Global Oil Price and its impact on South Korean macroeconomy

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Abstract

This study contributes to the empirical macroeconomics literature about South Korean economy by employing a Bayesian Time Varying Parameter model to analyze the changing effects of the global crude oil price change onto the South Korean macroeconomy.

The inner volatilities of the macroeconomic variables are separated out using the time-varying variance terms and such incorporation can yield a more robust impulse response analysis. Compared to the existing literature, this study finds the initial oil shock spontaneously impact the South Korean inflation, but there exists a time-variation in the initial impacts after 2008.

The impact to the industrial production also changes over time; TVP model can capture the changing impact of both initial and 1-period ahead impulse response and it can show the changing initial response from 2014: from year 2008 the intial impact drops and by 2014 the sign flips. Such change is discussed by the trade literature, as China is catching up in terms of technology and economic status of South Korea.

Model

$$A_t y_t = F_0 + F_1 y_{t-1} + \cdots + F_p y_{t-p} + \nu_t \quad \text{where} \quad \nu_t \sim N(0, \Sigma_t \Sigma_t')$$

The structural form matrix A_t represents the simultaneous relations of the observed variables to the structural shock. I construct this matrix to be identified by recursive ordering identification, assuming that A_t is lower-triangular square matrix such that:

$$A_t = \begin{pmatrix} 1 & 0 & \cdots & 0 \\ \alpha_{21,t} & 1 & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ \alpha_{k1,t} & \cdots & \alpha_{k(k-1),t} & 1 \end{pmatrix} \quad s.t. \quad A_t^{-1} = \begin{pmatrix} 1 & 0 & \cdots & 0 \\ \tilde{a}_{21,t} & 1 & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ \tilde{a}_{41,t} & \cdots & \tilde{a}_{k(k-1),t} & 1 \end{pmatrix}$$

Every lower-triangular matrix is invertible so we can write as a reduced form equation:

$$y_t = A_t^{-1} F_0 + A_t^{-1} F_1 y_{t-1} + \cdots + A_t^{-1} F_p y_{t-p} + A_t^{-1} \nu_t$$

$$\implies y_t = B_0 + B_1 y_{t-1} + \cdots + B_p y_{t-p} + u_t \tag{1}$$

Model

Stacking the row elements of the B_i's gives β which is a $(k + k^2p) \times 1$ vector. Defining $X_t = I_k \otimes (1, y_{t-1}, \ldots, y_{t-p})$ where $\otimes$ is the Kronecker product, **Equation (1)** can be reduced to:

$$y_t = X_t\beta + A_t^{-1}\Sigma_t\varepsilon_t \quad \text{where } \varepsilon_t \sim (N, I_k) \tag{2}$$

Notice that the reduced form error $u_t = A_t^{-1}\nu_t = A_t^{-1}\Sigma_t\varepsilon_t$ because $\nu_t \sim N(0, \Sigma_t\Sigma_t')$ and $\varepsilon_t \sim N(0, I_k)$. Here Σ_t is a $k \times k$ diagonal matrix of the variance of the error terms $\text{diag}(\sigma_{1,t}, \ldots, \sigma_{k,t})$.

By incorporating the time-varying factor to the β of **Equation (2)** gives the Time-Varying Parameter Structural VAR with Stochastic Volatility model:

$$y_t = X_t\beta_t + A_t^{-1}\Sigma_t\varepsilon_t \quad t = p + 1, \ldots, n \tag{3}$$

Identification via ordering restriction

$$y_t = X_t\beta_t + A_t^{-1}\Sigma_t\varepsilon_t \quad \text{where } \varepsilon_t \sim (N, I_k)$$

where $u_t = A_t^{-1}\Sigma_t\varepsilon_t = A_t^{-1}\nu_t$ is a reduced form error :

$$\begin{pmatrix} u_t^{oil} \\ u_t^{\Delta cpi} \\ u_t^{\Delta ip} \\ u_t^{\Delta ue} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ \tilde{a}_{21,t} & 1 & 0 & 0 \\ \tilde{a}_{31,t} & \tilde{a}_{32,t} & 1 & 0 \\ \tilde{a}_{41,t} & \tilde{a}_{42,t} & \tilde{a}_{43,t} & 1 \end{pmatrix} \begin{pmatrix} \nu_t^{oil} \\ \nu_t^{inf} \\ \nu_t^{do} \\ \nu_t^{ue} \end{pmatrix}$$

ν_t^{oil} refers to global oil shocks,
ν_t^{inf} refers to South Korean inflation shocks,
ν_t^{do} refers to South Korean output shocks, and
ν_t^{ue} refers to South Korean unemployment shocks

- Identification is done through the ordering of the variable. This assumption indicates one-directional channel of South Korean macroeconomy as a small open economy; the global oil price change can impact the South Korean economy but not vice versa.

Data

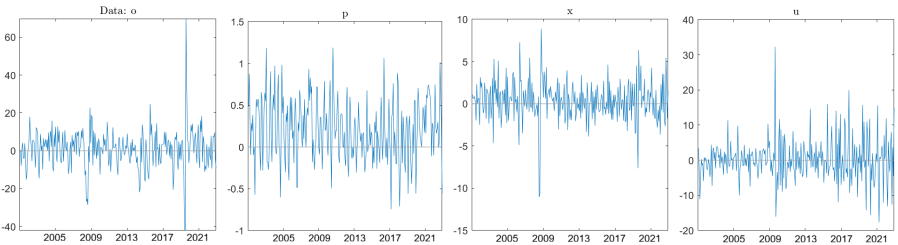


Figure: Global Oil, Industrial Production growth, Inflation growth and Unemployment change

1. Global Price of WTI Crude Oil in percentage change term
2. South Korean Consumer Price Index All items total in percentage change term
3. South Korean Production, Sales, Work Started and Orders Production Volume Economic Activity Industry (Except Construction) in percentage change term
4. Harmonized Unemployment Monthly Levels Aged 25 and over All Persons for South Korea in percentage change term

Stochastic Volatility

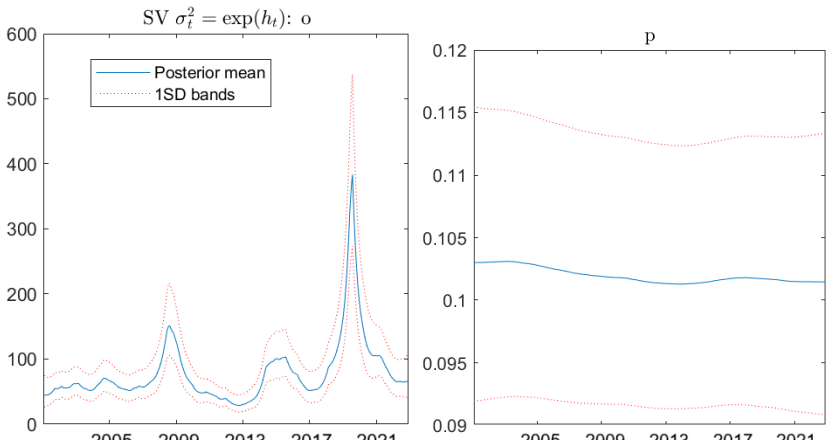


Figure: Stochastic Volatility terms of the Oil Price and Inflation

Stochastic Volatility

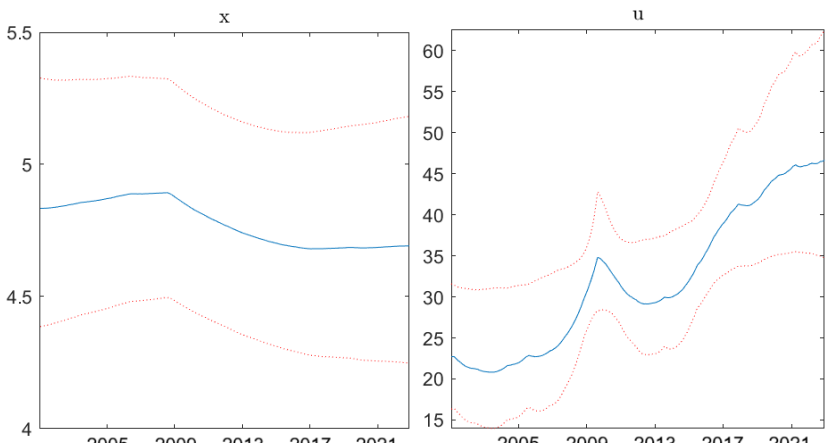
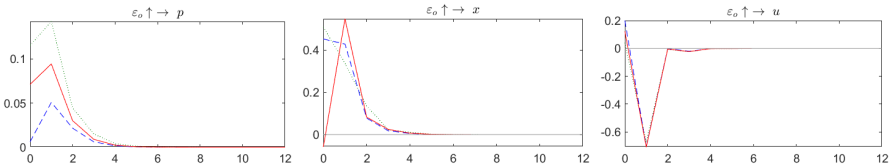


Figure: Stochastic Volatility terms of Output and Unemployment

Global Oil price on Korean macroeconomy



Impulse Response function periods: 2002, 2010, 2019

In one liner: an increase in Global Oil price leads to:

1. an increase in the Korean inflation,
2. increase in production and
3. increase in unemployment initially but it later restored.

2. is a bit interesting result; it is an empirical puzzle and explained as:
South Korea benefits more from global aggregate demand shocks, which significantly and sustainably increase economic growth, exports, and currency stability. (Arsalane & Kim (2024, Journal of Economic Integration))

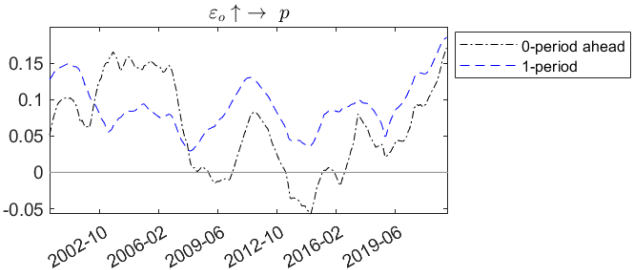


Figure: Initial impulse responses of inflation

Initial oil shock spontaneously impact the South Korean inflation, but during 2002 to 2007 the initial impact was greater than the rate of inflation in next period, i.e. the inflation shock has decayed during those years.

But not after 2008, which the inflation has an amplification from the oil shock, as we can see the one-period ahead impulse response is greater than the initial shock. Also we can see that from 2020 the impulse response from the oil shock has an upwarding trend.

Impact of Global Oil price change to Korean Inflation

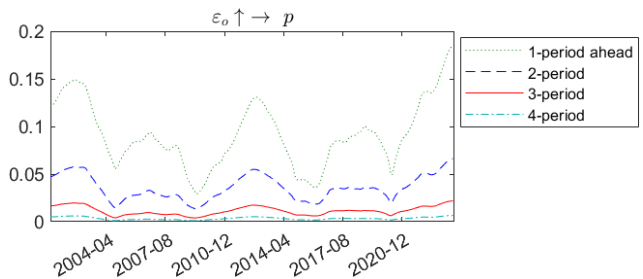


Figure: Impulse Response function in terms of time horizon

There exists a time-variation in the impact of oil shock to inflation. The impulse response of the 1-month ahead effect is positive for all periods and this generally disappears by 3 to 4-months after.

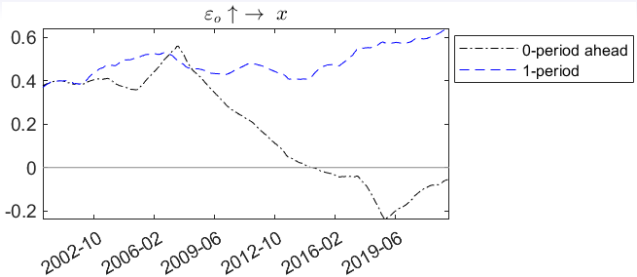


Figure: Initial impulse responses of output

This is an interesting part of this research that differs from the previous literature. Basically the general explanation is: the global oil price change/shock during early 21 centuries is demand-driven typically by the expansion of Chinese economy: aggregate demand shock from outside benefits Korea although the price of oil increases, because the oversea demand compensates for it.

TVP model can capture the changing impact of both initial and 1-period ahead impulse response and it can make a contribution in the changing initial response from 2016. The change from the year 2014 is discussed by the trade literature, as China is catching up in terms of technology and economic status of South Korea. This is a novel finding that is not in the existing papers.

Impact of Global Oil price change to Korean output

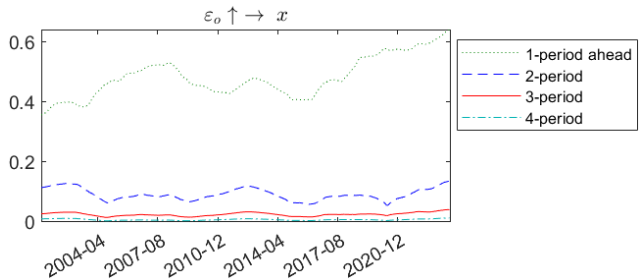


Figure: Impulse Response function in terms of time horizon

We can see, although it is not strictly monotonic, a gradual increase in the impact of the oil price change to the output in terms of the impulse response function of 1-month ahead period.
This impact is short-lasting, by 3 to 4 months the effect seems to disappear.

Impact of Global Oil price change to Korean Unemployment

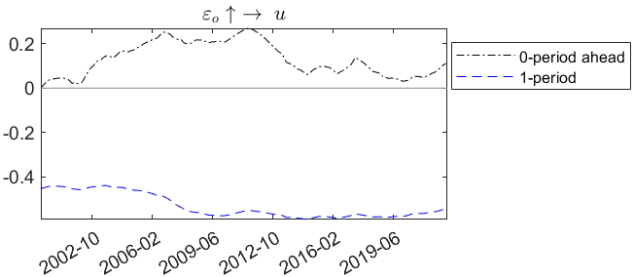


Figure: Initial impulse response of unemployment

Global oil price initially increases the percentage change in unemployment of people over 25 years old. What is interesting is, the unemployment rate drops in the impulse response function of 1-month ahead but it returns back and disappear very quickly. This is quite consistent tendency across the time. This drop in unemployment, meaning the increase in employment for at least short period time, could be related to the consistent positive 1-month period impulse response of the industrial production. For a demand-driven shock the companies could anticipate the increase in demand for Korean production from overseas, which could compensate the employment condition and the impact on unemployment could be quickly disappear. Also Korea is notorious for its rigid labor market; firms cannot fire full-time employees easily.

Impact of Global Oil price change to Korean Unemployment

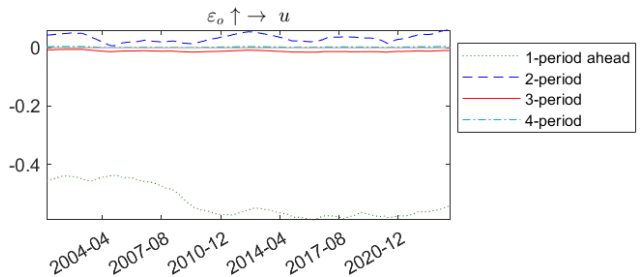


Figure: Impulse Response function in terms of time horizon

The drop in unemployment in 1-month ahead impulse response quickly disappears in the next month.