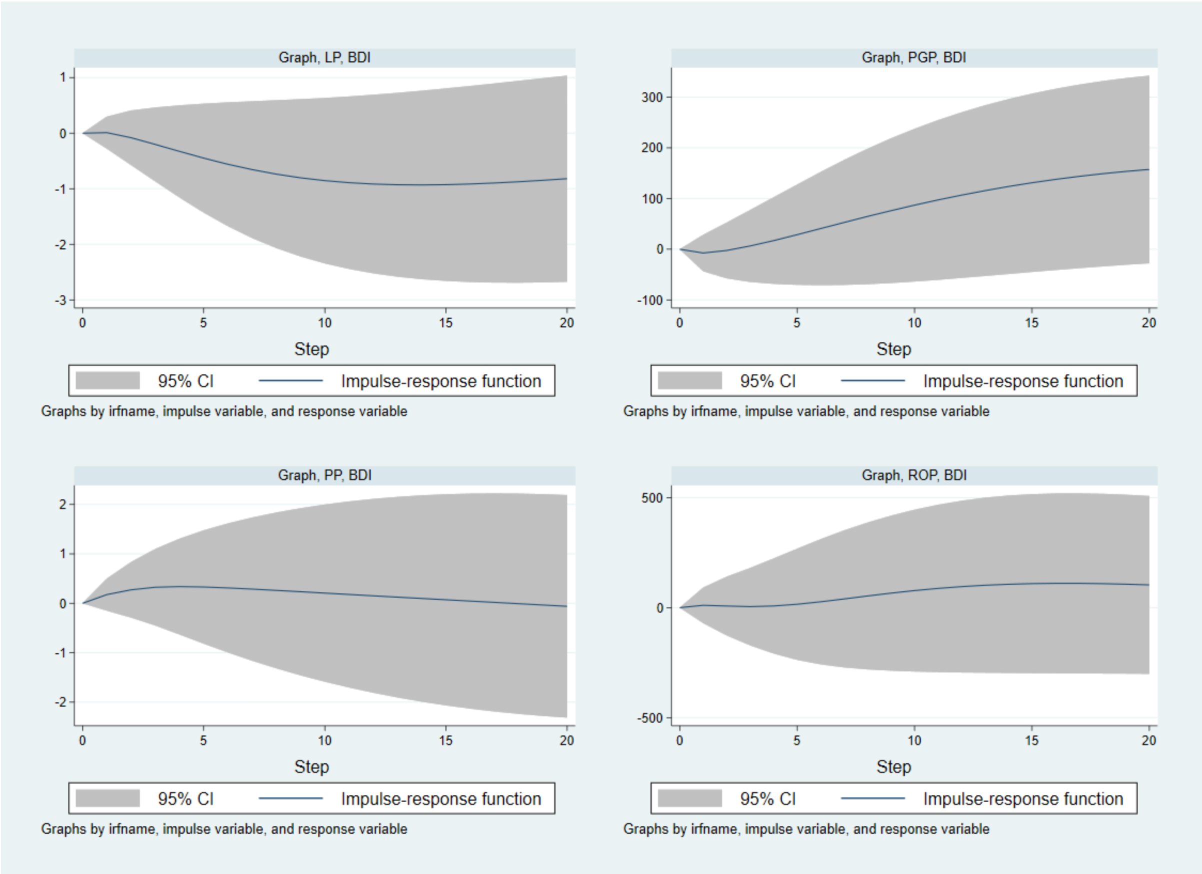
Note: This figure shows the results of the CUSUM tests for the regressions of Steel, Titanium, and Wheat between the 1st of January 2013 and the 1st of January 2015.

Figure 40: *Impulse response functions with BDI as the response and aluminum, crude oil, corn, and fertilizers as impulses for the first SVAR model*



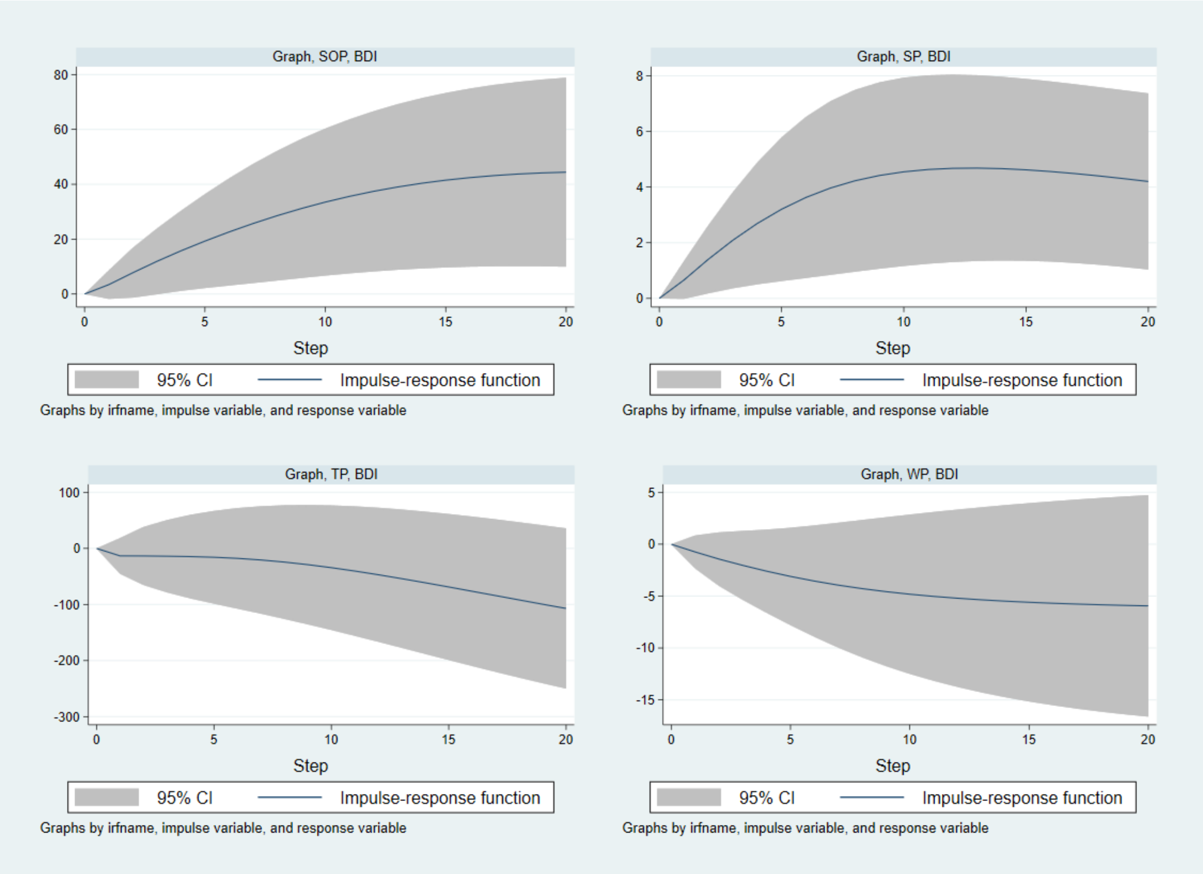
Note: This figure shows the response of the BDI to structural one standard deviation errors in aluminium, crude oil, corn, and fertilizers.

Figure 41: *Impulse response functions with BDI as the response and lead, petroleum gas, platinum, and refined oil as impulses for the first SVAR model*



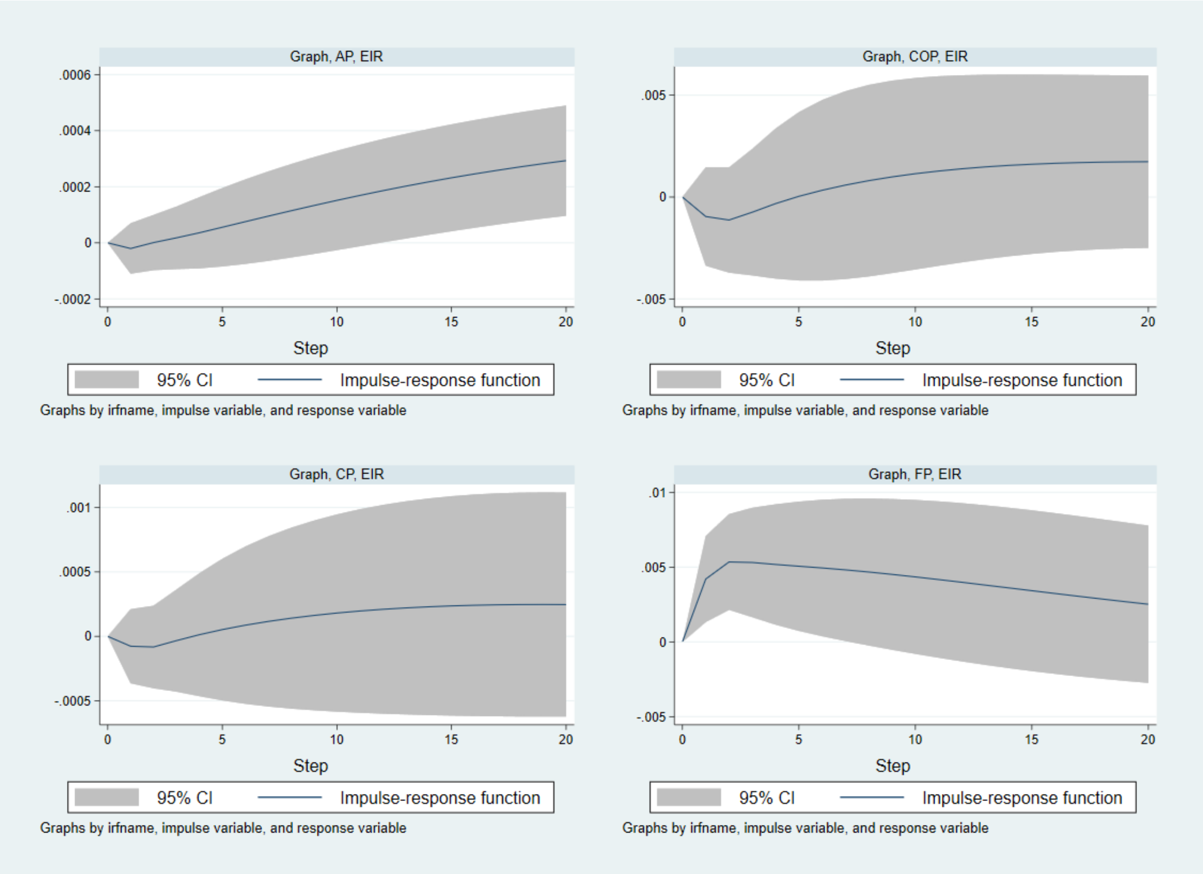
Note: This figure shows the response of the BDI to structural one standard deviation errors in lead, petroleum gas, platinum, and refined oil.

Figure 42: *Impulse response functions with BDI as the response and seed oils, steel, titanium, and wheat as impulses for the first SVAR model*



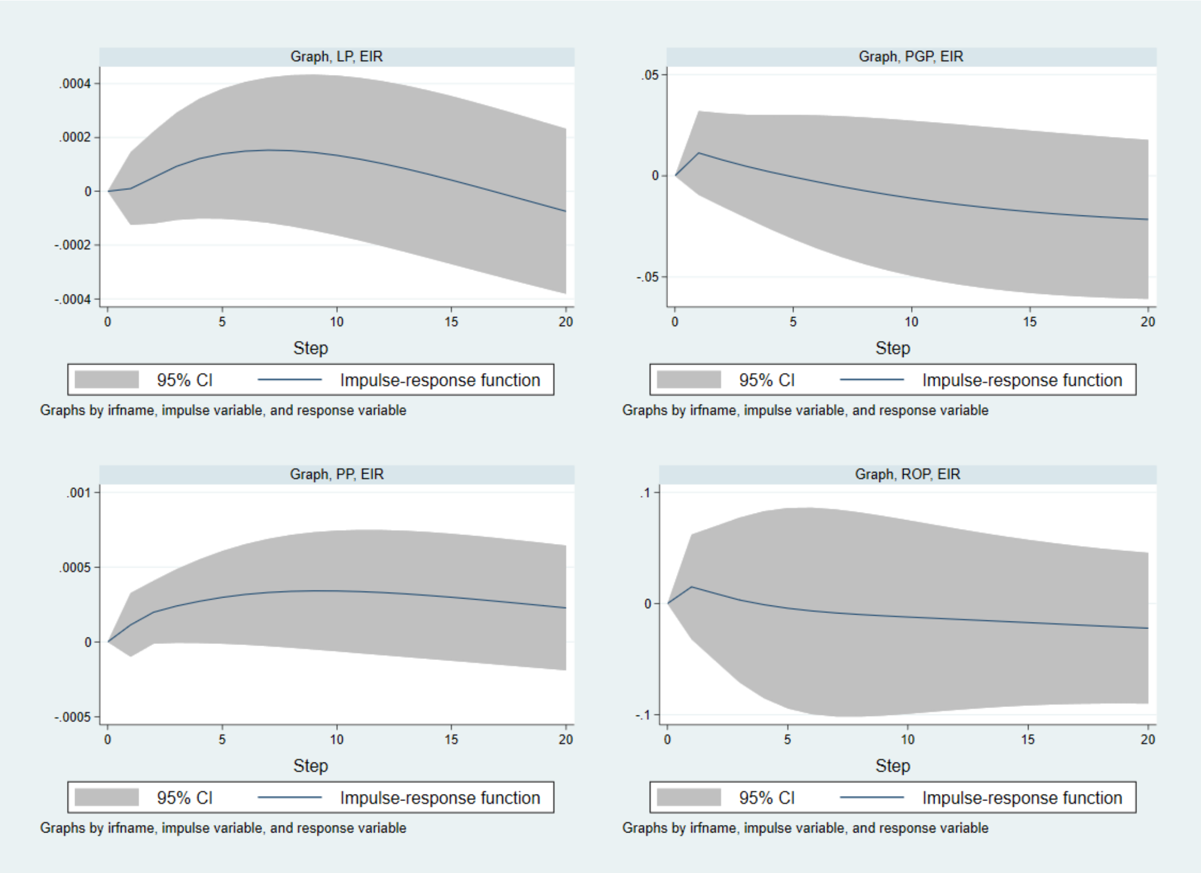
Note: This figure shows the response of the BDI to structural one standard deviation errors in seed oils, steel, titanium, and wheat.

Figure 43: *Impulse response functions with EIR as the response and aluminum, crude oil, corn, and fertilizers as impulses for the first SVAR model*



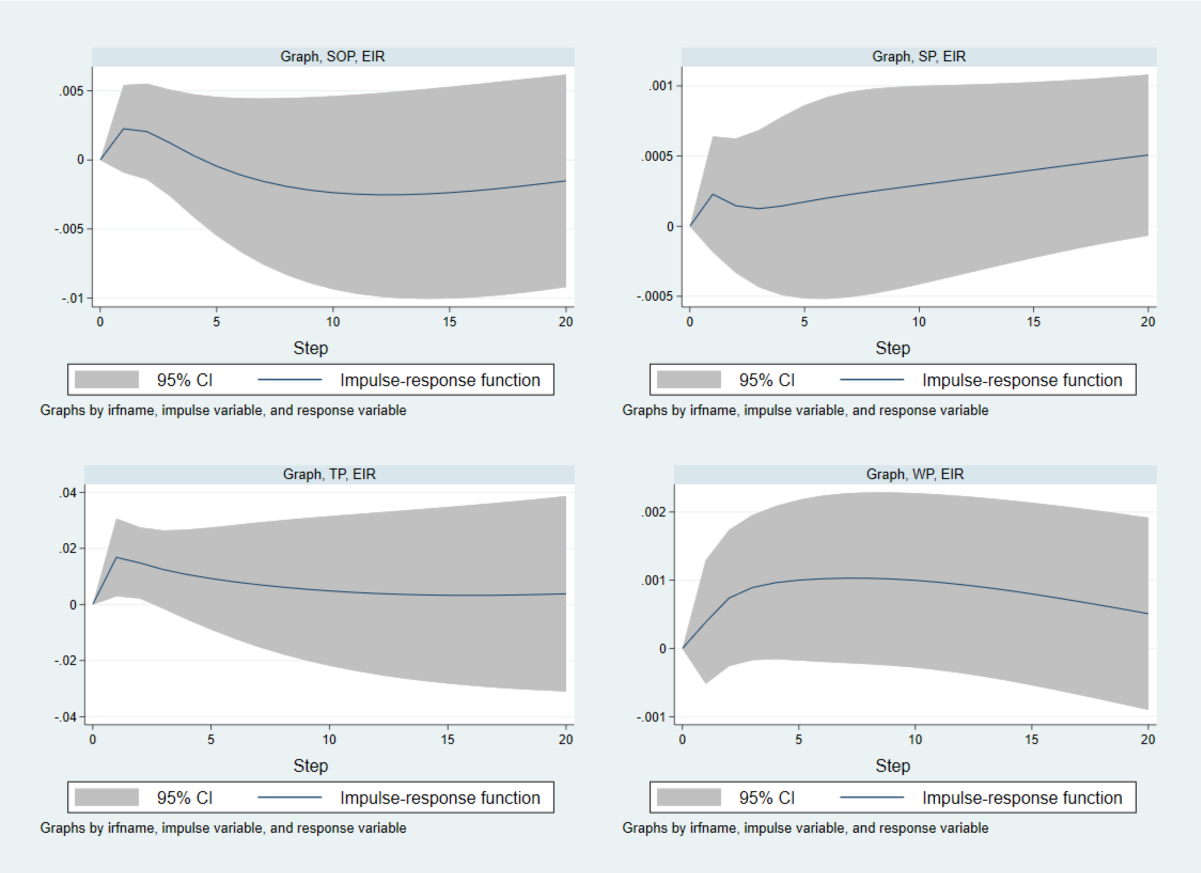
Note: This figure shows the response of the EIR to structural one standard deviation errors in aluminium, crude oil, corn, and fertilizers.

Figure 44: *Impulse response functions with EIR as the response and lead, petroleum gas, platinum, and refined oil as impulses for the first SVAR model*



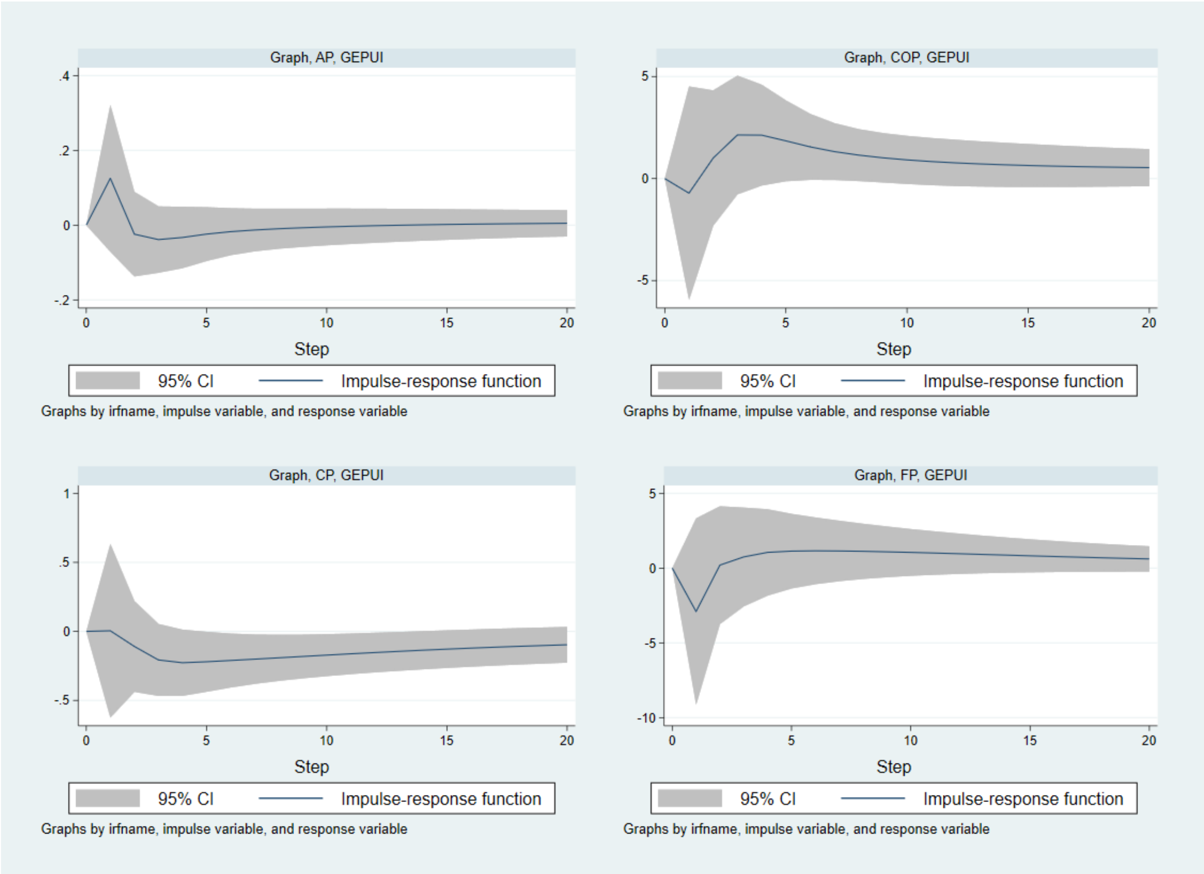
Note: This figure shows the response of the EIR to structural one standard deviation errors in lead, petroleum gas, platinum, and refined oil.

Figure 45: *Impulse response functions with BDI as the response and seed oils, steel, titanium, and wheat as impulses for the first SVAR model*



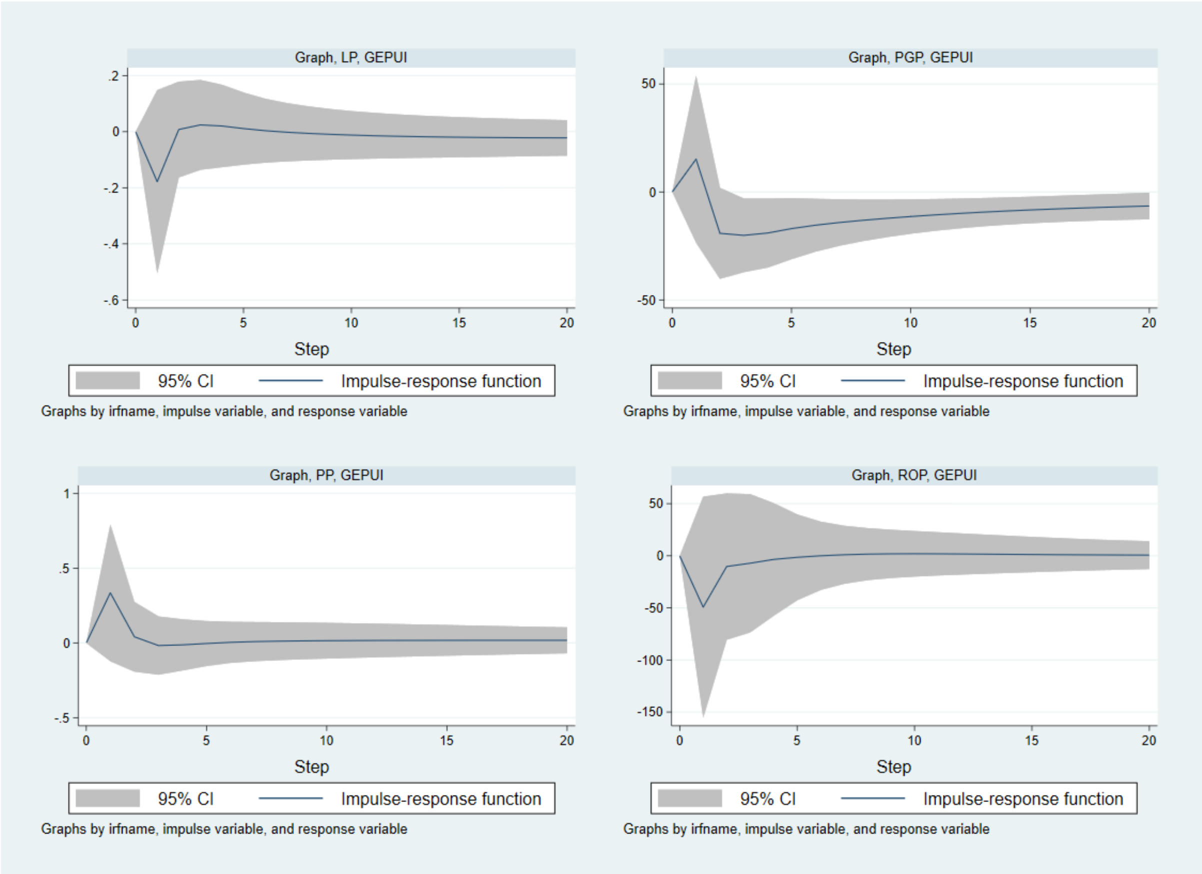
Note: This figure shows the response of the EIR to structural one standard deviation errors in seed oils, steel, titanium, and wheat.

Figure 46: *Impulse response functions with GEPUI as the response and aluminum, crude oil, corn, and fertilizers as impulses for the first SVAR model*



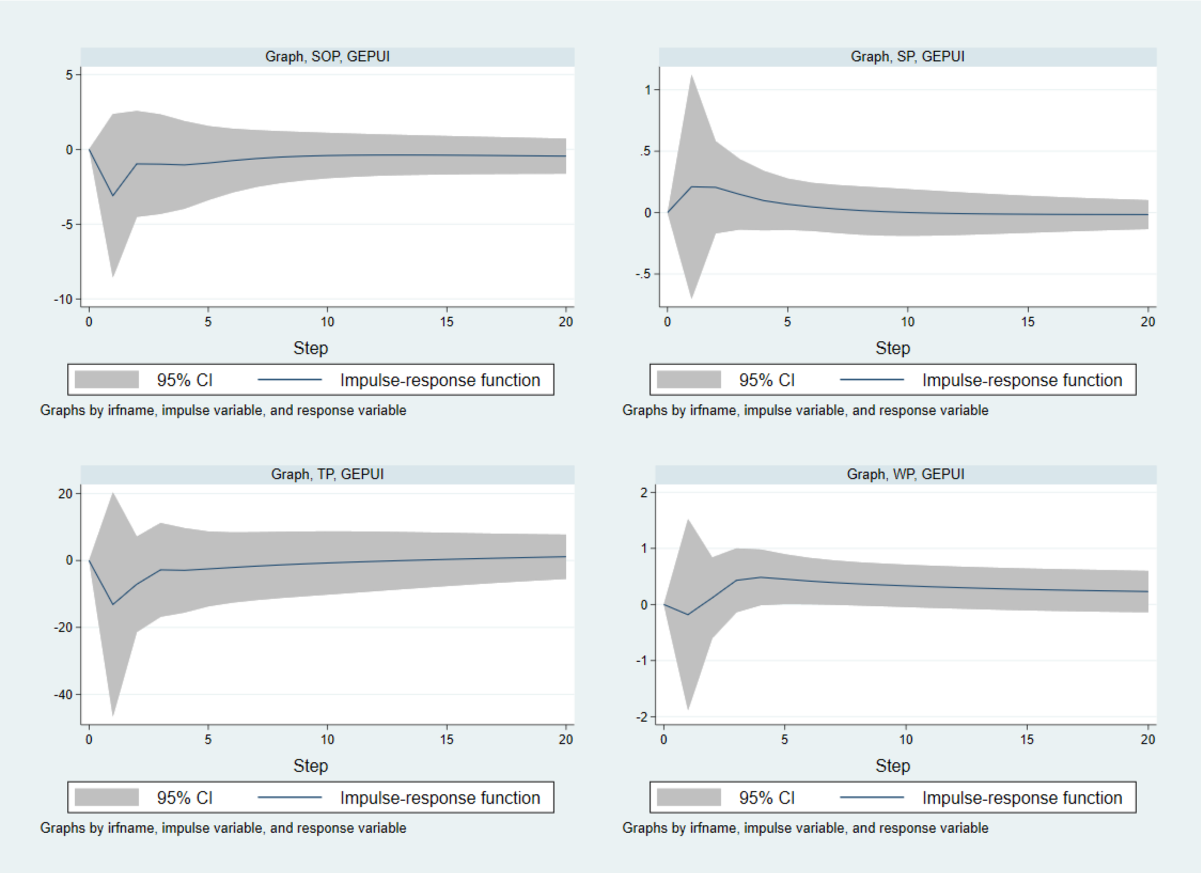
Note: This figure shows the response of the GEPUI to structural one standard deviation errors in aluminium, crude oil, corn, and fertilizers.

Figure 47: *Impulse response functions with GEPUI as the response and lead, petroleum gas, platinum, and refined oil as impulses for the first SVAR model*



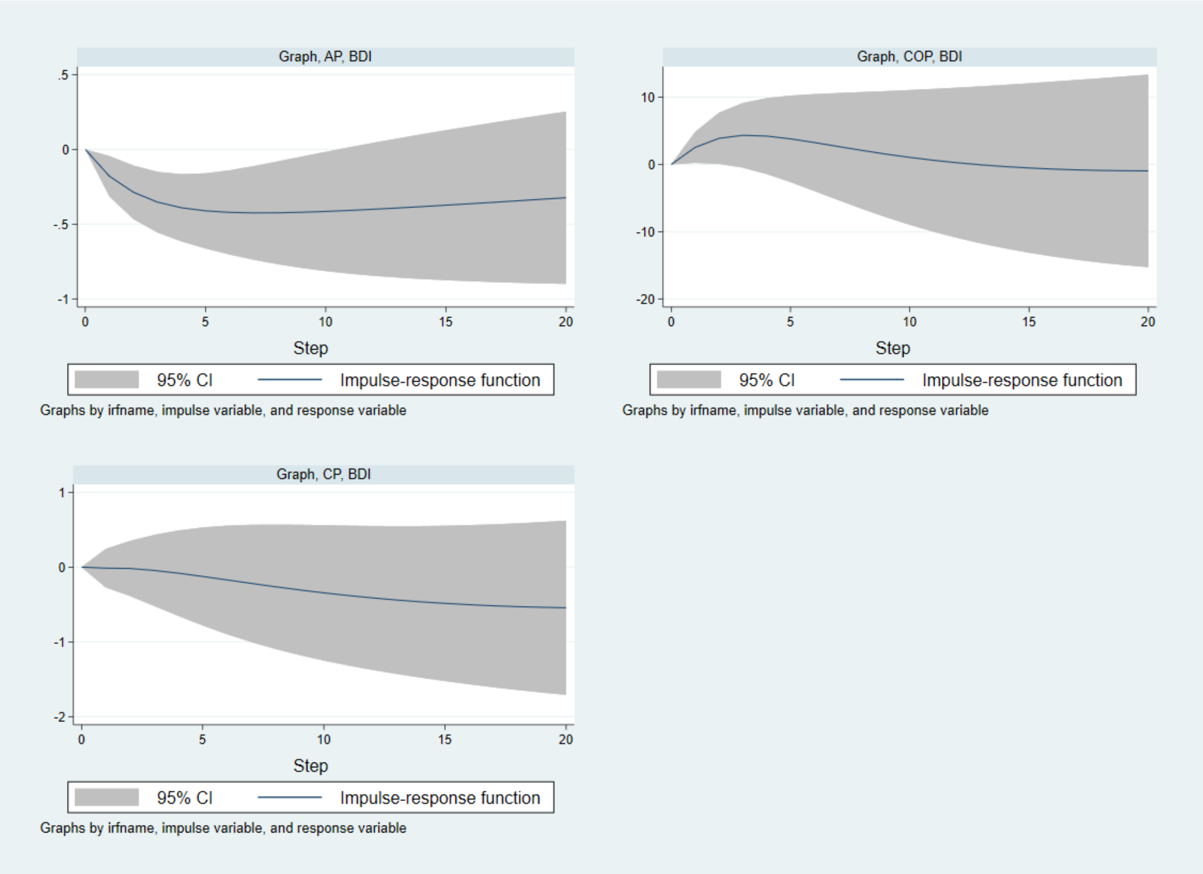
Note: This figure shows the response of the GEPUI to structural one standard deviation errors in lead, petroleum gas, platinum, and refined oil.

Figure 48: *Impulse response functions with GEPUI as the response and seed oils, steel, titanium, and wheat as impulses for the first SVAR model*



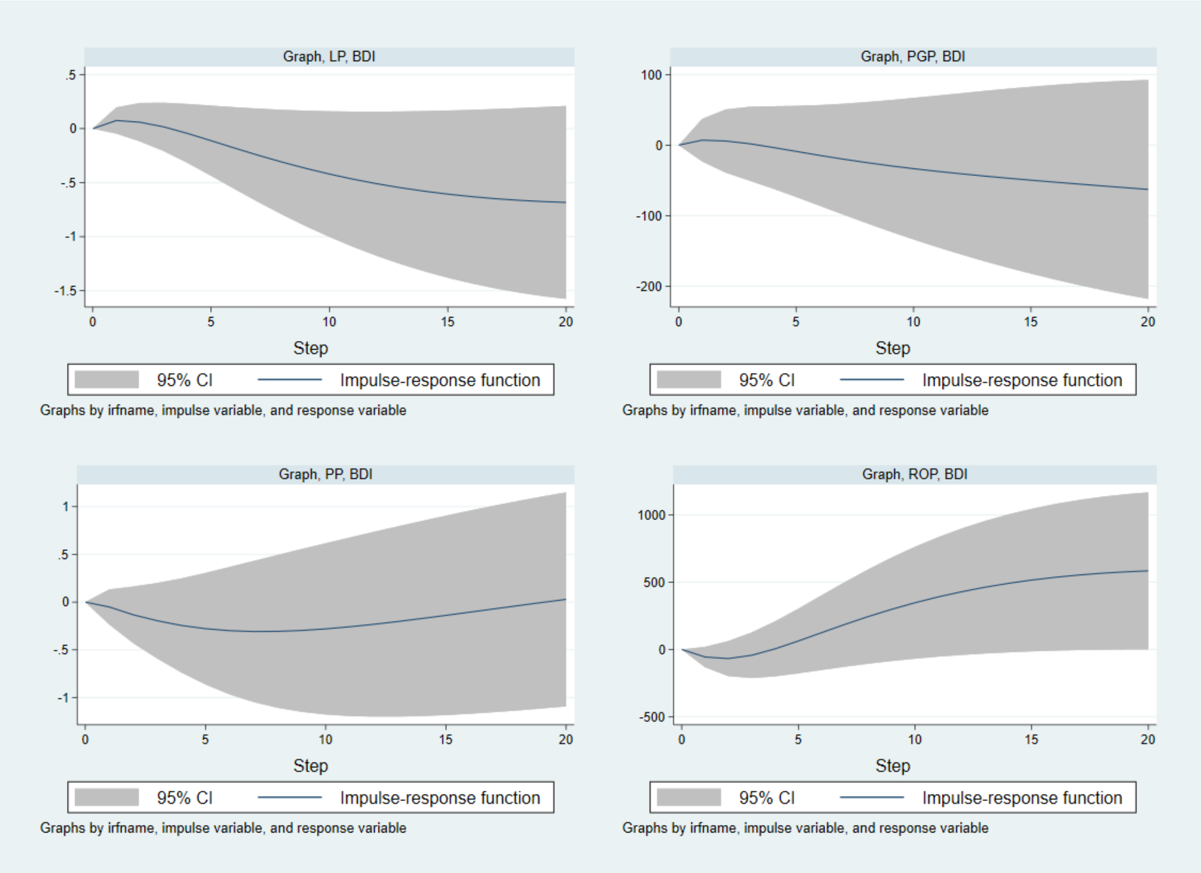
Note: This figure shows the response of the GEPUI to structural one standard deviation errors in seed oils, steel, titanium, and wheat.

Figure 49: *Impulse response functions with BDI as the response and aluminum, crude oil, and corn as impulses for the second SVAR model*



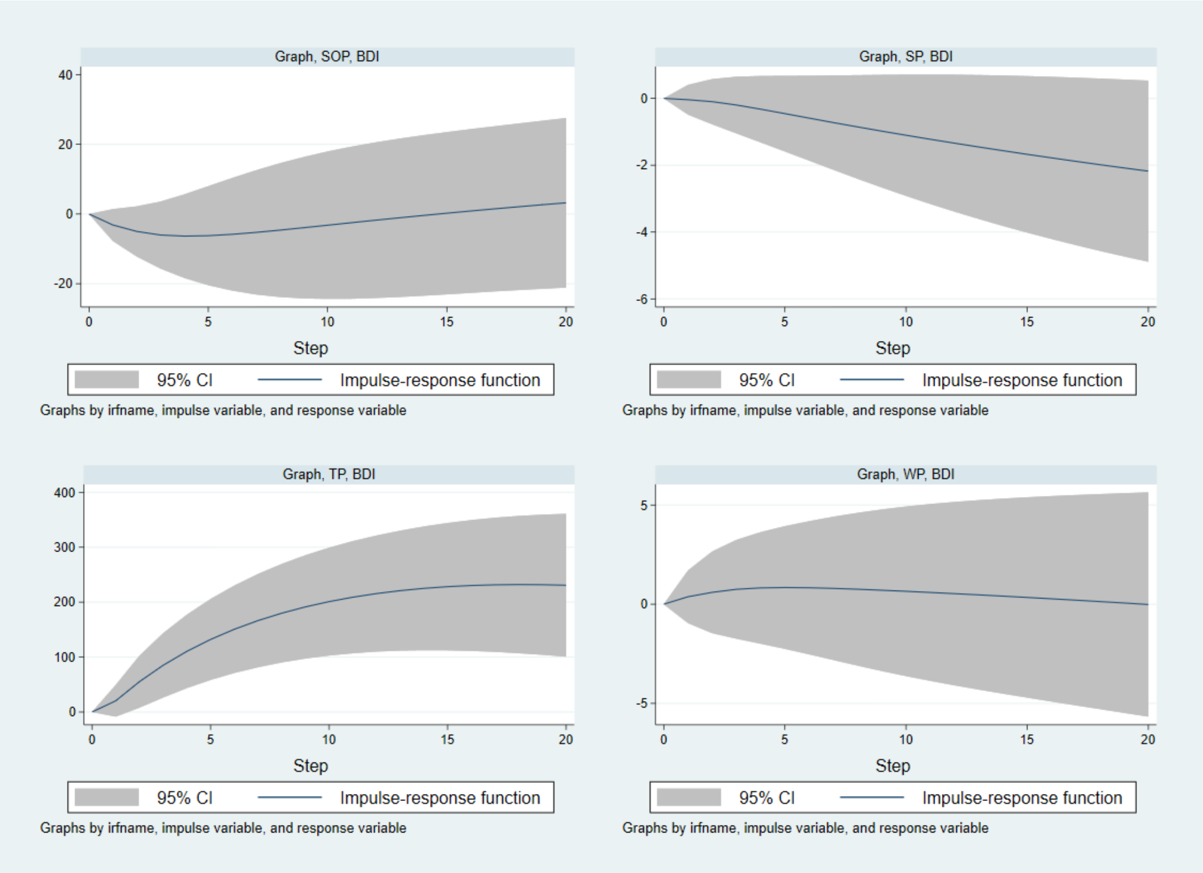
Note: This figure shows the response of the BDI to structural one standard deviation errors in aluminium, crude oil, and corn.

Figure 50: *Impulse response functions with BDI as the response and lead, petroleum gas, platinum, and refined oil as impulses for the second SVAR model*



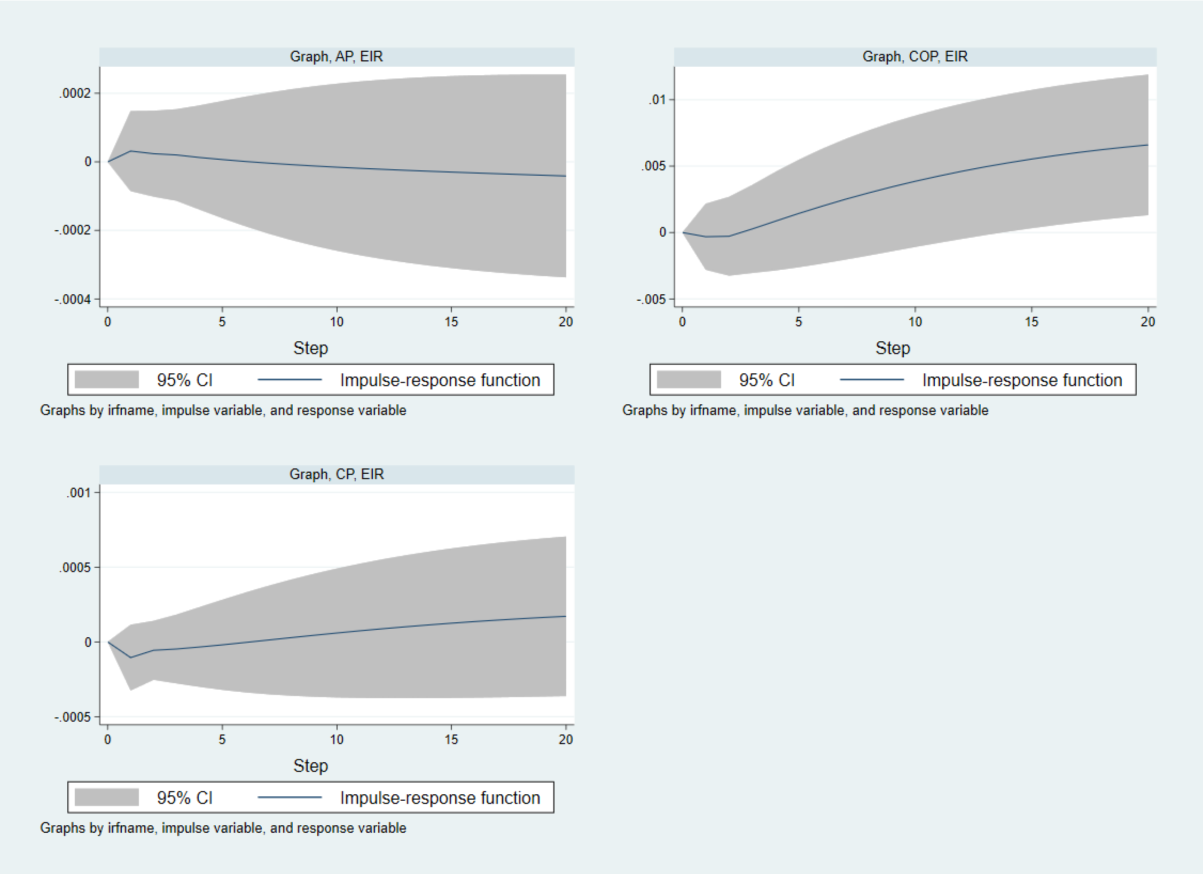
Note: This figure shows the response of the BDI to structural one standard deviation errors in lead, petroleum gas, platinum, and refined oil.

Figure 51: *Impulse response functions with BDI as the response and seed oils, steel, titanium, and wheat as impulses for the second SVAR model*



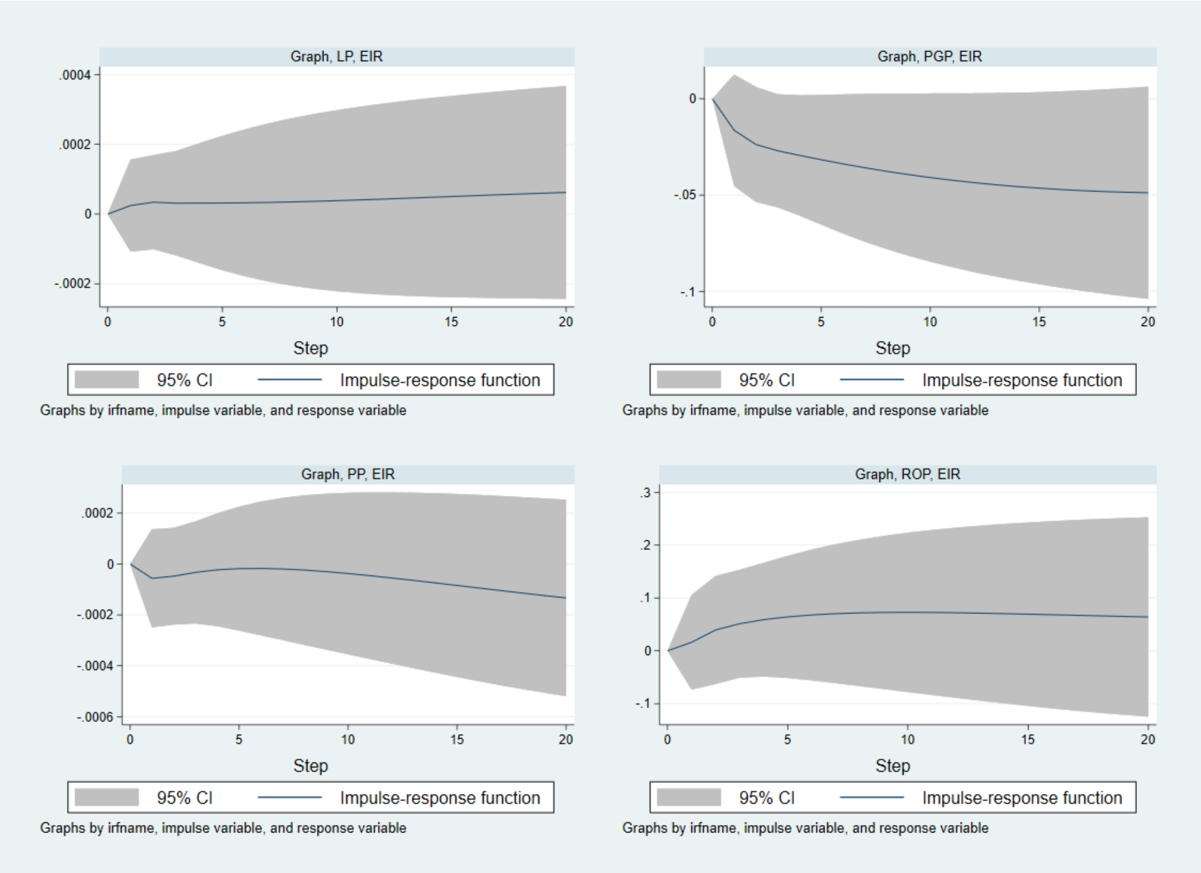
Note: This figure shows the response of the BDI to structural one standard deviation errors in seed oils, steel, titanium, and wheat.

Figure 52: *Impulse response functions with EIR as the response and aluminum, crude oil, and corn as impulses for the second SVAR model*



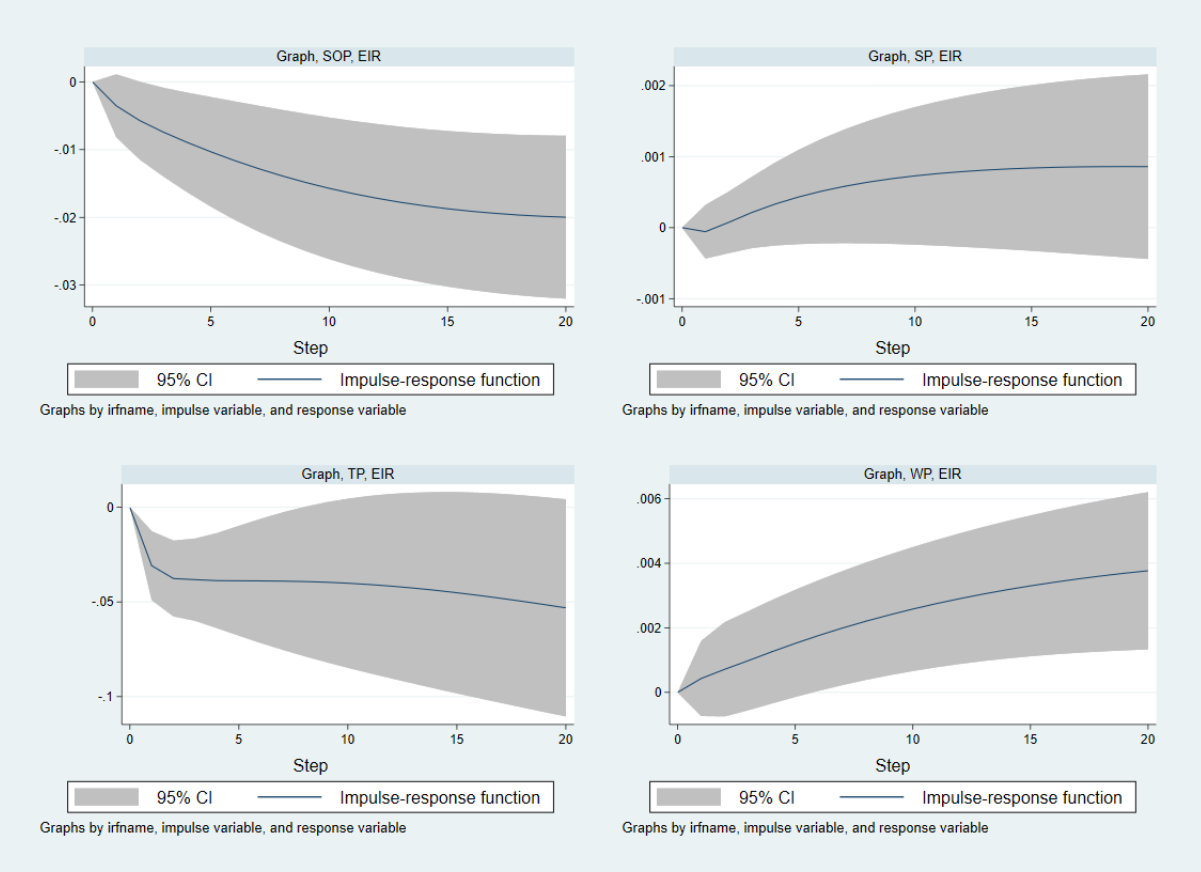
Note: This figure shows the response of the EIR to structural one standard deviation errors in aluminium, crude oil, and corn.

Figure 53: *Impulse response functions with EIR as the response and lead, petroleum gas, platinum, and refined oil as impulses for the second SVAR model*



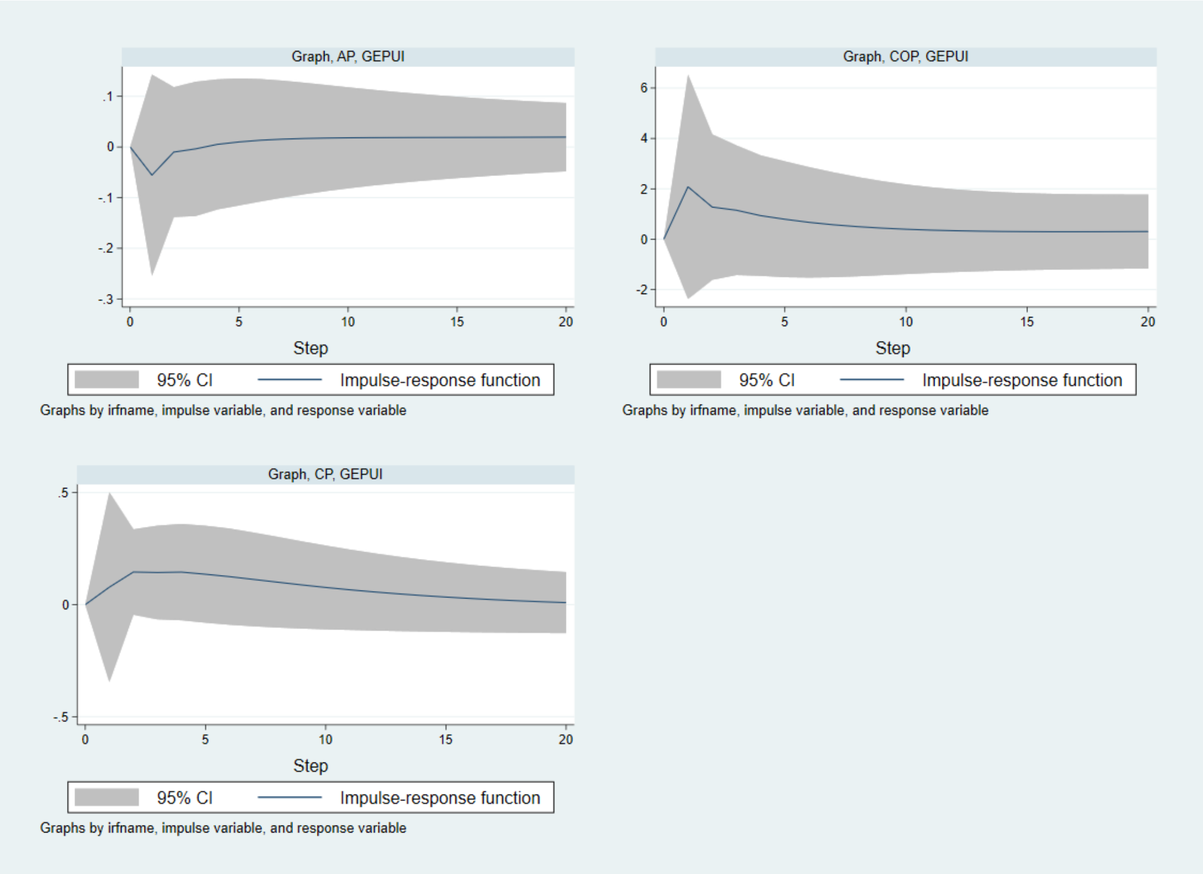
Note: This figure shows the response of the EIR to structural one standard deviation errors in lead, petroleum gas, platinum, and refined oil.

Figure 54: *Impulse response functions with BDI as the response and seed oils, steel, titanium, and wheat as impulses for the second SVAR model*



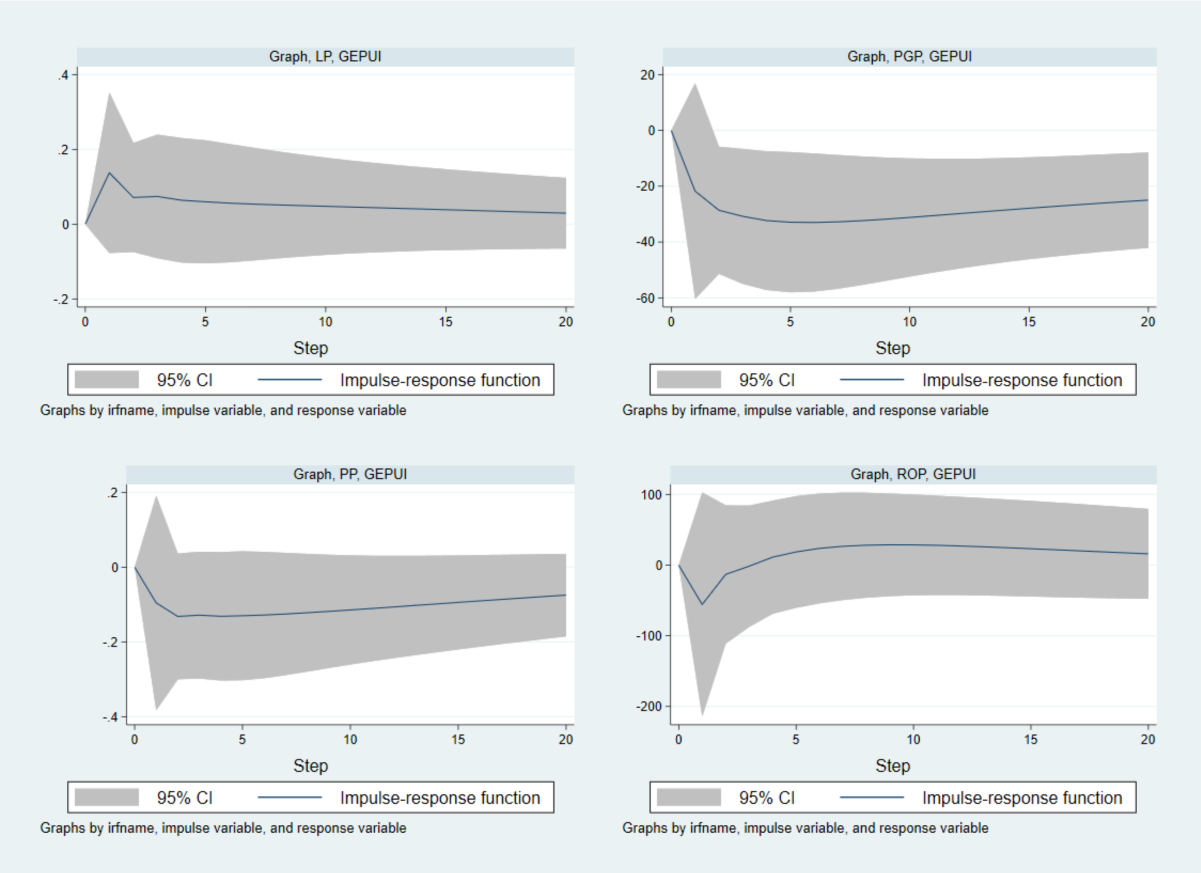
Note: This figure shows the response of the EIR to structural one standard deviation errors in seed oils, steel, titanium, and wheat.

Figure 55: *Impulse response functions with GEPUI as the response and aluminum, crude oil, and corn as impulses for the second SVAR model*



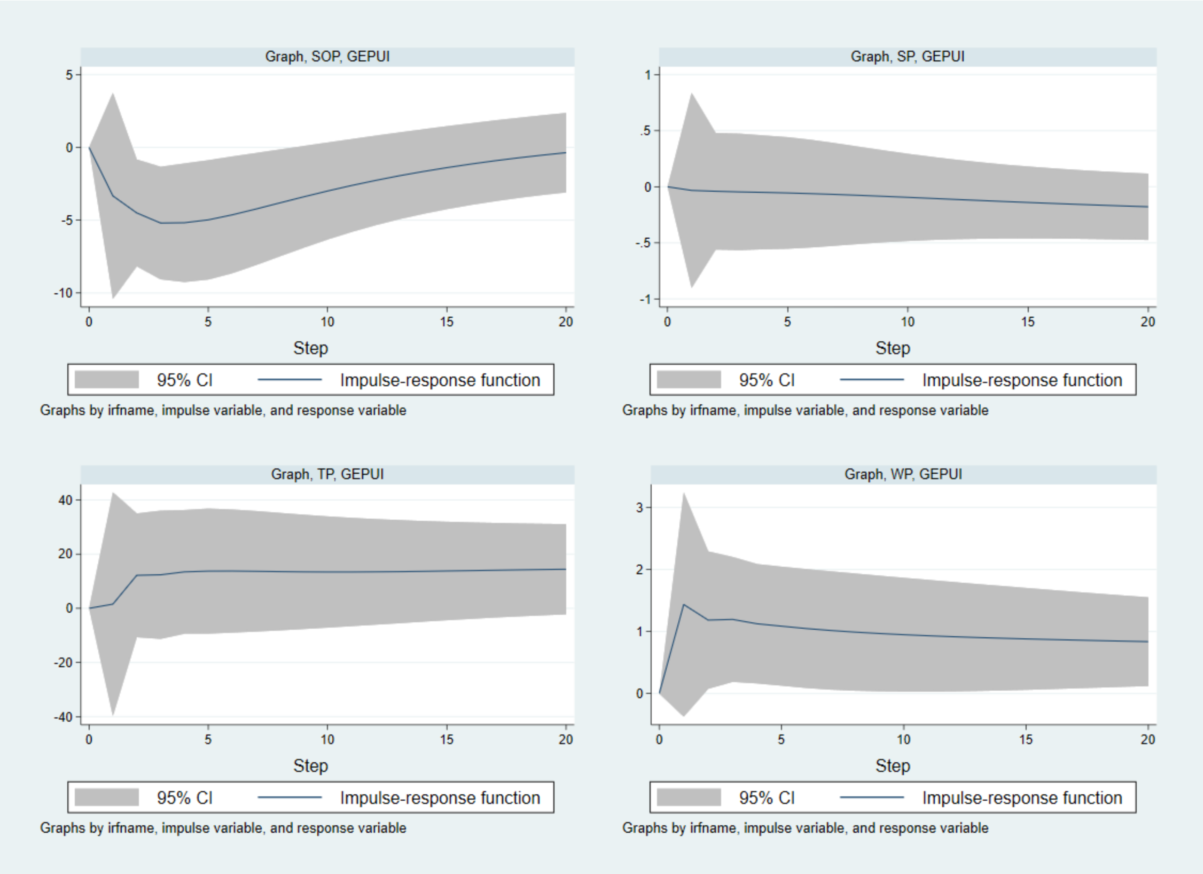
Note: This figure shows the response of the GEPUI to structural one standard deviation errors in aluminium, crude oil, and corn.

Figure 56: *Impulse response functions with GEPUI as the response and lead, petroleum gas, platinum, and refined oil as impulses for the second SVAR model*



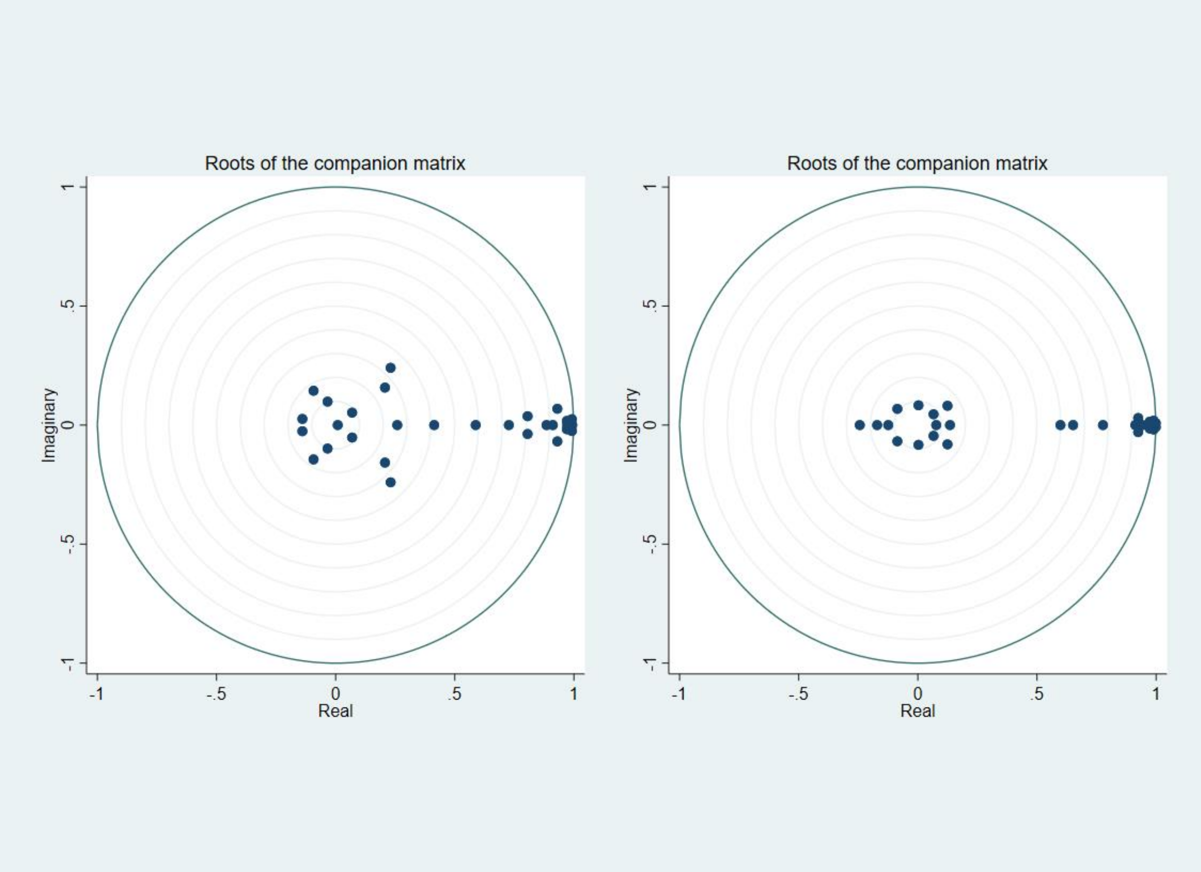
Note: This figure shows the response of the GEPUI to structural one standard deviation errors in lead, petroleum gas, platinum, and refined oil.

Figure 57: *Impulse response functions with GEPUI as the response and seed oils, steel, titanium, and wheat as impulses for the second SVAR model*



Note: This figure shows the response of the GEPUI to structural one standard deviation errors in seed oils, steel, titanium, and wheat.

Figure 58: *Test of the two SVAR models for the stability condition*



Note: This figure shows the plot of the eigenvalues calculated during the test for the stability condition of the two SVAR models. All eigenvalues are within the circles implying a satisfied stability condition. The graph on the left shows the results for the first model (2020 to 2022). And the graph on the right shows the results for the second model (2013 to 2015).

A6. Equations

Equation 1: *Interpolation Formula*

$$y = \frac{y_1 - y_0}{x_1 - x_0}(x - x_0) + y_0$$

Note: This formula is used to linearly interpolate or extrapolate values in time-series. It is used in this research to fill in the gaps in the time-series of the commodity prices. y *represents the researched value,* x *is the time at which* y *occurred.* (x_0, y_0) *are the coordinates of the observation at the right (smaller) of the researched point.* (x_1, y_1) *are the coordinates of the observation at the left (larger) of the researched point.*

Equation 2: *Commodity prices linear regression*

$$Commodity = \beta_1 \times BDI + \beta_2 \times Inflation + \varepsilon$$

Note: This equation represents the twelve simple linear regressions used in the first part of our research. Where $Commodity$ *is the price of a commodity (corn, wheat, fertilizers, seed oils, crude oil, refined oil, petroleum gas, aluminum, steel, titanium, platinum, lead ore); BDI is the Baltic Dry Index;* $Inflation$ *is the expected inflation rate;* β_i *with* $i = 1{,}2$ *are the regression coefficient; and* ε *is the error term.*

Equation 3: *The Eicker-Huber-White heteroskedasticity consistent estimator*

$$V(\hat{\beta}) = \alpha(X^T X)^{-1}(\sum_{j=1}^{n} \hat{\varepsilon}_j^2 x_j^T x_j)(X^T X)^{-1}$$

Note: This formula displays the calculation of heteroskedasticity consistent estimator to obtain robust standard errors. $V(\hat{\beta})$ *is the so-called heteroskedasticity consistent estimator;* X *an* $n \times k$ *matrix of covariates;* X^T *the transposed matrix;* $(X^T X)^{-1}$ *a constant matrix;* $\sum_{j=1}^{n} \hat{\varepsilon}_j^2 x_j^T x_j$ *is the estimated variance of* $X^T y$ *with* y *the dependent variable;* $\alpha = \frac{n}{(n-k)}$ *is the default bias correction.*

Equation 4: *The Wald statistic*

$$W = (R\hat{\beta} - r)^T (RVR^T)^{-1}(R\hat{\beta} - r)$$

Note: This equation shows the calculation of the Wald test statistic used in this paper to estimate regression coefficient stability. Where: the estimated n *regression coefficients tested are the* $n \times 1$ *vector* $\hat{\beta}$*; the estimated variance-covariance matrix is* V*;* R *is the* $Q \times n$ *matrix where* Q *is the number of hypotheses to be tested jointly; the* T *annotation refers to a transposed matrix.*

Equation 5: *The likelihood-ratio test*

$$LR = -2(L_1 - L_0)$$

Note: This formula shows the calculation of the likelihood-ratio test statistic used in this paper to estimate regression coefficient stability. Where: L_0 *and* L_1 *be log-likelihood values of the full and constrained regression respectively.*

Equation 6: *The cumulative sum test*

$$C_t = \frac{1}{\hat{\sigma}} \sum_{j=k+1}^{j=t} e_j$$

$$\hat{\sigma}^2 = \frac{1}{T-k} \sum_{t=k+1}^{t=T} (e_t - \overline{e_t})^2$$

$$e_t = \frac{y_t - x_t^T \hat{\beta}_{t-1}}{\sqrt{1 + x_t^T (X_{t-1}^T X_{t-1}) x_t}}$$

Note: The first formula represents the cumulative sum statistic used in this paper to estimate regression coefficient stability. The second formula is the estimated volatility. And the last formula shows the calculation of the recursive residuals. With: C_t is the cumulative sum statistic; e_t the recursive residuals; t is the time dimension which ends at time $t = T$; y_t the dependent variable; x_t a $1 \times k$ matrix of covariates; β_t is a matrix of the regression coefficients and $\widehat{\beta_t}$ is the matrix of the estimated regression coefficients; X_t is a $1 \times t$ matrix of the covariate matrixes x_t; $\hat{\sigma}^2$ is the estimated volatility of the hypothesized normally distributed recursive residuals e_t.

Equation 7: *Two-sample t-test*

$$t = \frac{\bar{x} - \bar{y}}{s_p \sqrt{\frac{1}{n_x} + \frac{1}{n_y}}}$$

$$s_p^2 = \frac{(n_x - 1)s_x^2 + (n_y - 1)s_y^2}{n_x + n_y - 2}$$

Note: The first formula is the two sample t-test statistic which we use in this paper to answer the third hypothesis. With: t is the t statistic; $\bar{x}$ and $\bar{y}$ are the mean of the first sample and second sample respectively; n_x and n_y are the number of observations in the first sample and second sample respectively; s_x and s_y are the variance of the first sample and second sample respectively; s_p is the pooled variance.

Equation 8: *Underlying VAR(p) model*

$$\begin{bmatrix} y_{1,t} \\ \vdots \\ y_{15,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ \vdots \\ c_{15} \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} a_{1,1}^i & \cdots & a_{1,15}^i \\ \vdots & \ddots & \vdots \\ a_{15,1}^i & \cdots & a_{15,15}^i \end{bmatrix} \begin{bmatrix} y_{1,t-i} \\ \vdots \\ y_{15,t-i} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ \vdots \\ e_{15,t} \end{bmatrix}$$

Note: This equation represents the underlying $VAR(p)$ model, with p the number of lags, used in the second part of our investigation. With: $\begin{bmatrix} y_{1,t} \\ \vdots \\ y_{15,t} \end{bmatrix}$ the 15 endogenous variables of our model (Baltic Dry Index, Economic Policy Uncertainty Index, Expected Inflation Rate, and the futures prices of: Corn, Wheat, Fertilizers, Seed Oils, Crude Oil, Refined Oil, Petroleum Gas, Aluminum, Steel, Titanium, Platinum, Lead Ore); $\begin{bmatrix} c_1 \\ \vdots \\ c_{15} \end{bmatrix}$ the constant term of each of the 15 regressions; $\begin{bmatrix} a_{1,1}^i & \cdots & a_{1,15}^i \\ \vdots & \ddots & \vdots \\ a_{15,1}^i & \cdots & a_{15,15}^i \end{bmatrix}$ the coefficients of each term in each regression; $\begin{bmatrix} y_{1,t-i} \\ \vdots \\ y_{15,t-i} \end{bmatrix}$ the lagged values of each variables; $\begin{bmatrix} e_{1,t} \\ \vdots \\ e_{15,t} \end{bmatrix}$ the error terms of each regression.

Equation 9: *Structural vector autoregressive model with no exogenous variables*

$$A\left(I_K - A_1L - A_2L^2 - \cdots - A_pL^p\right)y_t = A\epsilon_t = Be_t$$

Note: This formula is the formal expression of a structural vector autoregressive model with short run restrictions, used on our research to answer the fourth, fifth, and sixth hypotheses. With: L the lag operator; A, B and $A_1, \cdots, A_p$ are $K \times K$ restriction matrices; ϵ_t is a $K \times 1$ matrix of the residuals of the standard VAR model; e_t is a $K \times 1$ matrix of the residuals of the structural VAR model; K is the number of endogenous variables used in the model; y_t is a $K \times 1$ matrix of the endogenous variables.

A7. Interpolation and Extrapolation of Missing Values[6]

As mentioned in the Data section 4, we use linear interpolation and extrapolation techniques in order to fill in the gaps in our time-series. The following method is applied: let y be the researched value, x be the date at which this value occurred. We find y by looking at the closest points (x_0, y_0) and (x_1, y_1), with $x_0 < x < x_1$ and with y_0, y_1 known values. Then we calculate y with the following equation :

$$y = \frac{y_1 - y_0}{x_1 - x_0}(x - x_0) + y_0$$

This explains the methodology for interpolation. We use what is called extrapolation when there are no observed values on one side of x, thus if either $y_0$or $y_1$is unknown. In this case we select two points on the same side of x, for example $((x_{-1}, y_{-1}), (x_0, y_0))$ or $((x_1, y_1), (x_2, y_2))$, and use the same formula. Thus:

$$y = \frac{y_0 - y_{-1}}{x_0 - x_{-1}}(x - x_{-1}) + y_{_{-1}} \; or \; y = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1) + y_{_1}$$

For this research we use interpolation for each commodities. For the steel prices, we do not use interpolation to fill in the missing values between 2017 and 2021. We use extrapolation otherwise on all commodity prices to determine the first and last eventual missing values. However, we do not extrapolate the values of fertilizers before 2018, nor the values of titanium before 2012. The precise results of these interpolation and extrapolation are displayed in Table 5 in Appendix A4.

We proceed likewise concerning the economic variables, namely the economic activity, uncertainty, and inflation. For Global Economic Policy Uncertainty, there are no gaps in the time series, rendering the interpolation unnecessary. For the Baltic Dry index, we do not have data earlier than 2012, therefore the extrapolation will not be used to fill the gap until 2010. Lastly, the inflation time-series has data from 2010 to 2022 and does not present large gaps. The precise results of these interpolation and extrapolation are displayed in Table 9 in Appendix A4.

[6] We describe this technique based on the literature of the STATA statistical software (STATA, 2022). We also refer to academic articles about interpolation methods (Meijering, 2002).

A8. Wald and Likelihood-Ratio Tests for Regression Coefficients Stability[7]

As explained in the Methods section 3, we test the hypothesis of structural breaks in our times series regression using Wald and likelihood-ratio tests. Concerning the Wald tests, the following method is applied: the estimated n regression coefficients tested are the $n \times 1$ vector $\hat{\beta}$; the estimated variance-covariance matrix is V; R is the $Q \times n$ matrix where Q is the number of hypotheses to be tested jointly; the null hypothesis is $H_0: R\beta = r$ and the alternative hypothesis is $H_1: R\beta \neq r$ where β is the set of hypothesized regression coefficients; the T annotation refers to a transposed matrix. Then the Wald test statistic is:

$$W = (R\hat{\beta} - r)^T (RVR^T)^{-1} (R\hat{\beta} - r)$$

The test follows a χ^2 distribution with Q degrees of freedom.

With regard to the likelihood-ratio test: let L_0 and L_1 be log-likelihood values of the full and constrained regression respectively. Then the likelihood-ratio test is:

$$LR = -2(L_1 - L_0)$$

The null hypothesis is that the unconstrained model is correct, whereas the alternative hypothesis is that the constrained regression is correct, in which case the test follows a χ^2 distribution with $d_0 - d_1$ degrees of freedom where d_0 and d_1 are the degrees of freedom of the full and constrained regressions respectively.

[7] We describe this technique based on the literature of the STATA statistical software (STATA, 2022) (STATA, 2022). We also refer to the associated academic articles (Beale, 1960) (Canette, 2022) (Clarke, Romano, & Wolf, 2020) (Dietz & Kalof, 2009) (Gourieroux & Monfort, 1995) (Holm, 1979) (Griffiths, Judge, Hill, Lütkepohl, & Lee, 1985) (Korn & Graubard, 1990) (Mehmetoglu & Jakobsen, 2022) (Ye & Sun, 2018) (Greene, 2003) (Gutierrez, Carter, & Drukker, 2001) (Hosmer, Lemeshow, & Sturdivant, 2013).

A9. Cumulative Sum Test for Parameter Stability[8]

As explained in the Methods section 3, we use the cumulative sum test to verify the results obtained concerning the first two hypotheses of this research. The cumulative sum (CUSUM) test is a statistical tool which we use to determine whether the regression coefficients of our time-series. The CUSUM used in this paper is based on recursive residuals and is built using one-step ahead standardized forecast error as follows:

$$e_t = \frac{y_t - x_t^T \hat{\beta}_{t-1}}{\sqrt{1 + x_t^T (X_{t-1}^T X_{t-1}) x_t}}$$

With: e_t the recursive residuals; t is the time dimension which ends at time $t = T$; y_t the dependent variable; x_t a $1 \times k$ matrix of covariates; β_t is a matrix of the regression coefficients and $\widehat{\beta_t}$ is the matrix of the estimated regression coefficients; X_t is a $1 \times t$ matrix of the covariate matrixes x_t. The null hypothesis states that the coefficients β_t are constant. The CUSUM test statistic is then:

$$C_t = \frac{1}{\hat{\sigma}} \sum_{j=k+1}^{j=t} e_j$$

With:

$$\hat{\sigma}^2 = \frac{1}{T-k} \sum_{t=k+1}^{t=T} (e_t - \overline{e_t})^2$$

Where $\hat{\sigma}^2$ is the estimated volatility of the hypothesized normally distributed recursive residuals e_t.

[8] We describe this technique based on the literature of the STATA statistical software (STATA, 2022). We also refer to the associated academic articles (Brown, Durbin, & Evans, 1975) (Enders, 2004) (Ploberger & Krämer, 1992).