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External Shocks and Economic Fragility: Insights from Germany's Macroeconomic Response

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Abstract: The global economy is vulnerable to external shocks and it increases regularly. This study investigates the macroeconomic effects of exogenous Brent crude oil prices, World Uncertainty Index (WUI), inflation, interest rates, and GDP in Germany. The study is analyzed within the framework of the SVAR model using monthly data for the period 2000:Q1-2023:11, and empirical findings are informed by variance decomposition. According to the variance decomposition results, the most effective shocks in interest rate were the oil shock by 10.25%, the World uncertainty index shock by 5.58%, the inflation shock by 4.55% and finally the GDP shock by 0.45%. The most effective shocks to inflation were 30.13% from the oil shock, 4.64% from the interest rate shock, 1.22% from the GDP shock and finally 0.51% from the World uncertainty index shock and the most effective shocks to GDP were 17.42% from the oil shock, 2.71% from the inflation shock, 2.43% from the World uncertainty index shock and finally 1.63% from the interest rate shock. These results show the significant vulnerability of the German economy to external shocks. This paper highlights the importance of proactive policy responses to mitigate economic fragility.

Keywords: Germany; External shocks; SVAR; Economic fragility

JEL Classification: E60; F40; C32; E65

1. Introduction

Open economies are affected by exogenous shocks with different severity and in different ways regardless of their level of development. In particular, developing countries with high macroeconomic vulnerability are heavily affected by changes in commodity prices and interest rate policies in developed countries, which are able to shape the world economy. This situation has become more obvious due to several factors such as fluctuations in energy prices, geopolitical uncertainties, interest rate changes, global inflation pressures, and etc. In December 2019, the Covid-19 outbreak began in China and a few months later, the World Health Organization (WHO) declared March 11, 2020 as the global pandemic year (WHO, 2020). The Covid-19 pandemic has caused millions of people to lose their lives and has not only put a burden on health expenditures, but has also shaken almost the entire industry, causing uncertainty in the markets. About two years after the Covid-19 outbreak, when the pandemic restrictions

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were lifted and lives started to return to normal and most countries were under severe financial impacts, a new shock was added with the outbreak of the Russian-Ukrainian War on February 24, 2022 (Liadze et al., 2023).

Advanced economies are highly dependent on energy imports and these economies are more vulnerable to exogenous shocks rather than other shocks. In this study, Brent oil prices, the World Uncertainty Index (WUI), inflation, interest rates and Gross Domestic Product variables are analyzed within the framework of the structural vector autoregression (SVAR) model with monthly data from 2000:1-2023:11. The results show that sustainable energy investments and more robust policies should be implemented to make the macroeconomic structure more resilient, and sustainable energy investments should be implemented to have important implications for policymakers by revealing the effects on the structural fragility of the German economy. According to the results obtained in the study, oil price shocks and global uncertainty shocks have a significant impact on interest rate, inflation, and GDP in the German economy. Moreover, the findings analyzed is not only be limited to the development of policy recommendations for the German economy, but also serve as a guide for other countries to implement more resilient monetary and fiscal policies in the face of exogenous shocks.

Research Questions:

- *How do changes in oil prices and global uncertainty differently affect Germany's economic stability, and what steps could be taken to reduce these risks?*
- *How Germany's monetary and fiscal policies may work together to reduce the negative effects of oil price changes and global uncertainty on inflation and economic growth?*
- *How do long-term strategies like energy diversification and investment in renewables assist Germany become less vulnerable to external shocks in the future?*

Our goal is to simply identify the shocks that influence Germany's economy with these research questions. Our findings showed that oil price shocks and global uncertainty play a major role, however the policy side and long-term structural solutions remain less explored. By these questions, we address this gap. We investigate not only the immediate effects of shocks but also how coordinated policies and structural changes could improve resilience. This approach allows us to connect the empirical results with practical strategies that can help strengthen Germany's economic stability in the face of future external shocks.

The following sections of the paper are organized as follows. Section 2 reviews the existing literature on external shocks and their macroeconomic impacts. Section 3 expresses the methodology and defined data with a particular focus on the SVAR framework. In section 4, we emphasize and discuss the empirical results, while Section 5 concludes by highlighting key findings, policy implications, and directions for future research.

2. Literature Review

The impact of the external shocks on the macroeconomic aspect has been widely investigated in the literature, which considers different variables, methodologies, and country-specific analyses. Several scientific papers have examined the influence of oil price fluctuations, inflation shocks, and interest rate changes on financial markets and economic growth. This part of the paper reviews key previous studies,

dives into their datasets, variables, research questions, and findings to provide a comprehensive understanding of external shocks' effects on macroeconomic performance.

Rodríguez et al., (2023) analyzed the exogenous shocks in Chile, Colombia, Mexico and Peru with the VAR method for the period 1994Q1-2019Q4. They found that FED interest rate shocks significantly affected GDP in the countries they analyzed between 2002 and 2011, mostly in Mexico due to trade proximity, and that the countries showed resistance to commodity shocks by implementing the correct monetary policy. Schmitt-Grohé and Uribe (2018), using SVAR method with annual data for 38 countries for the period 1980-2011, found that exogenous shocks affect 10% of the changes in trade. Raduzzi and Ribba (2020) analyzed the economies of several countries in the European region using SVAR method with annual data for the period 1999-2015 and found that oil price shocks caused economic stagnation in the related countries. Angelini et al. (2016), using the New Multi-Country Model (NMCM), find that an aggregate demand shock in Germany from 2012Q3 to 2018Q4 was not enough to lead to a recovery in economic activity and to eliminate external imbalances in the rest of the Eurozone.

Sadorsky (1999, p. 456) investigated the relationship between oil price shocks and stock market activity using data from the United States. The study applied oil prices, stock returns, and interest rates as core features to understand how energy market volatility influence financial markets. The research question aims to determine how oil price volatility contributes to inflationary pressures and economic slowdowns. The results expressed that oil price increases lead to higher inflation and lower GDP growth, while the effects being stronger in the short term (Smyth & Narayan, 2018). Bodenstein has also been investigated the role of oil price shocks in shaping inflation and monetary policy responses in advanced economies. The research addressed how central banks respond to inflationary pressures triggered by oil price movements and the findings highlighted that central banks often fullfil restrictive monetary policies in response to rising oil prices, which increases interest rates to control inflationary effects (Bodenstein, Guerrieri & Kilian, 2012). Menna and Tobal studied the impact of financial crises and interest rate shocks on macroeconomic stability in emerging and advanced economies and the study utilized interest rate data, capital flows, and GDP growth rates as key variables. The primary research question examined how sudden changes in interest rates influence economic stability and financial markets. The findings suggested that interest rate shocks lead to capital flight, increased financial volatility, and economic contractions, particularly in economies with weaker financial institutions (Menna & Tobal, 2018).

In addition, the broader effects of macroeconomic shocks explored by Afonso and Sousa, including fiscal and monetary policy shifts, are explored by Afonso and Sousa on long-term economic growth. Exchange rate effects are checked in developed economies, including Germany, by utilizing trade balance, inflation, and currency exchange rate data. The study aimed to understand how exchange rate fluctuations influence import prices and inflation level, and whether currency depreciation leads to higher consumer prices. The findings indicated that exchange rate movements significantly affect inflation, particularly in highly open economies, where imported goods constitute a large share of consumption (Aron, Macdonald & Muellbauer, 2014).

The unconventional monetary policy measures and their impact on liquidity are analyzed in terms of credit risk and macroeconomic stability in the Eurozone. One of the previous studies used data on central bank policies, bond yields, and credit spreads, and used the research question centered on how unconventional monetary interventions, such as quantitative easing, influence financial market conditions. The results identified that such policies effectively stabilize liquidity conditions and decrease credit risk; however, they might also cause distortions in financial markets over the long term (Peersman, 2011).

A review of the literature reveals that exogenous shocks have been analyzed in various country groups and that the countries included in the analysis have been adversely affected, even though their impact levels are different.

3. Methodology and Empirical Results

Table 1. Variance Decomposition of Brent Oil Prices

Variables	Variables Definition	Source
Brent Crude Oil	Brent Crude Oil (Nominal $)	Fred
WUI	World Uncertainty Index	Fred
GDP	Gross Domestic Product (Real, Seasonally Adjusted,$)	Destatis
Inflation	Inflation Rate (Annual Percentage Change, %)	Destatis
Interest Rate	German Central Bank Interest Policy Interest Rate (Annual %, Nominal)	Destatis

Source: Own Elaboration

In Table 1, we see the variables and their sources, respectively. The Brent crude oil price and the World Uncertainty Index (WUI) data are from the Federal Reserve Economic Data (FRED), while inflation, interest rates, and Gross Domestic Product (GDP) are from the German Federal Statistical Office (Destatis).

The same pre-tests applied in the VAR model also apply to the SVAR model. In order for the variables in our model to give accurate results, pre-tests such as stationary testing and determining the optimal lag length are important. At this stage, since our variables are not stationary at their level values, they are stationary at level 1 by taking their differences. At the same time, the lag length with the most stars (lag 1) in the Akaike Information Criterion (AIC) and Final Prediction Error (FPE) criteria was chosen (Enders, 2008). To ensure that our analysis does not contain the autocorrelation problem and provides reliable results, modulus values are less than 1, and AR unit root tests are applied, which show that our approach is reliable by determining that they are all within the circle.

In SVAR analysis, the order of the variables is important for the correct interpretation of the results (Sims, 1986). Therefore, the order of influence of variables (Brent crude oil prices, World Uncertainty Index (WUI), interest rate, inflation rate, and GDP) is analyzed in accordance with economic theory.

Table 2. Variance Decomposition of Brent Oil Prices

Number of Periods	Brent Crude Oil	Wui	Interest Rate	Inflation	GDP
1	100.0000	0.000000	0.000000	0.000000	0.000000
2	96.97976	0.613893	0.797931	1.579676	0.028738
3	95.72933	0.605863	1.087895	2.501340	0.075570
4	95.31013	0.617045	1.150391	2.826216	0.096215
5	95.19353	0.616563	1.169845	2.914784	0.105283
6	95.16225	0.617037	1.174394	2.938612	0.107705
7	95.15448	0.617022	1.175615	2.944482	0.108403
8	95.15257	0.617040	1.175890	2.945933	0.108570
9	95.15211	0.61740	1.175959	2.946276	0.108613
10	95.15200	0.617041	1.175975	2.946358	0.108623

Source: Own Elaboration

Table 2 shows that the Brent crude oil price shock is 100% affected by its own shock at the end of period 1, while it is not affected by other shocks at all. At the end of 10 periods, the most affected shocks were 95.15% from its own shock, 2.94% from the inflation shock, 1.17% from the interest rate shock, 0.61% from the World uncertainty index shock, and finally 0.10% from the GDP shock.

Table 3. Wui Variance Decomposition

Number of Periods	Brent Crude Oil	Wui	Interest Rate	Inflation	GDP
1	0.240448	99.75955	0.000000	0.000000	0.000000
2	1.502422	97.68534	0.408181	0.262226	0.141828
3	1.505466	97.49227	0.543811	0.262101	0.196357
4	1.501417	97.46121	0.542649	0.297745	0.196982
5	1.500941	97.45121	0.547660	0.300896	0.199291
6	1.500852	97.44906	0.547630	0.303183	0.199278
7	1.500862	97.44843	0.547843	0.303474	0.199393
8	1.500865	97.44829	0.547847	0.303600	0.199395
9	1.500867	97.44826	0.547856	0.303620	0.199401
10	1.500867	97.44825	0.547856	0.303627	0.199401

Source: Own Elaboration

Table 3 displays that the World uncertainty index (Wui) shocks are 99.75% affected by its own shock and 0.24% affected by the oil shock at the end of period 1, while it is not affected by other shocks at all. At the end of 10 periods, the most affected shocks were 97.44% from its own shock, 1.50% from the oil shock, 0.54% from the interest rate shock, 0.30% from the inflation shock, and finally 0.19% from the GDP shock.

Table 4. Interest rate Variance Decomposition

Number of Periods	Brent Crude Oil	Wui	Interest Rate	Inflation	GDP
1	6.256557	6.161156	87.58229	0.000000	0.000000
2	10.35769	5.595623	79.58089	3.772789	0.423008
3	10.28541	5.588961	79.32837	4.359300	0.437956
4	10.26020	5.590280	79.19089	4.502643	0.451177
5	10.25929	5.587131	79.15635	4.540398	0.455921
6	10.25913	5.586722	79.14625	4.550802	0.456934
7	10.25909	5.586515	79.14383	4.553290	0.457237
8	10.25909	5.586481	79.14322	4.553905	0.457306
9	13.06358	5.586470	79.14307	4.554048	0.457324
10	10.25908	5.586468	79.14304	4.554082	0.457328

Source: Own Elaboration

Table 4 portrays that interest rate shocks are affected by 87.58% of its own shock, 6.25% of oil shock, and 6.16% of World uncertainty index shock at the end of 1 period, while it is not affected by other shocks at all. At the end of 10 periods, the most affected shocks were 79.14% from its own shock, 10.25% from the oil shock, 5.58% from the World uncertainty index shock, 4.55% from the inflation shock, and finally 0.45% from the GDP shock.

Table 5. Inflation Rate Variance Decomposition

Number of Periods	Brent Crude Oil	Wui	Interest Rate	Inflation	GDP
1	34.77614	0.245356	3.489173	61.48933	0.000000
2	31.18238	0.363529	4.302137	63.20046	0.951495
3	30.35731	0.518198	4.535621	63.43741	1.151464
4	30.18432	0.514556	4.621356	63.47142	1.208348
5	30.14353	0.518868	4.635934	63.48257	1.219105
6	30.13434	0.518894	4.640159	63.48461	1.222194
7	30.13215	0.518847	4.640979	63.48518	1.222836
8	30.13166	0.518841	4.641247	63.48529	1.223005
9	30.13154	0.518847	4.641247	63.48532	1.223041
10	30.13152	0.518847	4.641259	63.48533	1.223050

Source: Own Elaboration

Table 5 displays that at the end of period 1, inflation shocks are affected by 61% by own shock, 34.77% by oil shock, 0.24% by World uncertainty index shock, 3.48% by interest rate shock, but not by GDP shock. At the end of the 10-period, the most affected shocks were 63.48% from own shock, 30.13% from oil shock, 4.64% from interest rate shock, 1.22% from GDP shock, and finally 0.51% from World uncertainty index shock.

Table 6. GDP Variance Decomposition

Number of Periods	Brent Crude Oil	Wui	Interest Rate	Inflation	GDP
1	3.387287	1.383509	1.654839	0.077386	93.49698
2	16.02583	2.353990	1.384807	1.058187	79.17719
3	17.53825	2.448499	1.497928	1.997254	76.51807
4	17.48432	2.431029	1.635837	2.465957	75.98285
5	17.44204	2.433507	1.671023	2.642560	75.81087
6	17.43087	2.431986	1.681743	2.692370	75.76303
7	17.42815	2.431895	1.684216	2.705867	75.74987
8	17.42755	2.431799	1.684880	2.709202	75.74657
9	17.42741	2.431787	1.685031	2.710028	75.74575
10	17.42738	2.431781	1.685069	2.710224	75.74555

Source: Own Elaboration

Finally, Table 6 shows that GDP shocks are 93.49% affected by its own shock, 3.38% affected by oil shock, 1.38% affected by World uncertainty index shock, 1.65% affected by interest rate shock, and 0.07% affected by inflation shock at the end of period 1. At the end of 10 periods, the most affected shocks were 75.74% from own shock, 17.42% from oil shock, 2.71% from inflation shock, 2.43% from World uncertainty index shock, and finally 1.63% from interest rate shock.

4. Conclusion

In this study, exogenous Brent crude oil prices, World Uncertainty Index (WUI), inflation, interest rates and GDP variables in Germany are analysed by Structural Vector Autoregression (SVAR) with monthly frequency for the period 2000:Q1-2023:11. According to the variance decomposition results, the most effective shocks on the interest rate were the oil shock with 10.25%, the World Uncertainty Index shock

with 5.58%, the inflation shock with 4.55% and the GDP shock with 0.45%. The oil shock had the strongest impact on inflation (30.13%), followed by the interest rate shock (4.64%), the GDP shock (1.22%), and the world uncertainty index shock (0.51%). In terms of GDP, the most significant shock was again the oil shock (17.42%), followed by the inflation shock (2.71%), the world uncertainty index shock (2.43%), and the interest rate shock (1.63%). Our findings reveal that Germany is highly energy dependent which is particularly influenced by oil price shocks, followed by world uncertainty shocks. These results reveal that Germany is significantly affected by oil price shocks as it is an energy-dependent economy. Furthermore, global uncertainty shocks have negative effects on both interest rates and GDP on Germany's economy. Overall, the findings suggest that the German economy is vulnerable to exogenous shocks.

In this study, Germany's economy is negatively affected by exogenous shocks, and the Central Bank of Germany should take measures against future exogenous shocks by implementing strengthening policies such as increasing the amount of reserves and investing in alternative energy sources that will reduce energy import dependence in the face of macroeconomic vulnerabilities. In addition, future researchers should examine economic risks more comprehensively with different samples, such as shocks from climate change.

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Appendix

Table 7. VAR Stability Test

Root	Modulus
0.480458	0.480458
-0.391280	0.391280
0.320096	0.320096
0.040466-0.145696i	0.151211
0.040466+0.145696i	0.151211

Source: Own Elaboration

Table 7 illustrates the root and modulus results from the Vector Autoregression (VAR) Stability Test. Stability is confirmed as all module are less than 1 and these results are supporting the main analysis's assumption of a stable VAR model which is discussed in Methodology section.

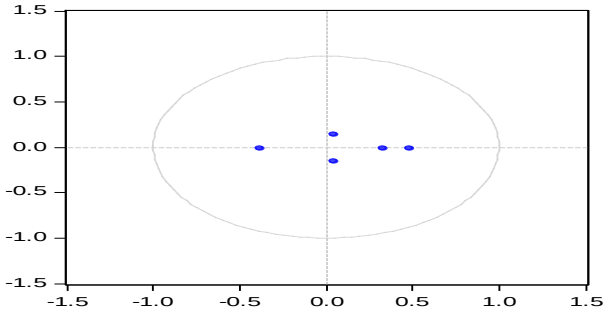

Figure 1. Inverse Roots of AR Characteristic Polynomial

The Figure 1 shows the inverse roots of the Autoregressive (AR) characteristic polynomial plotted within the unit circle. All roots are located inside the circle which display the AR model used in the analysis. This figure is explained in the Methodology section.