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Macroeconomic Impact of Oil Shocks: A Large-Scale Bayesian SVAR Approach in South Korea

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Abstract This study employs a Large-Scale Bayesian Vector Autoregression (LS-BVAR) model to examine the impact of oil price shocks on South Korea's economy using monthly data spanning from January 2001 to September 2023. The analysis includes key macroeconomic variables such as industrial production, inflation, interest rates, money supply, exchange rates, imports, exports, and foreign direct investment (FDI) abroad. Our findings indicate that while oil supply shocks have limited effects on these variables, both oil aggregate demand shocks and oil-specific demand shocks significantly impact the Korean economy. The study's findings highlight the importance of leveraging global demand that could potentially boost the economic growth of the country.

Keywords: Oil Shocks, Korean Economy, Structural VAR, Bayesian Estimation, Shrinkage Prior

JEL Classifications: C11, E32, Q43

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I. Introduction

During the 1970s, the oil crises, triggered by geopolitical events and production cuts, led to sharp increases in oil prices. These shocks had far-reaching effects on the global economy, leading to stagflation in many countries, simultaneous high inflation and high unemployment. Oil prices have experienced sharp fluctuations since 2000. For example, a decrease in demand for crude oil due to the global economic downturn and an increase in crude oil supply due to the production of shale oil in the U.S. have led to a trend of low oil prices. More recently, following Russia's invasion of Ukraine, WTI crude oil prices surged to their highest point since 2013 by May 2022. In the subsequent period, prices experienced a notable decline, reflecting a 31% decrease.

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Oil price fluctuations can be attributed to several factors, including disruptions in production caused by geopolitical events or intentional production cuts by oil producers. Changes in global economic activity also play a significant role. For example, the global economic recovery following the 2008 financial crisis led to increased oil demand, whereas the COVID-19 pandemic caused a significant drop in global oil consumption due to lockdowns and reduced industrial activity. Additionally, speculative trading in oil futures markets has become increasingly influential in recent years. Traders and investors often respond to news and forecasts about future supply and demand, leading to rapid price changes. For instance, the expectation of disruptions in key shipping routes or tighter supply due to potential sanctions on major oil producers can drive prices up, even if the actual supply remains unchanged.

This study employs large-scale structural Bayesian Vector Autoregressions (LS-BVAR) to assess the impact of different oil price shocks (oil supply, oil demand, and oil-specific demand shocks) on South Korea's macroeconomic indicators. The variables include crude oil production, the global real economic activity index, real oil prices, and South Korea's industrial production, inflation, interest rate, money supply, exchange rate, imports and exports indices, and foreign direct investment abroad which ranges from 2000M1 to 2023M9. As a result, we find that oil supply shocks initially reduce economic growth, inflation, and imports, with no significant impact on FDI. In contrast, since oil demand shocks increase global real economic activity, Korean industrial production and inflation both increase, which leads to increasing interest rates and imports, while FDI sees a small positive effect. Oil-specific demand shocks initially stimulate growth and inflation but lead to a downturn in economic activity, with a complex interplay between imports, exports, and exchange rates. The study demonstrates South Korea's resilience to oil supply shocks, likely due to strategic oil reserves and effective monetary policies. The findings underscore the varied macroeconomic responses to different types of oil price shocks and the importance of large Bayesian VARs in portraying these dynamics. Our study indicates that South Korea benefits more from global aggregate demand shocks than from oil-specific demand shocks. These shocks lead to a significant and sustained increase in the country's economic growth due to the increased industrial production caused by a surge in the global real economic activity, exports, and potentially currency stability. Given South Korea's export-oriented economy, leveraging the positive effects of global aggregate demand can drive economic prosperity. Policymakers should strengthen economic integration and trade agreements to take advantage of global demand, using this as an opportunity to enhance export competitiveness and capitalize on periods of increased global demand, while managing the initial short-term inflationary effects caused by the global demand shock.

This study contributes to the existing literature by employing a Large Bayesian SVAR model to capture the intricate interactions and dynamic effects of oil price shocks on a broader set of macroeconomic variables, including inflation, interest rate, economic growth, exchange rate,

money supply, total exports, and imports, and FDI abroad. This approach allows us to provide a more comprehensive understanding of how oil price shocks affect the South Korea economy. The existing literature had focused on small systems with a few variables due to concerns about parameter multiplication and processing limits. (Bernanke, Boivin, & Eliasz, 2005) argues that small VAR models may not capture all the information available for a limited set of variables, missing broader economic impacts. (Ellahie & Ricco, 2017) demonstrates that using a large Bayesian VAR addresses informational insufficiencies in conventional models and explains result inconsistencies.

For South Korea, an industrial powerhouse heavily reliant on oil imports, the effects of oil price shocks are particularly pronounced. The country's economic performance, characterized by its advanced manufacturing sector and high energy consumption, makes it susceptible to global oil price shocks. There are some reasons for studying the impact of oil price shocks on the Korean economy. South Korea, holding the position of the world's fourth-largest oil-importing nation, finds itself particularly exposed to the dynamics of the global commodity market, a vulnerability that significantly impacts the country's economy. According to the U.S. Energy Information Administration, International Energy Statistics, and BP Statistical Review of World Energy 2022, South Korea heavily relies on imports, covering nearly 98% of its fossil fuel consumption. This dependence extends to the use of tanker shipments for crude oil to meet its domestic energy demand. Notably, the nation's economic vitality hinges on exports, with key sectors including automobiles, ships, semiconductors, and petrochemicals. This reliance on international markets for economic sustenance underscores the critical role of exports in propelling South Korea's economic growth. On the other hand, this dependence exposes the country to external shocks and fluctuations in the global oil markets, thereby influencing various domestic macroeconomic indicators.

The remainder of the paper is structured as follows. We begin with a literature review in the next section. Following that, we explain our empirical model specification in section 3. In Section 4, we present the data, and discuss our main results and key findings. Section 5 concludes.

II. Literature Review

Researchers have extensively studied the complexities of oil price dynamics, particularly the disentangling of oil shocks (Kilian L., 2009) propose a trivariate structural VAR model with the global oil production, global real economic activity, and the real price of oil, that identified three oil shocks: crude oil supply shocks caused by unexpected innovations to global oil production, shocks to global demand for all industrial commodities, which reflect innovations to global economic activity that cannot be explained by oil supply shocks, and demand shocks

specific to the global crude oil market, these are innovations to the real oil price that capture shifts in the precautionary demand for oil associated with concerns about future oil supply shortfalls.[1)]

The understanding of oil price shocks was significantly advanced by (Kilian, 2009), by differentiating between oil supply shocks, aggregate demand shocks, and oil-specific demand shocks. The study emphasized the heterogeneous effects of different types of oil shocks on the economy. This differentiation is crucial for accurately assessing the impacts and formulating appropriate policy responses. Following this, different methodologies have been used to identify and estimate these types of oil price shocks.[2)] (Peersman & Robays, 2009) and (Baumeister, Peersman, & Van Robays, 2010) utilized structural vector autoregression (SVAR) frameworks to analyze the importance of understanding the underlying causes of oil price changes, and emphasizes the significant differences in regional responses, particularly between the Euro area and the US (Peersman & Robays, 2009). (Kilian & Murphy, 2012) improves upon earlier models by demonstrating that combining sign restrictions with bounds on oil supply elasticity and real activity responses can provide reliable estimates of demand and supply shocks in oil markets. This methodology was further extended by (Kilian & Murphy, 2014), the study incorporated speculative demand shocks using comprehensive oil inventory data from the Energy Intelligence Group (EIG), which provides a broader coverage of global crude oil stocks. Their findings revealed that speculative demand significantly influenced oil price surges during the 1979, 1986, and 1990 episodes but not during the 2003-2008 surge, while they focus on the speculative component of oil prices, showing that speculative demand can raise prices significantly during geopolitical events. (Baumeister & Peersman, 2013), identify oil supply shocks with sign restrictions and account for changing volatility in their analysis. (Ratti & Vespignani, 2013) employed a structural vector error correction model to analyze the real price of oil and oil production as endogenous variables. Their model considered from global oil supply, global real aggregate demand, specific oil-demand, aggregated real M2 for G3 countries, and aggregated real M2 for BRIC countries, attributing unexplained shocks by these factors to oil-specific or precautionary concerns related to future oil supply. (Basak & Pavlova, 2016) contributes to the theoretical literature on the financialization of commodities by developing a multi-good, multi-asset dynamic model to disentangle the effects of institutional flows from traditional supply

1) The global economic activity index has a critical role in understanding global macroeconomic dynamics. While oil supply shocks are in general measured using oil production data and oil-specific demand shocks through fluctuations in real oil prices, aggregate demand shocks are analyzed using this index. (Kilian L. , 2009) has developed a monthly global economic activity index by tracking fluctuations in dry cargo shipping rates. Unlike traditional measures like GDP, it reflects economic health through the demand for raw materials and finished goods. This is particularly useful for getting a near real time display of economic trends.

2) Various indices have been utilized to measure global economic activity through alternative measures including commodity prices, global steel production, and the World Industrial Production (WIP) index (OECD+6), including data from OECD countries and six major emerging markets (Brazil, China, India, Indonesia, the Russian Federation, and South Africa), allowing for analysis of longer-term global industrial trends (see (Baumeister & Guerin, 2021), (Alquist, Bhattari, & Coibion, 2020), (Ravazzolo & Vespignani, 2020), (Baumeister & Hamilton, 2019)).

and demand factors on commodity futures prices, volatilities, and their comovement. It also examines the impact of financialization on commodity spot prices and inventories. (Baumeister & Hamilton, 2019) revisited the importance of supply and demand shocks using a Bayesian approach. Their findings indicated that supply disruptions have played a larger role in historical oil price movements than previously thought (Kilian & Murphy, 2012), (Kilian & Murphy, 2014), while demand shocks tend to have a more immediate but less prolonged impact on global economic activity. Moreover, (Kanzig, 2021) identifies oil supply news shock using a novel strategy that leverages OPEC's institutional features and high-frequency data to examine the impact of changes in oil supply expectations on oil prices and the macroeconomy.

The impact of oil price shocks on the macroeconomy has been a well-established area of empirical examination for a long time. ((Bernanke, Gertler, Watson, Sims, & Friedman, 1997); (Barsky & Kilian, 2001); (Kilian L., 2008); (Blanchard & Riggi, 2009); (Kilian & Hicks, 2013). Early studies laid the foundation for understanding how oil price changes influence the broader economy, affecting production costs, inflation rates, trade balances, and economic growth. (Hamilton, 1983) was among the first to prove a direct link between oil price shocks and economic recessions, emphasizing the importance of oil prices in maintaining economic stability. These foundational theories focused on the mechanisms through which oil price changes influence the broader economy, such as through production costs and consumer prices. Changes in oil prices are a critical factor influencing a wide range of economic activities, from production costs and inflation rates to trade balances and economic growth ((Vlastakis, Triantafyllou, & Neil, 2020); (Syed & Bouri, 2021)). (Hamilton, 2005) found that changes in spending patterns due to oil price hikes can disrupt resource allocation, reduce consumption, and increase unemployment. Central banks may raise interest rates to curb inflation, affecting borrowing costs and business investments. Conversely, falling oil prices can lower production costs, stimulate consumer spending, and therefore the economic growth, though the macroeconomic response can be asymmetric (see (Moshiri & Banihashem, 2012); (Bruna & Tran, 2023); (Garzon & Hierro, 2021); (Zhang & Shang, 2023); (Deheri & Ramachandran, 2023); (Ge & Sun, 2024)).

Methodologically, (Antolin-Diaz & Rubio-Ramirez, 2018) apply narrative sign restrictions to oil market models and monetary policy shocks, finding that incorporating historical events significantly sharpens identification and yields more robust economic conclusions. (Jimenez-Rodriguez, 2022) employed a Time-Varying Parameter Vector Autoregression model, considering global economic activity, world crude oil production, and real oil prices, applying bayesian estimation following (Primiceri, 2005) and (Negro & Primiceri, 2015). (Jimenez-Rodriguez, 2022) found that unanticipated oil supply disruptions consistently lead to declines in global economic activity, while unexpected aggregate demand expansions boost it, and oil-specific demand increases have short-lived effects, particularly during major economic events. (Degirmen, Tun, Saltik, & ul Rehman, 2023) examined the impact of oil price shock uncertainty on key

macroeconomic variables in both oil-exporting and oil-importing nations, the authors employ the block-exogeneity SVAR model, encompassing twelve developing countries engaged in oil trade, enables the analysis of global dynamics and the intricate interplay between energy markets and macroeconomic factors.

Studies on the impact of oil prices on economies may vary depending on the characteristics of the country. (Moshiri & Kheirandish, 2024) found that oil-exporting countries benefit from higher oil prices, especially developing ones, though trade can dampen these benefits. Oil-importing countries, particularly developing ones, face negative impacts from higher oil prices with a one-year delay, but these effects are not statistically significant, and trade has minimal influence. For instance, the oil price crash in 2020, triggered by the COVID-19 pandemic, had profound effects on both oil-exporting and oil-importing countries ((Atif, et al., 2022)). Rising oil prices typically increase production and transportation costs for businesses, resulting in higher consumer prices and inflationary pressures. This inflation can reduce consumer purchasing power and slow economic growth as consumers defer expenditures ((Peersman & Robays, 2009); (Lee & Song, 2009); (Moshiri & Banihashem, 2012); (Moshiri & Kheirandish, 2024)). (Zhu, Li, & Huang, 2023) show that oil prices have stronger, long-term connection with currencies of exporting countries, which tend to strengthen with rising oil prices, while the impact on oil-importing countries is weaker and more varied.

Several previous research have investigated the impact of oil price shocks on South Korea's economy. For instance, (Lee & Kim, 2018) shows oil price fluctuations heavily impact Korea's import-reliant economy. The study reveals industries using more oil are most affected, while those relying on internal supplies might see weaker or even negative impacts. Interestingly, lower oil prices do not always benefit exports due to Korea's intricate industrial structure. Following a positive oil price shock, (An & Heedon, 2011) found that the exchange rate initially appreciates. However, as oil imports and output recover, accompanied by inflation increases, the currency experiences a subsequent depreciation. (Cunado, Jo, & Perez de Gracia, 2015) demonstrate, in the context of macroeconomic research on the pass-through of oil prices to the exchange rate of oil-importing countries, that the interest rate responses and exchange rate interventions by the central banks of Japan and South Korea effectively mitigate the impact of oil price shocks on the exchange rate. (Park & Shin, 2018) suggests that while short-term financial conditions play a bigger role initially, Korea's dependence on imported energy makes it more vulnerable to oil price fluctuations in the long run. (Baek, 2023) shows that the impact of oil shocks on Korea's exports and imports varies depending on the source of the oil price fluctuations and the specific trading partner. In a following study, (Baek, 2024) indicate that Korea's economic growth is primarily driven by aggregate and oil-specific demand shocks rather than oil supply shocks in both the short and long term, with an asymmetric influence of demand shocks on long-term growth. (Park & Meng, 2024) find that oil price shocks have a stronger

impact on inflation in the long term compared to the short term. Additionally, higher oil prices tend to decrease industrial production, while the effect of oil prices on unemployment weakens over time.

III. Empirical Model

Bayesian Vector Autoregressions (VARs), introduced by (Sims, 1980), have become a widely employed tool in macroeconomic forecasting and structural analysis. Despite their utility, VARs often involve numerous parameters. Early work by (Doan, Litterman, & Sims, 1984) and (Litterman, 1986) developed Bayesian methods that incorporate non-data information into informative priors, significantly enhancing forecast performance. However, limitations in computational resources and concerns over parameter proliferation confined empirical studies to small systems with few variables persisted until recently.

There was a big change when (Banbura, Giannone, & Reichlin, 2010) showed that using large Bayesian VARs with more than two dozen dependent variables is better than using smaller ones. This finding led to more research on using big Bayesian VARs for forecasting and structural analysis. Some examples of this research include works by (Carriero, Kapetanios, & Marcellino, 2009), (Koop, 2013), and (Carriero, Clark, & Marcellino, 2015). These large Bayesian VARs provide another way to deal with big datasets, offering an option different from the usual factor models like (Stock & Watson, 2002) and (Mario, Hallin, & Lippi, 2005).

Estimating small-scale VAR models with numerous variables poses a challenge because economists aim to include numerous macroeconomic variables. This results in models with an excessive number of parameters. When a VAR model is confronted with many parameters but a short time series, overfitting becomes a significant concern. This overfitting occurs because the model captures noise rather than the underlying process, leading to high variance in predictions. The small-scale VAR models often yield large standard errors and unstable estimates due to the imbalance between the number of parameters and available data points. These issues pose challenges not only for hypothesis testing, with reduced power, but also for forecasting, where high variance undermines prediction accuracy.

Consider the large scale Bayesian structural VAR (LS-BVAR) model with a lag of p

$$Ax_t = \Gamma_1 x_{t-1} + \Gamma_2 x_{t-2} + \cdots + \Gamma_p x_{t-p} + \epsilon_t$$

where A is a matrix that captures the contemporaneous effects of shocks on the endogenous variables. $\Gamma_i, i = 1, \ldots, p$ are matrices representing the lagged effects of the endogenous variables

on themselves $\epsilon_t \sim N(0, \Sigma)$ represents the structural shocks at time t. x_t is a k-dimensional vector of endogenous variables and $x_{t-1}, x_{t-2}, \ldots, x_{t-p}$ represent the lagged values of the endogenous variables. The reduced form VAR(p) model is seen from the above structural VAR model, and can be written as

$$x_t = B_1 x_{t-1} + B_2 x_{t-2} + \cdots + B_p x_{t-p} + v_t \ , \quad v_t \sim N(0, \Omega = A^{-1'} A^{-1})$$

where $B_i = A^{-1}\Gamma_i$ is a $p \times p$ matrix of coefficients for the ith lag of x_i, $i = 1, \ldots, p$, and the reduced form shock $v_t = A^{-1}\epsilon_t$ follows a normal distribution with mean 0 and a variance-covariance matrix of dimension $p \times p$.

For variance-covariance matrix, the inverse-Wishart distribution is followed with the degree of freedom v and scale matrix R. Denoted as:

$$\Omega \sim IW(v, R)$$

Let $\beta = vec(B)$ where $B = \left(B_1', B_2', \cdots, \Phi_p'\right)'$. For modeling the parameters of our VAR model, we employ the Minnesota prior, proposed by (Litterman, 1986) and further discussed by (Doan et al., 1984). This approach involves shrinking the VAR estimates towards a multivariate random walk model. The original proposal has proven to be effective in forecasting numerous persistent economic time series. The formulation involves specifying the prior mean and covariance matrix based on two key hyperparameters: λ and θ. The mean and covariance matrix of the prior are specified as follow:

$$b_{ij,p} \sim N(\mu_{ij,p}, v_{ij,p})$$

where $b_{ij,p}$ is the ijth element of B_p, regression effect of x_{jt-p} on x_{it} and

$$\mu_{ij,p} = \begin{cases} 0.5, & \text{if} \quad r = 1 \text{ and } i = j \\ 0, & otherwise \end{cases}$$

$$v_{ij,p} = \begin{cases} (\lambda/p)^2, & \text{if } i = j \\ (\lambda\theta\sigma_i / p\sigma_j)^2, & \text{if } i \neq j \end{cases}$$

Here, λ is the prior standard deviation, θ controls the relative tightness of the prior variance in other lags compared to own lags, and σ_i is the ith diagonal element of the innovation covariance matrix Σ. The shrinkage parameter λ determines the strength of shrinkage towards

the prior mean. The advantage in the utilization of the Minnesota prior lies in its capacity to simplify the complexities associated with defining a prior distribution in a high-dimensional framework. Recently, (Giannone, Lenza, & Primiceri, 2015) propose a method that allows the hyper-parameters λ and γ to be determined by data as additional parameters to be estimated. They show that the explanatory power of the model can be improved through this method. Based on the method proposed by (Giannone, Lenza, & Primiceri, 2015), our study assumes the following hierarchical prior for λ and γ.

$$\lambda \sim IG(\alpha_0, \delta_0) \text{and } \gamma \sim IG(\tau_0, \varkappa_0)$$

We adopt the short-run restrictions (Cholesky identification) that is based on the assumption that certain shocks exhibit no contemporaneous impacts on one or more endogenous variables within the system. This implies a structural zero in the corresponding position of the impact coefficients matrix. Furthermore, we categorize the variables into two groups: oil shocks and endogenous variables. We set the identification restriction based on the following economic reasoning. First, the domestic macroeconomic indicators of South Korea used in our study lack significant capacity to influence and determine the oil prices, since the latter is determined by global demand and supply dynamics, therefore, oil shocks indicators are placed at the forefront, allowing it to impact all other variables contemporaneously. For the oil shocks variables, we set the order as crude oil production, the index of real economic activity, and the real price of oil as delineated in (Kilian L. , 2009) work. These variables serve as essential measures for quantifying oil supply shock, oil aggregate demand shock, and oil specific-demand shock, respectively.

Second, following (Basnet & Upadhyaya, 2015) ,we make an assumption that the economic growth variable does not concurrently react to changes in the domestic variables. Next, given that transportation costs constitute a significant component of South Korea's CPI basket, (113.77 points in January 2022 with an average of 75.62 points over the period from 1985 to 2024), fluctuations in oil prices tend to exert immediate effects on this aspect and changes in the domestic economic growth cause shift in price level, therefore, we placed inflation second in the order an allow it to be impacted by the variables that preceding it. The interest rate is assumed to be influenced by inflation as a response by the Central Bank to maintain price stability in the economy. Following (Buyangeral & Kim, 2013), money supply contemporaneously reacts to interest rate, based on the results of the study, money supply experiences a rapid decrease in the short run following an interest rate shock over the period of the study, however, it does not react to the exchange rate.

Next, the exchange rate is assumed to be affected by all the above variables, including money supply. Changes in the money supply can impact on the exchange rate by influencing

the supply and demand dynamics of the domestic currency. An increase in the money supply can lower the value of the domestic currency, and typically leads to its depreciation relative to other currencies. Conversely, a decrease in the money supply can cause the domestic currency to appreciate. Furthermore, the exchange rate has a great role in shaping the short-run trade dynamics, it directly affects imports and exports by altering their relative costs. A depreciation makes exports cheaper and imports costlier, potentially boosting exports and curbing imports, while an appreciation has the opposite effect. FDI abroad might substitute for exports in the short run. Companies may choose to invest in foreign production facilities to serve local markets rather than exporting goods from the home country.

Our VAR model is estimated using Bayesian methods to evaluate the collective posterior distribution of parameters and hyperparameters. Bayesian methods effectively handle high dimensionality by dividing the parameter space into blocks, simplifying the estimation process. The Markov Chain Monte Carlo (MCMC) algorithm, specifically the Gibbs sampling procedure, is utilized to draw from conditional posterior distributions of parameter blocks. Here, we briefly describe the MCMC sampling algorithm as follows:

Algorithm: MCMC Algorithm

Step 0: Set initial values and MCMC size n_0 and n_1

Step 1: Sample β conditional on X, Ω, λ and γ

Step 2: Sample Ω conditional on X, β, λ and γ

Step 3: Sample λ conditional on X, β, Ω and γ

Step 4: Sample γ conditional on X, β, Ω, and λ

Step 5: Compute the impulse response based on the model parameters

Step 6: Repeat Steps 1 to 5 $n_0 + n_1$ times

Step 7: Discard the first n_0 draws, and retain the subsequent n_1 draws

IV. Empirical Results

A. Data

To study the impact of oil price shocks on the main macroeconomic indicators in South Korea, this study utilizes monthly data spanned from January 2001 to September 2023, determined by the availability of industrial production records. These variables include crude oil production (OP), the index of global real economic activity in industrial commodity market as proposed in (Kilian L., 2009) (REA), real price of crude oil (RPO), and macroeconomic indicators of South Korean economy including industrial production (IP) to measure the country's

economic growth, inflation (INF) interest rate by the South Korea Korean consumer price index, interest rate (IR), money supply aggregates (MS), exchange rate (FX), imports (IM) and export (EX) price indices, and foreign direct investment (FDI).[3)]

The crude oil production data is obtained from the Energy Information Administration (EIA) and measured in thousand barrels per day on a monthly basis. The real economic activity index is sourced from the U.S. Department of Energy. Additionally, global crude oil prices are sourced from the U.S. Energy Information Administration, as U.S. Crude Oil Imported Acquisition Cost by Refiners reported in US dollars per barrel on a monthly basis. The other macroeconomic variables of South Korea's economy are sourced from Bank of Korea's Economic Statistics System (ECOS), reported monthly and indexed accordingly. The real price of oil is derived by adjusting the nominal prices deflated by U.S Consumer Price Index. The other variables ΔOP, ΔIP, ΔMS, ΔFX, ΔIM, ΔEX, and ΔFDI are expressed in year-on-year change.

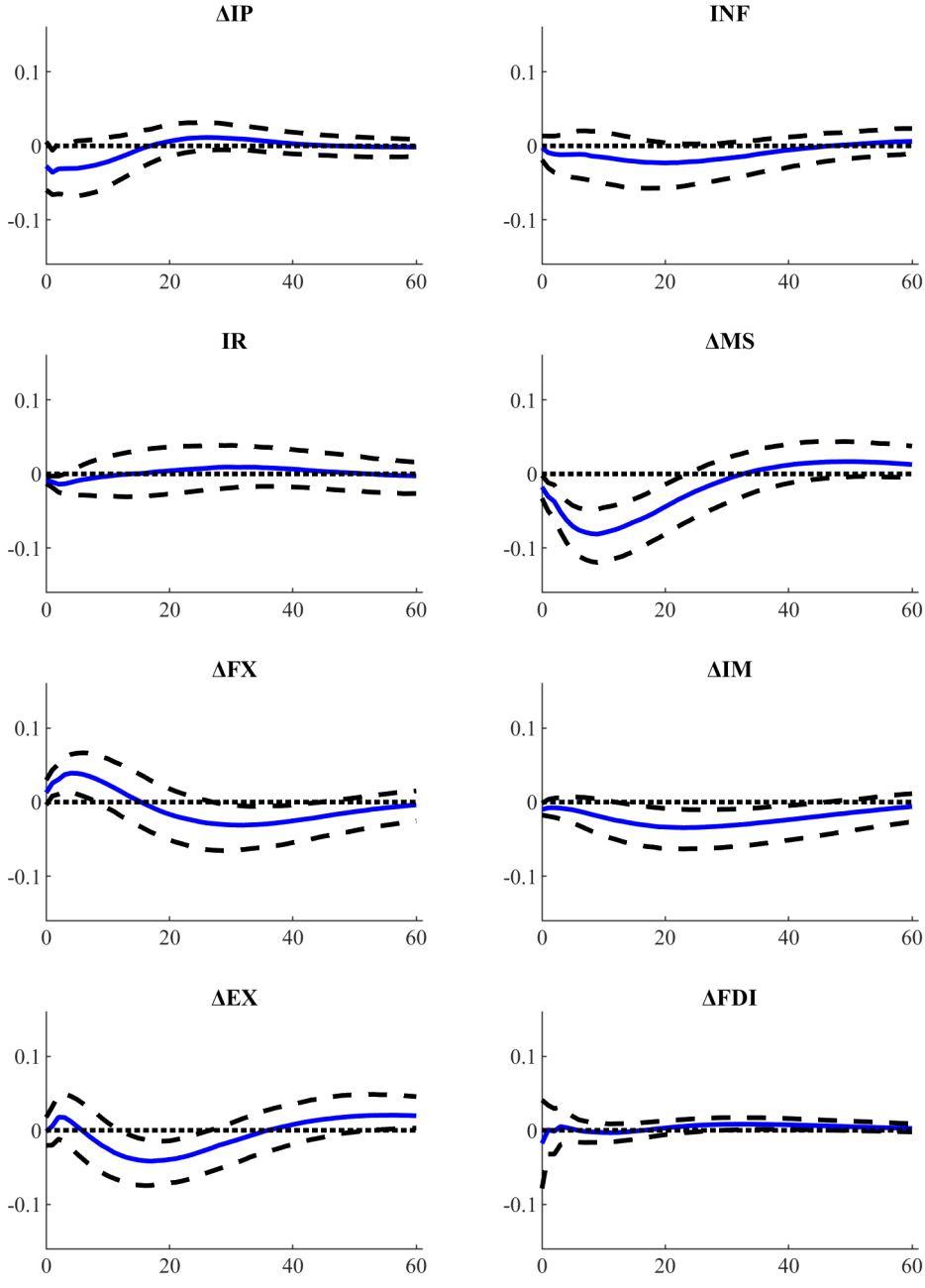
B. Impulse response analysis

To evaluate the impact of oil price shocks, we conduct an impulse response analysis involving three distinct types of oil price shocks, oil supply shock, oil aggregate demand shock, and oil-market specific demand shock, on chosen macroeconomic indicators. Figures 1, 2, and 3 display the impulse response of South Korea macroeconomic variables (growth rates, inflation rates, interest rates, money supply, exchange rate, imports, exports, and FDI) to one-standard-deviation structural innovation in each shock type (namely, oil supply shock, oil demand shock, and oil-specific demand shock) along with 68% confidence bands. As shown in Figure 1, economic growth initially exhibits a negative response for up to nineteen months, suggesting a temporary slowdown in economic activities due to the oil supply shock. This is likely due to disruptions in oil production and high energy costs. However, the negative impact is followed by a moderate positive response indicating a short-lived recovery, which fades after forty months. Our empirical findings coincide with the works of (Jo & Shim, 2024) and (Cunado, Jo, & Perez de Gracia, 2015). (Jo & Shim, 2024) has provided an explanation for the limited impact of oil supply shocks on overall industrial production.[4)]

3) A detailed statistical summary of oil market and South Korean macroeconomic data is provided in the online Appendix A.

4) A detailed explanation of optimal lag selection for LB-SVAR is provided in the online Appendix B.

Figure 1. Impulse response of the macroeconomic indicators to oil supply shock This figure shows the response of growth(ΔIP), inflation(INF), interest rate(IR), money supply(ΔMS), exchange rate(ΔFX), imports(ΔIM), exports(ΔEX), and FDI(ΔFDI) to a one-standard-deviation structural shock in oil supply. The solid line represents the median of posterior distribution and the dashed lines indicate one standard deviation upper and lower bands.



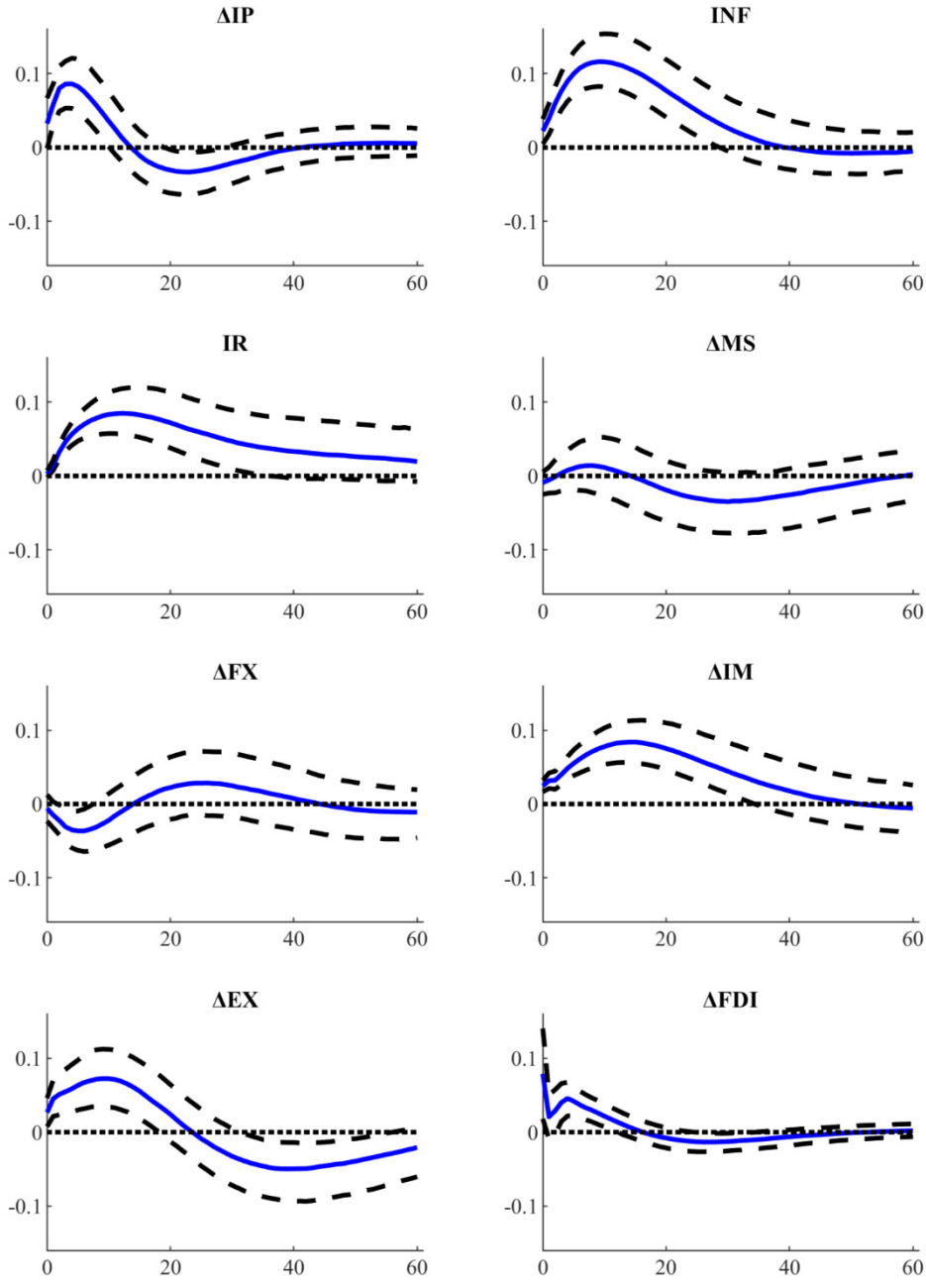
Inflation, on the other hand, experiences an initial decline persisting for up to forty months before returning to baseline levels, which imply a temporary reduction in price levels believed to be driven by decreased demand. The response of interest rates to oil supply shocks is more gradual. There is a slow decrease starting around the fourth month, which diminishes after forty months, reflecting that monetary policy reacts cautiously to oil price fluctuations. Money supply shows an immediate drop at the onset of the shock. This decrease persists for about twenty months before gradually starting to recover around thirty-five months. The initial decline in money supply might be a response to lower economic activity and potentially an attempt to manage inflation.

An oil supply shock prompts an initial positive reaction in the exchange rate for ten months, gradually shifting towards zero by the forty-fifth month, while both imports and exports register negative responses initially, however, the impact on exports is shorter-lived, with effects fading after six months. Imports, on the other hand, take longer to recover, with the negative effect persisting for up to forty months. The decrease in the total imports may be attributed to a decline in crude oil imports resulting from supply disruptions. As for exports, the country largely relies on exporting products whose production relies on petroleum. Therefore, the exports decline due to a decline in oil imports and the country's reserves tend to serve domestic demand. Interestingly, there is no significant impact on foreign direct investment abroad.

Oil supply shocks have had limited effects due to changes in the country's structure that make it less susceptible to such shocks. Importing countries maintain storage facilities to stockpile oil reserves during periods of sufficient available supply, allowing them to manage temporary disruptions in oil supply without experiencing significant disruptions. Despite not having significant domestic reserves, South Korea actively manages its strategic reserves to enhance energy security and stability. This strategic management of reserves may explain our results of the impact of potential oil supply disruptions and shows South Korea's energy resilience in the response of the macroeconomic indicators.

Next, we present in Figure 2 the impulse response of macroeconomic variables to a one-standard-deviation structural innovation in global oil demand. The shock initially exerts a positive impact on economic growth, reflected by the growth in the aggregate industrial production index, which peaks around five months and then gradually diminishes after approximately fifteen months. This initial increase is more likely to be due to its reliance on exports of goods and services which benefits from increased global demand. This implies that the growth in the global economy (stronger global economic activity) can help balance the increase in production costs for the industries. The response of inflation to the demand shock shows a significant inflationary effect that peaks around ten months and dissipates after approximately forty months, indicating that higher production costs are initially passed on to consumers before the economy adjusts.

Figure 2. Impulse response of the macroeconomic indicators to oil aggregate demand shock this figure shows the response of growth(ΔIP), inflation(INF), interest rate(IR), money supply(ΔMS), exchange rate(ΔFX), imports(ΔIM), exports(ΔEX), and FDI(ΔFDI) to a one-standard-deviation structural shock in oil aggregate demand. The solid line represents the median of posterior distribution and the dashed lines indicate one standard deviation upper and lower bands.

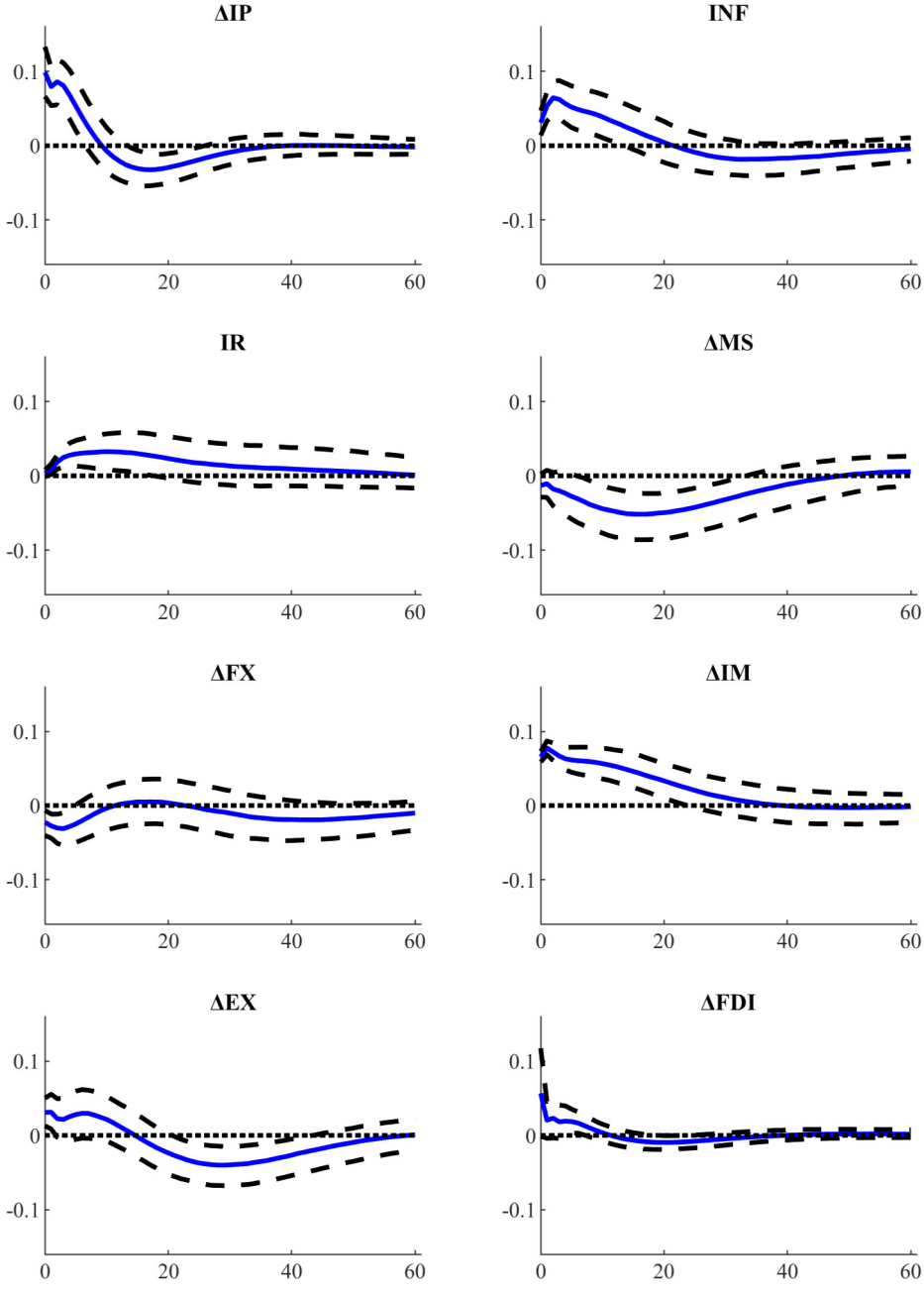


The interest rate response indicates an increase substantially for a prolonged period, peaking around thirteen months and gradually declining over the sixty-month horizon. Bank of Korea (BOK) raises interest rates as a monetary policy measure to counteract the inflationary pressures induced by the shock. The money supply slightly increases initially, as a response to the high inflation and liquidity demand in the economy, as firms and households seek additional funds to support their transactions. The exchange rate declines at the start, reflecting an appreciation of the Korean won against the US dollar. The higher interest rate attracts foreign capital seeking higher returns, further increasing demand for the domestic currency. In addition, when investors perceive that South Korea will benefit from the increased demand for its exports, they increase their investments in Korean assets. However, a depreciation follows around month twenty as the currency weakens. The subsequent depreciation around twenty months indicates a correction as the currency adjusts to new economic conditions.

The import response exhibits a significant increase, peaking around five months and stabilizing by thirty months. The surge in global demand for South Korean products triggers an increase in imports as the country relies on imported materials essential for the production process of its major exports, mainly electronic integrated circuits, cars, refined petroleum oils, automobile parts and accessories, and flat panel displays. As economic conditions tighten, import growth slows down. Export responses mirror this trend, showing significant initial reactions that diminish after thirty months, indicating that increased global demand positively impacts South Korea's export sector initially but stabilizes over time. Finally, the foreign direct investment response shows a small immediate positive effect, likely due to the initial appreciation of the Korean won, which makes foreign investments cheaper for Korean firms, prompting increased overseas investments. As a result, the aggregate demand shock initial impact is positive, with increased economic growth, inflation, and interest rates. The Korean Won appreciates initially but then depreciates as the economy adjusts. Imports rise to meet production needs for exports, which also rise initially but stabilize over time. Finally, there's a small increase in foreign direct investment. An increase in global demand significantly expands to South Korea's export-oriented economy and overall economic growth.

Figure 3 reports the impulse response of macroeconomic variables to oil-specific demand shocks. Economic growth initially responds positively for ten months before transitioning into a downturn, which dissipates after thirty-eight months. This initial positive response suggests that the shock stimulates economic activity initially. When the price of oil increases, South Korea is more likely to depend on its oil reserves for the production in the initial period. However, the subsequent downturn indicates that prolonged high oil prices lead to decreased production and economic growth. Higher cost of oil leads to increased production expenses for manufacturers in industries that rely heavily on oil-based inputs. The price level exhibits a small positive reaction for fifteen months before diminishing, reflecting increased production costs passed on to consumers.

Figure 3. Impulse response of the macroeconomic indicators to oil-market specific demand shock this figure shows the response of growth(ΔIP), inflation(INF), interest rate(IR), money supply(ΔMS), exchange rate(ΔFX), imports(ΔIM), exports(ΔEX), and FDI(ΔFDI) to a one-standard-deviation structural shock in oil specific demand. The solid line represents the median of posterior distribution and the dashed lines indicate one standard deviation upper and lower bands.



To counteract the initial inflationary pressures, the Bank of Korea (BOK) raises the interest rate, which also shows a positive reaction for the first fifteen months before diminishing. The money supply shows a muted response to the shock, indicating limited monetary policy adjustments beyond interest rate changes. The exchange rate initially declines corresponding to an appreciation of the KRW against the USD, then displays a continuous rise for the first eight months before fading after thirty months. The increase of the exchange rate results in a depreciation of the KRW. Both imports and exports show contemporaneous positive reactions to the shock, the imports exhibit a prolonged positive response that diminishes after thirty months, reflecting the country's heavy reliance on imported oil and other goods. Conversely, exports switch to a negative response after about twenty months. The depreciation of the KRW initially increases exports but later leads to a decrease, potentially due to inelastic demand from key export destinations like China, as noted by (Baek, 2023). Despite lower prices resulting from KRW depreciation, demand may remain insensitive, resulting in a decreased overall exports value to China. The shock has had a positive impact on FDI for ten months. The initial increase in FDI abroad could be driven by Korean firms seeking to diversify and hedge against domestic economic uncertainty caused by higher oil prices. Over time, as domestic economic conditions stabilize, the rate of FDI outflows normalizes. Overall oil-specific demand shocks positively impact economic growth, inflation, and interest rates initially, but these effects diminish over time. The exchange rate appreciates before later depreciating, while imports rise significantly and exports eventually decline. Foreign direct investment sees a brief initial increase.

Overall, the results indicate that different types of oil shocks, oil supply shock, global oil demand shock, and oil specific demand shock, affect South Korea's macroeconomic variables in distinct ways. An oil supply shock initially causes a temporary slowdown in economic growth, a decline in inflation, a gradual decrease in interest rates, and a drop in money supply, while the exchange rate appreciates and imports and exports decline. In contrast, an oil aggregate demand shock leads to an immediate increase in global real economic activity, which boosts South Korea's industrial production, results in a significant inflationary pressures, increased interest rates, a slight rise in money supply, an initial appreciation of the exchange rate followed by depreciation, and substantial increases in imports and exports. Lastly, an oil-specific demand shock initially stimulates economic growth and inflation, prompting the central bank to raise interest rates, with the exchange rate showing an initial appreciation followed by depreciation, and both imports and exports reacting positively in the short term before stabilizing. While both shocks, oil aggregate demand shock and oil specific demand shock, have significant effects, the global aggregate demand shock appears to have more positive effect on the Korean economy. It leads to a more significant and sustained increase in the country's economic growth, exports, and potentially currency stability. These shocks are associated with global economic growth, therefore, the country's major trading partners, including China and the United States, experience

economic growth and rise in import demands, creating opportunities for Korean exporters. Korea's industrial base and its export dominance means that it is well-positioned to capitalize on increased global demand. The oil supply shock, on the other hand, has some initial positive effects but is eventually outweighed by the negative. These results are consistent with those of (Baek, 2024) who found that oil supply shocks do not have a significant impact on Korea's economy in both the short and long-run, whereas aggregate and oil-specific demand shocks have more persistent impact.

V. Conclusion

This study explores the dynamic impact of oil price shocks on South Korea's macroeconomic variables using a large-scale structural Bayesian Vector Autoregressions (LS-BVAR) to address the high dimensionality and parameter proliferation. Our findings reveal that oil price shocks trigger different economic reactions. Oil supply shocks initially reduce South Korea's economic growth, inflation, and imports, with no significant impact on FDI abroad. Conversely, oil demand shocks boost economic growth, due to the increased industrial production caused by a surge in the global real economic activity, causes an increase in inflation, leading to higher interest rates and a more volatile currency, with both imports and exports increasing, while FDI sees a small positive effect. Oil-specific demand shocks initially stimulate growth and inflation but eventually lead to a downturn in economic activity, affecting imports, exports, and exchange rates.

The study highlights South Korea's resilience to oil supply shocks, attributed to strategic oil reserves and effective monetary policies. The distinct effects of different oil shocks show the importance of strategic policy responses that align with global economic trends. South Korea benefits more from global aggregate demand shocks, which significantly and sustainably increase economic growth, exports, and currency stability. The country also stands to gain significantly from deeper economic integration given its position as a major export-oriented economy, policymakers should leverage the positive effects of global aggregate demand by deepening economic integration and trade agreements that could facilitate to easier movement of goods and services to major trading partners. The importance of this strategy is evident in enhancing export competitiveness and capitalizing on increased global demand and participating in regional economic blocs, while managing short-term inflationary effects. The Korean government's policies aiming to improve investment in research and development, and trade agreements, help Korean firms maintain a competitive advantage in the global market. Furthermore, policy shifts towards greener energy and carbon reduction targets in major economies are reshaping the landscape of global energy consumption. South Korea, like many other nations, is increasingly investing in renewable energy sources and enhancing energy efficiency to reduce its dependency

on oil. This transition not only aims to mitigate the economic instability associated with oil price shocks but also aligns with global efforts to combat climate change. As the world continues to navigate these dynamic and often unpredictable factors, the oil market remains a barometer of broader economic and geopolitical trends, reflecting the ongoing transition towards a more diversified and sustainable energy future. The interplay between traditional energy markets and emerging renewable technologies will be crucial in determining the resilience and stability of South Korea's economy in the face of future oil price fluctuations.

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