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The Macroeconomic Effects of Structural Oil Price Shocks: An International GVAR Analysis†

By SORA CHON*

This paper investigates the macroeconomic impacts of structural oil price shocks by employing a Global Vector Autoregression (GVAR) framework, utilizing the structural shocks as identified by Baumeister and Hamilton (2019). Our analysis differentiates among three types of oil shocks: economic activity shocks caused by fluctuations in global demand, oil supply shocks driven by production disruptions, and oil inventory demand shocks linked to shifts in market expectations about future supply-demand imbalances. Empirical findings indicate that the macroeconomic consequences of these shocks differ depending on their underlying sources and related structural characteristics.

In oil-importing countries such as Korea and China, oil supply disruptions and inventory-related shocks generally exert negative short-term effects on economic activity due to increased import costs and uncertainty-driven price volatility. Conversely, oil-exporting countries such as Canada and the United States respond differently, benefiting from increased export opportunities associated with higher oil prices. Overall, the study emphasizes the critical importance of distinguishing the structural causes of oil price fluctuations, highlighting how the indirect transmission of these shocks through international economic linkages significantly influences domestic macroeconomic performance outcomes. The results provide important implications for policymakers, underscoring the necessity of tailored policy responses to mitigate macroeconomic risks arising from energy transitions and geopolitical uncertainties.

Key words: Energy and commodity market, Global VAR (GVAR), Structural Oil Shock, Macroeconomic impact
JEL Code: Q41, Q43, E32

* Assistant Professor of Economics, Inha University (E-mail: sora28@inha.ac.kr)
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I. Introduction

Understanding the macroeconomic impacts of oil price fluctuations has long been an important research topic, given the central role of oil as a global energy source. Interest in this area has intensified recently due to heightened volatility and disruptions in global energy markets following the COVID-19 pandemic, ongoing geopolitical tensions, and shifts in international climate policies. Rising energy prices and global commitments toward carbon neutrality have further increased the relevance of oil price changes in relation to economic growth, inflation, employment, and overall financial stability.

Previous studies, notably Kilian (2009), have clearly demonstrated a strong link between oil prices and macroeconomic performance, highlighting significant implications across diverse economic contexts. Countries that are heavily reliant on imported energy resources, such as Korea, often described as an energy island, are especially vulnerable to global oil price fluctuations. In such economies, oil price volatility directly affects inflation, industrial production, employment, consumption, and financial stability, intensifying their sensitivity to certain developments in the international energy market.

Historically, economic analyses often treated oil price fluctuations as external, exogenous shocks. While this approach clarified short-term economic effects, it largely overlooked the underlying structural factors driving such price changes. This type of simplification could lead to incomplete interpretations and potentially ineffective policy recommendations, especially during periods of heightened uncertainty or complex global interactions.

More recent studies, particularly Baumeister and Hamilton (2019), emphasize the importance of explicitly identifying the structural factors behind oil price fluctuations. They distinguish clearly among economic activity (demand) shocks, oil supply shocks, and inventory shocks driven by market expectations. Inventory shocks, which involve market participants adjusting current inventories based on expected future supply-demand imbalances, significantly influence short-term price volatility. Clearly identifying these structural shocks enables policymakers to more accurately understand the economic implications of oil price movements, resulting in more effective policy responses.

Additionally, contemporary climate policies and carbon neutrality initiatives introduce further complexity into global oil markets. As countries transition toward low-carbon energy systems, expectations about future fossil fuel demand change substantially. Such expectations can influence current oil prices through inventory adjustments and investment decisions, underscoring the need for more structural analysis.

Building on the frameworks established by Kilian (2009) and Baumeister and Hamilton (2019), this study contributes to the existing literature by examining structural oil price shocks within an open economy context. While prior research extensively explored domestic impacts, it has rarely conducted detailed comparative analyses across both oil-importing and oil-exporting countries. To address this gap, we apply a global vector autoregression (GVAR) model, integrating international economic interdependence explicitly. We then analyze macroeconomic responses to

distinct structural oil shocks across selected major economies—Korea, China, Canada, and the United States.

Our empirical results indicate that macroeconomic responses differ significantly depending on the type of structural shock considered. Oil-importing economies such as Korea and China face adverse short-term effects from oil supply disruptions and inventory shocks due to increased import costs and market uncertainty. Conversely, oil-exporting economies such as Canada and the United States can benefit substantially from supply-driven oil price increases, as higher prices incentivize increased domestic production and exports (Cashin *et al*., 2014; Kilian, 2009. These differences underscore the limitations of treating oil shocks merely as short-term input-cost fluctuations and reinforce the importance of identifying their structural origins.

Overall, our study provides important insights for policymakers. A clear understanding of structural shocks is essential for effective macroeconomic management. Tailored policy measures that reflect the distinct characteristics of each type of shock can help mitigate economic risks, enhance resilience. Moreover, they respond effectively to ongoing geopolitical uncertainty, energy market volatility, and evolving climate policies.

The remainder of this paper is structured as follows. Section 2 thoroughly reviews relevant prior research, highlighting key findings, methodological advances, and identifying existing gaps. Section 3 details our empirical model and methodological approach, explicitly outlining the GVAR framework and the structural shocks identification strategy employed. Section 4 presents comprehensive empirical results, analyzing country-specific responses to distinct structural oil shocks. Finally, Section 5 summarizes the study's main findings, discusses significant policy implications, and offers suggestions for future research to deepen our understanding of oil price dynamics and their macroeconomic effects.

II. Literature Review

This section expands on the earlier discussions by reviewing previous studies of structural oil price shocks and their macroeconomic effects. Oil prices have been widely recognized as a crucial economic factor due to their significant influence on inflation, economic growth, employment, and overall financial stability. Owing to their broad impact, extensive research has aimed to clarify how oil price fluctuations affect economic performance and to identify precisely which underlying factors drive these changes.

Early studies, beginning notably with Hamilton (1983), generally treated oil price fluctuations as exogenous shocks, focusing primarily on short-term economic outcomes. Hamilton's foundational research demonstrated that sudden increases in oil prices negatively impacted major economies, resulting in lower economic growth, increased inflation, and higher unemployment rates. These early studies typically focused on direct, immediate effects and did not deeply investigate the structural factors underlying oil price fluctuations.

A significant methodological advance was introduced by Kilian (2009), who argued that interpreting oil price changes as purely external shocks could cause analytical biases, especially reverse causality, potentially leading to incorrect policy

recommendations. Kilian developed a structural vector autoregression (SVAR) model that explicitly identified different structural oil price shocks, in this case oil supply shocks, economic activity (global demand) shocks, and precautionary demand shocks, known as "oil-specific shocks." Oil supply shocks typically emerge from production disruptions due to geopolitical events, natural disasters, or deliberate output cuts by major oil producers. Economic activity shocks reflect broader global demand fluctuations driven by worldwide economic expansions or downturns. Precautionary demand shocks, in contrast, capture market uncertainty and expectations about future oil supplies, motivating market participants to adjust their inventories in anticipation of possible shortages.

Building upon Kilian's (2009) structural framework, Baumeister and Hamilton (2019) emphasized the importance of explicitly identifying inventory-related shocks driven by market expectations and uncertainty. While earlier studies typically grouped inventory-driven fluctuations under broader demand shocks, Baumeister and Hamilton argued that inventory shocks independently influence oil price dynamics and macroeconomic outcomes. They distinguished clearly between two distinct types of inventory shocks: precautionary inventory shocks, reflecting genuine market uncertainty regarding future oil supply disruptions, and speculative inventory shocks, driven by investor expectations about future price increases not necessarily aligned with market fundamentals. An important methodological contribution of Baumeister and Hamilton (2019) is their application of Bayesian econometric techniques to address identification uncertainty explicitly. Using Bayesian inference allowed them to quantify the uncertainty surrounding structural shock identification by imposing informative priors, thereby enabling more robust estimations and interpretations of the economic impacts of oil price fluctuations. This Bayesian approach provided a statistically rigorous foundation for distinguishing among competing structural hypotheses and underscored the significance of clearly identifying each type of shock to evaluate macroeconomic effects accurately and formulate appropriate policy responses.

Cashin *et al*. (2014) similarly investigated structural oil price shocks, distinguishing primarily between supply-driven and demand-driven shocks. Unlike Baumeister and Hamilton (2019), however, their approach did not explicitly separate inventory-related shocks into precautionary and speculative categories. Consequently, the analysis in Cashin *et al*. (2014) did not fully capture the distinct macroeconomic implications associated with these different inventory-driven shocks, representing a key methodological difference from the approach adopted by Baumeister and Hamilton (2019) and subsequently employed in our current study. Nonetheless, Cashin *et al*. (2014) highlighted that oil-importing economies tend to experience adverse economic effects following supply-driven price increases, aligning broadly with the findings of Baumeister and Hamilton (2019) and reinforcing the importance of explicitly differentiating among structural shocks to assess macroeconomic outcomes more accurately.

Cross *et al*. (2020) provided additional clarity regarding this distinction, emphasizing the different economic signals precautionary and speculative shocks generate. While precautionary shocks usually encourage producers to maintain stable production and inventory levels to manage potential disruptions, speculative shocks can send distorted signals, causing producers to delay production or investors to accumulate excessive inventories. These distinctions matter considerably because the macroeconomic effects

of precautionary versus speculative shocks differ substantially, impacting economic stability and informing different policy recommendations.

These explicit structural distinctions help explain why seemingly similar oil price increases may result in different macroeconomic outcomes depending on the underlying shock. For example, demand-driven oil price increases during global economic expansions tend to stimulate industrial production, increase exports, and boost economic activity, although they also raise inflation pressures due to higher input costs. In contrast, supply-driven price hikes caused by geopolitical disruptions typically produce negative economic impacts, particularly for importing economies, by directly raising production costs and reducing consumers' purchasing power, consequently slowing economic growth.

Several studies have specifically analyzed oil price shocks in the context of open economies, emphasizing how international economic connections shape domestic outcomes. Kilian *et al*. (2009) and Peersman and Van Robays (2012) investigated the international spillover effects of oil price shocks, demonstrating how global trade and financial linkages influence different countries' economic responses. They showed that global interdependencies can significantly amplify or mitigate the macroeconomic effects of oil price fluctuations, highlighting the necessity of analyzing oil price shocks within an open economy framework.

Specifically, several studies have focused on Korea due to its high dependence on imported energy. An *et al*. (2017) applied Kilian's structural framework to assess how distinct oil price shocks influence Korea's exports, imports, and current account balance differently. Their findings demonstrated that structural shocks—supply disruptions, economic activity changes, or precautionary shocks—resulted in distinct macroeconomic responses, depending on the type of shock. Chon and Jung (2021) reinforced these findings by incorporating Korea's GDP growth and inflation, showing clearly differentiated economic impacts between demand-driven and precautionary shocks. They found that demand-driven oil shocks generally increased economic growth, whereas precautionary shocks primarily raised inflation without significantly benefiting economic performance.

However, traditional single-country SVAR analyses, despite treating oil price shocks as exogenous variables, face limitations in clearly distinguishing domestic effects from indirect global spillover effects, particularly for small open economies such as Korea. To address this methodological gap, Jeong (2014) adopted a global VAR (GVAR) framework that explicitly incorporates international economic linkages while still treating oil price shocks as exogenous. Jeong's analysis clearly demonstrated that indirect international spillover effects significantly influenced Korea's macroeconomic outcomes. Similarly, studies by Kim and Park (2009) and Shin *et al*. (2013) employed GVAR models to analyze the spillover phenomenon in small open economies, highlighting the importance of capturing global economic interactions to improve the accuracy of macroeconomic analyses.

Despite these advances, existing studies based on GVAR models generally did not explicitly incorporate structural shock identification, limiting their explanatory power. Recognizing this gap, the current study integrates the explicit structural shocks methodology proposed by Baumeister and Hamilton (2019) into a comprehensive global analytical framework. Specifically, we apply their structural shock classification approach within a GVAR model, comparing macroeconomic responses across selected oil-importing countries (Korea and China) and major oil-exporting economies

(Canada and the United States). By explicitly combining global economic modeling with this type of structural shock analysis, our study provides clearer insights into how different structural oil shocks distinctly affect economic outcomes, contributing to the existing literature and informing policy discussions.

In the next section, we describe our empirical methodology in detail. We explicitly present the GVAR modeling framework and the structural shock classification method adopted from Baumeister and Hamilton (2019). This clear and integrated approach allows us to better identify macroeconomic impacts associated with distinct structural shocks, addressing existing research gaps and offering practical guidance to policymakers.

III. Empirical Model and Methodology

To analyze systematically how structural oil price shocks propagate through the global economy and influence macroeconomic outcomes, we adopt an integrated methodological approach combining the global vector autoregression (GVAR) model developed by Chudik and Pesaran (2015) and the structural shocks identification framework proposed by Baumeister and Hamilton (2019). This combined approach addresses certain key limitations of previous empirical analyses by explicitly considering structural shocks within an open economy framework. The methodological rigor here is particularly critical for accurately capturing the direct and indirect international transmission channels through which global oil shocks influence domestic economies.

The GVAR model was selected due to its proven capability in capturing international economic interdependencies and spillover effects, which is especially suitable for analyzing small open economies such as Korea. By explicitly incorporating foreign macroeconomic variables constructed as weighted averages based on bilateral trade flows, the GVAR framework provides a comprehensive tool for tracing how global shocks diffuse across interconnected economies, offering precise quantification of both direct and indirect macroeconomic impacts.

A. *Global VAR (GVAR) Framework*

The GVAR model, developed by Chudik and Pesaran (2015), captures the global interdependencies and dynamic relationships among international macroeconomic variables, making it especially suitable for analyzing the transmission of external shocks in small open economies such as Korea. Each country-specific VAR within the GVAR model includes both domestic and foreign variables, with foreign variables represented as trade-weighted averages of corresponding variables from other countries. Formally, the country-specific GVAR model for country i at time t can be expressed as in Equation [1] using a VARX* $(s_i s_i^*)$ model, as presented in Equation [2].

[Equation 1] $$\Phi_i\left(L, s_i\right) x_{it} = a_{i0} + a_{i1} t + \Gamma_i\left(L, s_i^*\right) x_{it}^* + A_i\left(L, s_i^{\omega}\right) \omega_t + u_{it}$$

Here, the error term u_{it} is assumed to have no cross-correlation or autocorrelation. The external variables x_{it} * for each country are constructed by taking the trade-

weighted cross-section average of other countries' domestic variables,

$$x_t* = \Sigma_{j=1}^{N} \omega_{ij} x_{jt}, \qquad j = 1, 2, \ldots, N,$$

and the weights sum to 1. Common global variables, such as structural oil shocks and oil prices, can be treated as exogenous in the model.

B. *Data Description and Variable Selection*

Our empirical analysis utilizes the Global VAR (GVAR) dataset introduced by Mohaddes and Raissi (2020), which covers 33 major economies collectively accounting for over 90% of global GDP. The dataset has been extended in this study to include the period from the second quarter of 1979 through the first quarter of 2020. The data include key macroeconomic variables necessary to analyze international economic interactions and spillover effects.

For each economy, this study constructs country-specific vector autoregression (VAR) models, capturing both domestic economic conditions and international linkages. The models incorporate real gross domestic product (GDP) data and the Consumer Price Index (CPI), obtained from seasonally adjusted IMF International Financial Statistics (IFS) and Haver Analytics. To reflect financial market conditions and monetary policy environments, short-term and long-term interest rates derived from Haver Analytics and the IMF IFS are included, specifically covering treasury bill rates, deposit rates, discount rates, and money market rates appropriate to each country's financial market structure. Additionally, exchange rates—calculated as quarterly averages of bilateral nominal exchange rates against the US dollar—are incorporated. All variables are consistently constructed across economies according to the standard GVAR framework, including logarithmic transformations.

To identify structural shocks, this study employs an updated version of the dataset used in Baumeister and Hamilton (2019). Oil supply shocks are identified using Brent crude oil prices sourced from Bloomberg, calculated as quarterly averages of daily closing prices. Aggregate demand shocks (economic activity shocks) are identified using the global economic activity index from the OECD Main Economic Indicators (MEI) database, which aggregates industrial production indices of OECD countries and six major non-member countries (Brazil, China, India, Indonesia, Russia, and South Africa) using weights provided by the IMF World Economic Outlook (WEO). Inventory-driven demand shocks are identified using quarterly global oil inventory data calculated from OECD crude oil inventory statistics, which are derived from U.S. crude oil inventory data provided by the U.S. Energy Information Administration (EIA), reflecting changes in market participants' expectations about future supply-demand imbalances.

Figure 1 illustrates quarterly averages of the identified structural shocks—economic activity shocks, oil supply shocks, and inventory shocks—over the period of 1979 to 2020. Economic activity shocks generally track major global economic cycles, while oil supply shocks are less volatile and correspond to recognized historical geopolitical or production events. Inventory demand shocks exhibit relatively frequent short-term volatility, reflecting market-driven expectations and

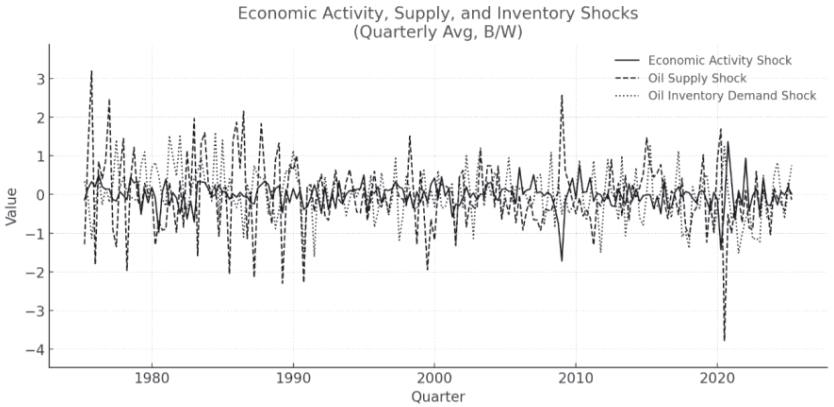

FIGURE 1. DOMESTIC GDP RESPONSES TO ECONOMIC ACTIVITY SHOCKS

Note: The figure displays quarterly averages of the economic activity, oil supply, and oil inventory demand shocks as identified by Baumeister and Hamilton (2019).

uncertainties. However, caution is required when interpreting these shocks directly, as their identification relies on specific modeling assumptions and the data sources used. By explicitly distinguishing these three structural shocks, our analysis provides clearer insights into how different factors driving oil price fluctuations affect key economic indicators.

Our estimation procedure within the GVAR framework relies primarily on generalized impulse response functions (GIRFs). GIRFs allow us to trace the dynamic effects of each structural oil price shock on economic variables such as the real GDP and consumer prices, explicitly accounting for global economic linkages. Using GIRFs, this paper demonstrates how distinct structural shocks propagate across interconnected global economies over time.

By combining the robustness of the GVAR modeling approach with the clear structural shock classification proposed by Baumeister and Hamilton (2019), our analysis delivers detailed insights. This methodology improves our understanding of how specific structural oil shocks differently influence oil-importing and oil-exporting economies, thus offering valuable guidance for policymakers facing complex global energy market dynamics.

In the following section, we present detailed empirical results derived from this methodological framework, highlighting country-specific responses to each type of structural oil shock.

IV. Empirical Investigation

A. *Weak Exogeneity Tests for Global Variables in the GVAR Model*

Before analyzing the transmission of structural oil price shocks through impulse response functions, first we assess the validity of including global variables—oil prices (oil price), economic activity demand shocks (Activity), oil supply shocks (Supply), and oil inventory demand shocks (Inventory)—in our global VAR model. Specifically, we conduct weak exogeneity tests following the methodology outlined

in the GVAR literature to determine whether these global variables can be treated as weakly exogenous at the 5% significance level. Establishing weak exogeneity justifies the inclusion of global variables as conditioning variables, ensuring the accuracy of subsequent impulse response analyses.

Table 1 summarizes the results of these tests for each country in the model. If the calculated F-statistic exceeds the critical value (CV), we reject the null hypothesis of weak exogeneity. The results confirm that, in most cases—including key economies such as Canada, China, Korea, the Euro area, and the United States—the global variables can be treated as weakly exogenous at the 5% significance level. Although there are a few isolated exceptions, these instances do not significantly affect the overall robustness of our model. Thus, the findings broadly support the assumption of weak exogeneity in our GVAR analysis.

TABLE 1—TEST FOR WEAK EXOGENEITY AT THE 5% SIGNIFICANCE LEVEL

Country	F test	CV	Oil Price	Activity	Supply	Inventory
ARGENTINA	F(2,101)	3.086	1.302	0.427	1.236	0.393
AUSTRALIA	F(4,98)	2.464	0.865	1.316	1.092	0.378
BRAZIL	F(2,102)	3.085	0.551	1.226	0.684	0.507
CANADA	F(5,97)	2.308	1.215	2.186	0.203	0.472
CHINA	F(2,98)	3.089	0.163	0.783	0.832	1.210
CHILE	F(2,101)	3.086	0.259	0.292	0.795	0.025
EURO	F(1,101)	3.935	0.071	0.054	0.484	1.902
INDIA	F(2,101)	3.086	0.078	0.241	0.729	0.148
INDONESIA	F(3,101)	2.694	1.119	3.182	0.088	0.798
JAPAN	F(2,100)	3.087	3.790	1.418	0.372	1.070
KOREA	F(4,98)	2.464	0.380	1.119	1.213	1.488
MALAYSIA	F(2,101)	3.086	1.235	4.318	1.52241	0.201
MEXICO	F(1,103)	3.933	0.001	1.678	1.952	0.012
NORWAY	F(3,99)	2.696	0.946	0.276	0.775	0.179
NEW ZEALAND	F(4,98)	2.464	0.659	0.529	0.773	0.300
PERU	F(3,101)	2.694	0.354	0.133	0.207	0.796
PHILIPPINES	F(3,100)	2.695	0.917	2.026	2.376	4.666
SOUTH AFRICA	F(2,111)	3.078	1.595	1.536	0.075	1.364
SAUDI ARABIA	F(3,102)	2.693	0.661	0.716	0.406	0.728
SINGAPORE	F(2,101)	3.086	0.430	0.271	0.204	0.180
SWEDEN	F(3,110)	2.687	1.621	2.634	0.182	1.620
SWITZERLAND	F(2,100)	3.087	0.681	0.086	0.130	0.174
THAILAND	F(3,100)	2.695	0.671	0.616	0.217	0.184
TURKEY	F(2,102)	3.085	1.976	0.091	0.387	2.516
UK	F(1,112)	3.925	0.108	0.129	1.460	0.936
USA	F(2,105)	3.082	0.542	0.490	0.739	4.658

Note: The table reports F-test statistics for weak exogeneity of global variables (oil price, economic activity shock, oil supply shock, and oil inventory demand shock) within each country-specific VAR model. The critical values (CV) indicate significance at the 5% level. An F-statistic exceeding the critical value implies rejection of weak exogeneity.

B. *Generalized Impulse Response Analysis*

Following the confirmation of weak exogeneity conditions within the global VAR (GVAR) framework, we proceed to analyze how structural shocks in oil prices propagate across the global economy using generalized impulse response functions (GIRFs), originally proposed by Koop, Pesaran, and Potter (1996). GIRFs are computed by examining the difference between two conditional forecasts of the endogenous variables: one conditional on a hypothetical shock and the other conditional on the absence of a shock. Unlike traditional impulse response functions, GIRFs do not rely on specific ordering of the variables, making them particularly suitable for large-scale global models in which the ordering of variables can be ambiguous. This method provides a quantitative assessment of the dynamic responses of key macroeconomic indicators—specifically real GDP and consumer prices—to economic activity, oil supply, and oil inventory demand shocks over a defined time horizon. The primary objective is to illustrate clearly the different effects of distinct types of structural shocks on economic growth and inflation, thus identifying precise transmission mechanisms through which oil-related shocks affect macroeconomic stability.

To provide a clear and focused analysis, this section explicitly focuses on selected major economies—Korea, China, Canada, and the United States—chosen from the comprehensive GVAR dataset of 33 countries due to their prominent roles in global energy markets and their distinct economic characteristics. According to the International Energy Agency (IEA, 2023), Korea and China are representative oil-importing economies, importing approximately 97% and 72% of their total oil consumption, respectively, due to their limited domestic oil reserves. In contrast, Canada and the United States represent major oil-exporting nations, with Canada exporting about 80% of its crude oil production, and the United States emerging as a net oil exporter since 2019, primarily due to the significant expansion in shale oil production (IEA, 2023).

Empirical findings regarding economic activity shocks, primarily driven by fluctuations in global demand, revealed broadly positive effects on economic activity across these selected countries. Figure 2 illustrates clearly that increases in economic activity due to global expansions tend to stimulate industrial production, consumption, and overall GDP growth significantly. Such positive economic outcomes, however, are accompanied by increased inflationary pressures due to higher demand-driven energy and transportation costs, permeating various economic sectors. As depicted in Figure 3, inflationary responses were statistically significant in Canada, China, and the United States, whereas the response was notably muted and less significant in Korea, suggesting country-specific factors related to price-setting mechanisms, regulatory environments, or differing degrees of energy dependency. These findings align closely with those of Cashin *et al*. (2014), who similarly reported differentiated macroeconomic effects of demand-driven oil price shocks, highlighting the tendency of such shocks to stimulate economic growth while simultaneously contributing to inflationary pressures.

When analyzing negative oil supply shocks—typically resulting from geopolitical events, conflicts, or production disruptions, as highlighted by Baumeister and Hamilton (2019)—our analysis identifies significant differences in macroeconomic outcomes between oil-importing and oil-exporting nations. Specifically, Figure 4

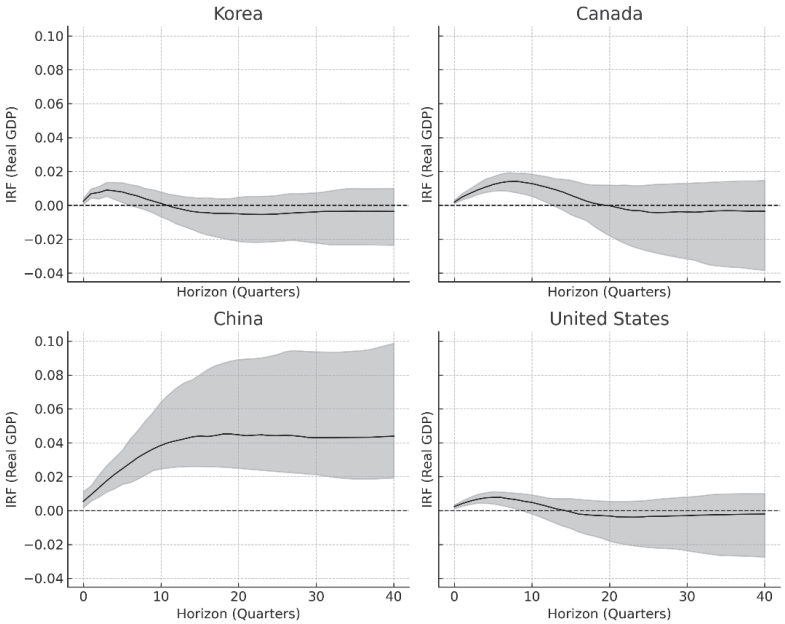

FIGURE 2. DOMESTIC GDP RESPONSES TO ECONOMIC ACTIVITY SHOCKS

Note: The solid line represents the median response of domestic GDP to a one-standard-deviation economic activity shock, estimated from the GVAR model. The dotted lines indicate the corresponding 90% bootstrap confidence intervals.

Source: Calculated by the author.

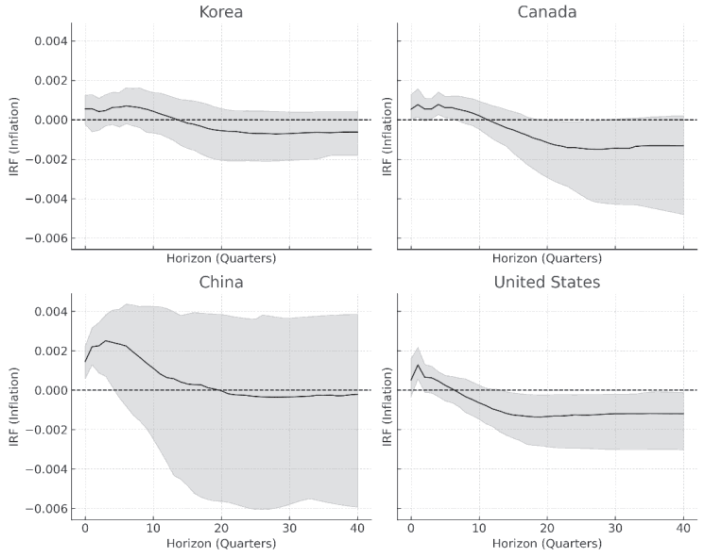

FIGURE 3. CPI RESPONSES TO ECONOMIC ACTIVITY SHOCKS

Note: The solid line represents the median response of the Consumer Price Index (CPI) to a one-standard-deviation economic activity shock, estimated from the GVAR model. The dotted lines indicate the corresponding 90% bootstrap confidence intervals.

Source: Calculated by the author.

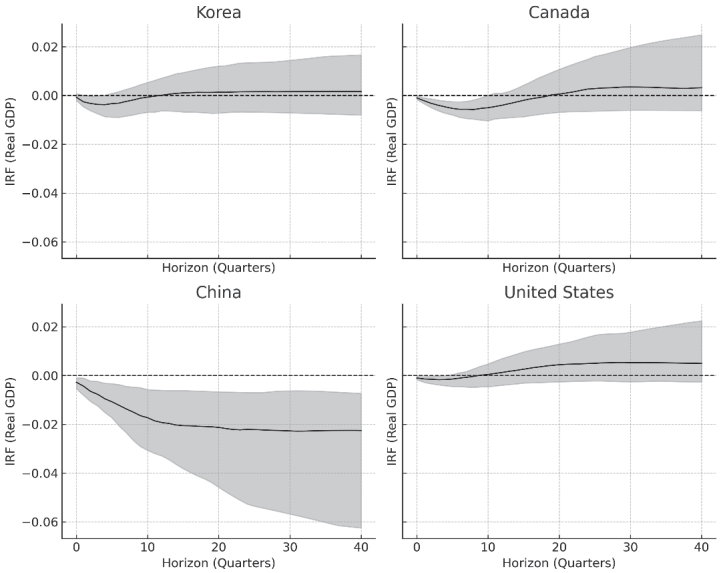

FIGURE 4. DOMESTIC GDP RESPONSES TO OIL SUPPLY SHOCKS

Note: The solid line represents the median response of domestic GDP to a one-standard-deviation oil supply shock, estimated from the GVAR model. The dotted lines indicate the corresponding 90% bootstrap confidence intervals.

Source: Calculated by the author.

illustrates that economies heavily dependent on imported oil, such as Korea and China, faced adverse economic impacts. Rising import prices directly elevate production costs and reduce consumer purchasing power, subsequently dampening economic growth overall. Increased input costs significantly burden manufacturing sectors, transportation, and household consumption, reflecting short-term economic challenges faced by such importing economies due to supply-driven price increases (Baumeister and Hamilton, 2019). These findings are broadly consistent with those of Cashin *et al*. (2014), who similarly found significant variations in economic responses to oil supply shocks, emphasizing the heightened vulnerability of oil-importing countries to sudden price increases.

In sharp contrast, oil-exporting nations such as the United States and Canada exhibited notably differentiated macroeconomic responses. Figure 5 suggests that, in the United States, rising oil prices caused by supply disruptions provided strong incentives for increased investment in the shale oil production capacity. Such incentives contributed positively to employment growth within the energy sector while also leading to higher exports, improved trade balances, and an overall economic expansion in the medium-to-long term. Conversely, Canada's initial economic responses were somewhat more nuanced due to its substantial dependence on oil exports to the U.S. market. Elevated oil prices motivated increased U.S. domestic production, thereby intensifying competitive pressures on Canadian oil exports. These conditions initially constrained Canada's economic performance.

However, subsequent market adjustments, strategic shifts in production, and export diversification eventually mitigated these adverse impacts, resulting in an economic recovery over time (Baumeister and Hamilton, 2019). This observation aligns with Cashin *et al*. (2014), who also documented differentiated impacts of oil price shocks,

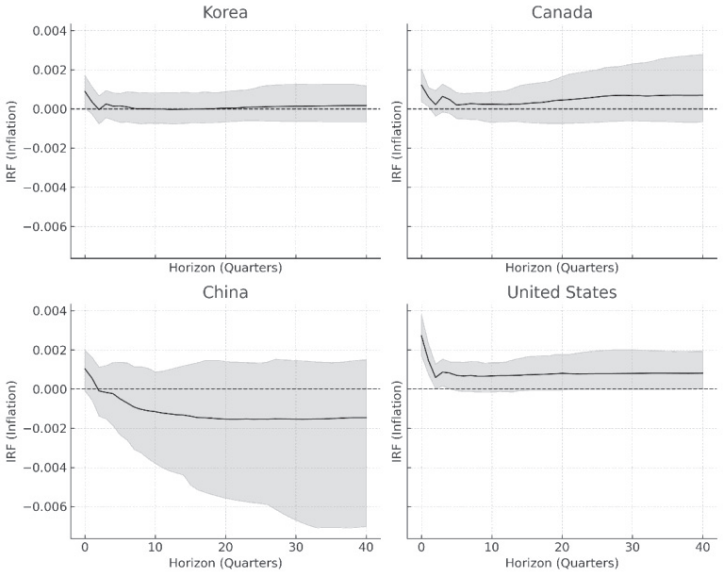

FIGURE 5. CPI RESPONSES TO OIL SUPPLY SHOCKS

Note: The solid line represents the median response of the Consumer Price Index (CPI) to a one-standard-deviation oil supply shock, estimated from the GVAR model. The dotted lines indicate the corresponding 90% bootstrap confidence intervals.

Source: Calculated by the author.

highlighting the resilience and adaptive capacity of major oil-exporting economies.

Positive oil inventory shocks, characterized by unexpected increases in oil inventories, typically reduce market participants' precautionary demand and exert downward pressure on crude oil prices. Baumeister and Hamilton (2019) emphasize that inventory shocks represent market reactions either to genuine uncertainty about future oil supplies (precautionary motives) or to speculative expectations about future price changes. Figure 6 indicates that this dynamic tends to be favorable for oil-importing countries such as Korea and China, as reduced oil prices can lower inflationary pressures and production costs in the manufacturing sector. Yet for Korea—an economy significantly reliant on petrochemical exports—falling oil prices could potentially affect profit margins and export competitiveness, suggesting nuanced economic trade-offs. For oil-exporting countries such as Canada and the United States, increased oil inventories initially present short-term economic challenges. As depicted in Figure 7, elevated inventory levels can signal reduced immediate demand, possibly prompting producers to curtail output and investment activities temporarily. However, these negative economic implications generally appear short-lived, and adjustments in inventories can help restore equilibrium conditions. Regarding consumer prices, increased inventories initially tend to exert downward pressure on inflation through lower crude oil prices, as indicated in Figure 8. This disinflationary effect, however, appears modest and temporary, illustrating the complex relationship between short-term inventory fluctuations and broader macroeconomic dynamics. These observations broadly align with findings from Baumeister and Hamilton (2019) and Cashin *et al*. (2014), highlighting the relevance

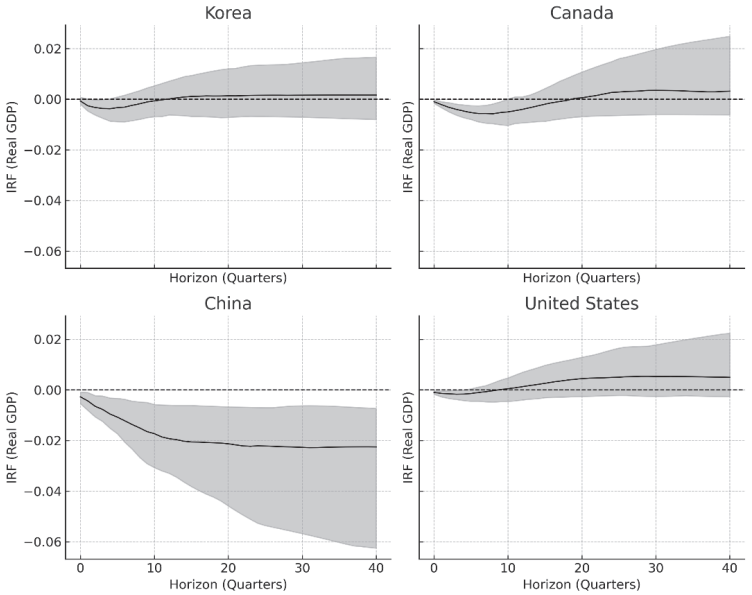

FIGURE 6. DOMESTIC GDP RESPONSES TO OIL INVENTORY SHOCKS

Note: The solid line represents the median response of domestic GDP to a one-standard-deviation oil inventory shock, estimated from the GVAR model. The dotted lines indicate the corresponding 90% bootstrap confidence intervals.

Source: Calculated by the author.

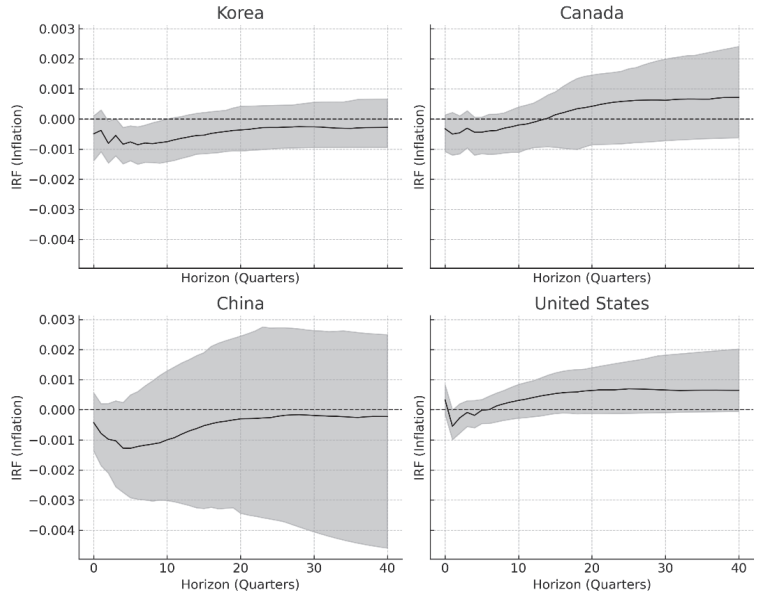

FIGURE 7. CPI RESPONSES TO OIL INVENTORY SHOCKS

Note: The solid line represents the median response of the Consumer Price Index (CPI) to a one-standard-deviation oil inventory shock, estimated from the GVAR model. The dotted lines indicate the corresponding 90% bootstrap confidence intervals.

Source: Calculated by the author.

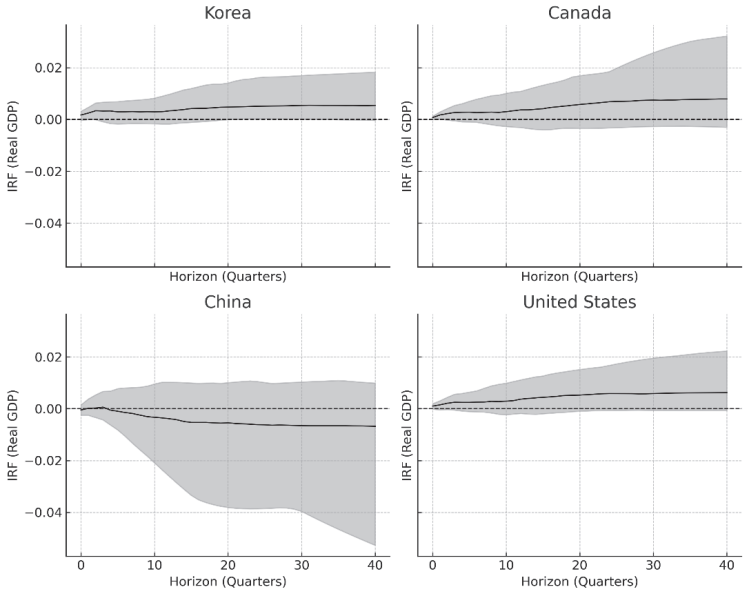

FIGURE 8. DOMESTIC GDP RESPONSES TO OIL PRICE SHOCKS

Note: The solid line represents the median response of domestic GDP to a one-standard-deviation shock in oil prices (oil price shock itself), estimated from the GVAR model. The dotted lines indicate the corresponding 90% bootstrap confidence intervals.

Source: Calculated by the author.

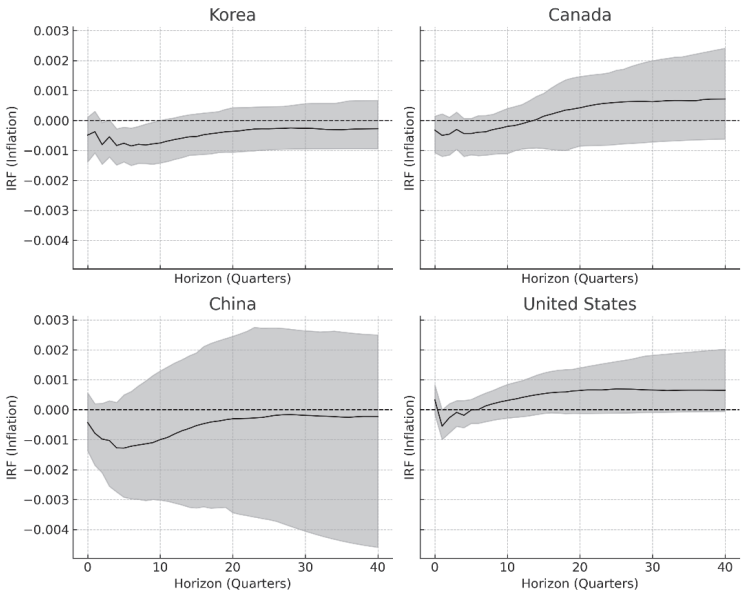

FIGURE 9. CPI RESPONSES TO OIL PRICE SHOCKS

Note: The solid line represents the median response of the Consumer Price Index (CPI) to a one-standard-deviation shock in oil prices (oil price shock itself), estimated from the GVAR model. The dotted lines indicate the corresponding 90% bootstrap confidence intervals.

Source: Calculated by the author.

of differentiating among structural shocks to assess macroeconomic impacts more comprehensively.

Overall, the comparative assessment of selected countries highlights substantial differences in macroeconomic outcomes compared to analyses not accounting for structural distinctions. Canada, China, the United States, and Korea generally demonstrated positive responses to economic activity shocks, though China displayed mixed or slightly negative responses in some scenarios. Specifically, Korea presented particular complexities in that positive economic responses occasionally coincided with unexpected declines in consumer prices, suggesting possible country-specific structural or market factors complicating straightforward interpretations. Similarly, China's economic responses to certain oil shocks, while negative in some cases, were statistically insignificant, highlighting the interpretative challenges inherent in analyses not specifically identifying structural shocks.

These findings emphasize a critical point: without explicit structural shock analyses, identifying the broader macroeconomic implications of oil price fluctuations remains challenging. Interpreting these shocks merely as short-term cost increases can lead to oversimplified and potentially misguided policy recommendations. Therefore, our analysis highlights the importance of explicitly distinguishing economic activity, supply, and inventory shocks, providing policymakers and researchers with nuanced insights into the diverse macroeconomic impacts associated with oil price fluctuations. This understanding is essential for developing informed and targeted policy responses that mitigate macroeconomic risks, enhance economic resilience, and strengthen macroeconomic stability amid ongoing global energy transitions and persistent geopolitical uncertainties.

In addition to structural shocks (economic activity, oil supply, and inventory shocks), we also directly analyze the macroeconomic responses to shocks stemming from oil price changes themselves. This analysis allows for a comparative assessment of the effects from explicitly identified structural shocks versus direct price fluctuations without structural identification. Figures 8 and 9 illustrate the responses of domestic GDP and consumer prices, respectively, to these direct oil price shocks. Notably, the responses to direct oil price shocks exhibit substantially different patterns compared to responses explicitly linked to structural factors, highlighting the potential risks of interpreting oil price changes solely as exogenous price movements. These findings further reinforce the importance of explicitly analyzing structural shocks to avoid misinterpretations regarding macroeconomic implications, a point also underscored by Baumeister and Hamilton (2019) and Cashin *et al*. (2014).

V. Summary and Implications

This paper empirically analyzed the macroeconomic impacts of structural oil price shocks using a global vector autoregression (GVAR) framework, incorporating the structural shock classification established by Baumeister and Hamilton (2019). We explicitly distinguished among economic activity shocks related to global demand conditions, oil supply shocks from geopolitical disruptions or production constraints, and oil inventory demand shocks reflecting market expectations about future supply-demand imbalances. This classification enabled a detailed assessment of the

macroeconomic effects associated with different types of oil shocks, particularly relevant for small open economies such as Korea, given its high dependency on imported energy and sensitivity to global oil price volatility.

Our analysis indicates substantial variation in macroeconomic outcomes depending on the type of structural shock. Economic activity shocks, driven by global demand changes, generally had positive effects on economic growth across the selected countries (Korea, Canada, China, and the United States). During periods of global economic expansion, industrial production, consumption, and GDP growth responded positively. However, these shocks also resulted in increased inflationary pressures due to higher energy and transportation costs. Inflation responses were statistically significant in Canada, China, and the United States but were less pronounced and statistically weaker in Korea. These differences may stem from factors such as energy market structures, regulatory environments, and the mechanisms transmitting oil price fluctuations to domestic prices—all areas requiring further research.

Negative oil supply shocks, typically resulting from geopolitical disruptions or production constraints, showed pronounced differences between oil-importing and oil-exporting countries. Oil-importing nations such as Korea and China experienced immediate negative economic effects from increased import costs, higher production expenses, and reduced consumer purchasing power. In contrast, oil-exporting countries such as the United States and Canada benefitted from higher oil prices, driven by their capacity to expand domestic production and exports. It should be noted, however, that additional complexities—such as market competition or production flexibility—were beyond the scope of this analysis.

The study also underscores the significance of oil inventory demand shocks, reflecting shifts in market expectations pertaining to future supply-demand imbalances. Inventory-driven shocks caused short-term volatility in oil prices and inflation, with differing implications for various economies. For oil-importing countries, increased oil inventories typically lowered oil prices, temporarily reducing inflationary pressures and production costs. However, for economies such as Korea, heavily reliant on petrochemical exports, falling oil prices could potentially compress profit margins and weaken export competitiveness, suggesting the need for sector-specific analyses.

In oil-exporting nations such as Canada and the United States, increased oil inventories were initially associated with temporary declines in immediate demand, leading to reduced production and investment levels. These negative effects were short-lived, with market adjustments quickly restoring equilibrium and supporting an economic recovery. Consumer price responses to inventory shocks were modest and temporary, requiring further investigation, particularly concerning inventory management practices and market dynamics.

Our empirical results also confirmed the assumption of weak exogeneity for global variables within the GVAR framework, supporting the validity of our model. However, these findings should be interpreted cautiously due to potential data or model limitations not explicitly tested here.

In conclusion, our study demonstrates the critical importance of distinguishing clearly among different structural shocks when analyzing oil price fluctuations. Recognizing the specific macroeconomic impacts associated with each shock type helps policymakers tailor responses to mitigate risks and enhance economic resilience. Given ongoing global energy transitions and geopolitical uncertainties, further research is needed to deepen our understanding of oil market dynamics and

to refine methods for identifying structural shocks, ultimately supporting more effective and targeted policy decisions.

APPENDIX

TABLE A1—DESCRIPTIVE STATISTICS OF GLOBAL VARIABLES

Statistics	Mean	Median	Maximum	Minimum	Std. dev.	Skewness	Kurtosis
Oil Price	3.741	3.868	4.811	2.407	0.691	-0.136	1.658
Demand	-0.024	0.007	1.368	-1.722	0.356	-0.633	8.811
Oil Invent	-0.110	-0.102	1.298	-1.615	0.635	-0.125	2.790
Oil Supply	-0.137	-0.134	2.566	-3.778	0.750	-0.522	7.447

Source: Calculated by the author.

TABLE A2—ORDER OF WEAK EXOGENEITY REGRESSION EQUATIONS

(p*: lag order of domestic variables, q*: lag order of foreign variables)

Country	p*	q*
ARGENTINA	1	2
AUSTRALIA	1	2
BRAZIL	1	2
CANADA	1	2
CHINA	2	2
CHILE	1	2
EURO	1	2
INDIA	1	2
INDONESIA	1	2
JAPAN	1	2
KOREA	1	2
MALAYSIA	1	2
MEXICO	1	2
NORWAY	1	2
NEW ZEALAND	1	2
PERU	1	2
PHILIPPINES	1	2
SOUTH AFRICA	1	1
SAUDI ARABIA	1	2
SINGAPORE	1	2
SWEDEN	1	1
SWITZERLAND	1	2
THAILAND	1	2
TURKEY	1	2
UK	1	1
USA	1	2

Source: Calculated by the author.

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