Surprise versus News Shocks: New Keynesian Small Open Economy

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Abstract

This paper examines the influence of monetary policy and productivity news shock in small open economy. Previous news-driven business cycle analyses which are mainly based on closed economy model is inappropriate for the analysis of small open economy. Based on a small open New Keynesian model, we apply to Korean economy. The Bayesian estimates of parameters and impulse responses describe major features of the Korean economy. The empirical findings are summarized as follows: **1.**Monetary policy and productivity news has larger effect on some variables than surprise shock, which means prior information before economic shock changes the effect of the shocks. **2.**Forecast error variance decomposition implies domestic news shocks has larger influence with a longer forecast horizon. **3.**Impulse responses implies that the communication in monetary policy and efforts for accurate evaluation of technology are able to strengthen the influence of monetary policy and productivity shock by enlarging information set of economic agents. We conduct senstivitiy test with regard to the degree of openness. Sensitivity test result reveals that previous actions to enlarge the information set of economic agents have state dependent effect.

Keywords: News Shock, Small Open Economy, Bayesian DSGE

JEL Codes: C11, C51, E12, E32, E52

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1 Introduction

Expectation formation of economic agents and its change have long been assumed to cause economic fluctuations. This idea traces back to Pigou (1929) and Clark et al. (1934). After development of DSGE modeling and IT bubble in United States, expectation-driven(news-driven) business cycle is reviewed again by Beaudry and Portier (2004), Beaudry and Portier (2006) and Jaimovich and Rebelo (2008). Many empirical works try to identify news shock and analyze the effect of news shock in the US economy focusing on whether the news-driven business cycle model is able to replicate the comovement of macroeconomic data to the news on total factor productivity(hereafter TFP).[1]

Empirical side of news-driven business cycle literature is mainly based on closed economy which may be inappropriate for countries such as Canada, Austrailia, Korea, and UK. Perhaps, United States and European Union are also insufficiently described by closed economy model if we are interested in long run economy reflecting the reactions of neighboring countries to the economic policies by main countries(US and EU). These interrelationship emphasizes the necessity of open economy environment in news-driven business cycle model. AlthoughJaimovich and Rebelo (2008) and Kamber et al. (2017) consider a small open economy model to generate the macroeconomic comovement in response to news shock, the investigation of the difference in the propagation of news shock between closed and open economy is less emphasized.

In this paper, we focus on the effects of news shocks in small open New Keynesian(hereafter NK) model. The objective of this paper is not to propose a model which replicate all the major comovement or finds the source of business cycle in the best fitting model. Instead, we aim to examine the news shock effect and role of openness in small open economy before constructing sophisticated news-driven business cycle model with New Keynesian small open economy properties. To this end, we separate the effect of news shock and that of surprise shock. Apart from news on TFP shock, we also consider news on monetary policy as Milani and Treadwell (2012). Expectations about future monetary policy is linked to expected inflation and aggregate demand. Expectation channel activated by unconventional monetary policy and forward guidance is regarded as a key factor of the recovery from global financial crisis in 2008(hereafter GFC).

We analyze Korean economy as a case of small open economy. Analysis of news shocks in Korean economy using Dynamic Stochastic General Equilibrium(hereafter DSGE) model is still insufficient for fully understanding the role of news shocks. Lee (2016) adopts similar approach to Khan and Tsoukalas (2012) and show news improve the fit of model in explaining business cycle of Korean economy, and news shock is mainly important of interest rate variation. Hur (2015) estimates a small open economy real business cycle model with news shock of technology. It is shown that anticipated technology shock causes weak fluctuations and its contribution to output and consumption varies over time. But Hur (2015) does not assume nominal rigidity, which cannot anlayze the real effect of monetary policy.

The rest of the paper is structured as follows. Section 2 describes New Keynesian small open economy model with news shocks. Section 3 explains the Bayesian approach and data. Afterward, we

[1] see Fujiwara et al. (2011), Khan and Tsoukalas (2012), and Schmitt-Grohé and Uribe (2012).

suggest the estimation results in section 4. These include posterior distribution of model parameters and impulse response analysis of news shocks. Finally, we close the paper with reviewing main results and implication of this paper in section 5.

2 New Keynesian Small Open Economy

This paper employs a small open NK model with nominal and real rigidities by Calvo-staggered price, incomplete pass-through and habit formation in consumption based on Gali and Monacelli (2005), Monacelli (2005) ,and Justiniano and Preston (2010). We heavily rely on a medium-scale DSGE model of Justiniano and Preston (2010) and add news shocks as in Fujiwara et al. (2011) and Milani and Treadwell (2012). We consider baseline model with only domestic news shocks and extend the model including foreign news shocks. Apart from high-end DSGE model for New Keynesian small open economy, the simplicity of the model is to narrow down our focus on the analysis of news shock effect in open economy environment.

2.1 Households

A representative household chooses consumption and labor to maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\epsilon_{g,t} \frac{(C_t - H_t)^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right]$$

where β is the discount factor or rate of time preference, σ is the inverse elasticity of intertemporal substitution, φ is the inverse (Frisch) labor supply elasticity, and $\epsilon_{g,t}$ is a preference shock. N_t denotes hours of labor or labor input, and $H_t = hC_{t-1}$ explicitly forms external habit formation for the optimizing household, $h \in (0, 1)$. C_t is a composite consumption index of domestic and foreign produced goods:

$$C_t \equiv \left((1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

where $\alpha \in [0, 1]$ is the measurement of openness of economy in the sense of share of import, and $\eta > 0$ is the elasticity of substitution between home and foreign goods. $C_{H,t}$ and $C_{F,t}$ are Dixit-Stiglitz aggregates of the domestic and foreign produced goods given by

$$C_{H,t} = \left[\int_0^1 C_{H,t}(i)^{\frac{\epsilon-1}{\epsilon}} di \right]^{\frac{\epsilon}{\epsilon-1}} \quad and \quad C_{F,t} = \left[\int_0^1 C_{F,t}(i)^{\frac{\epsilon-1}{\epsilon}} di \right]^{\frac{\epsilon}{\epsilon-1}}$$

where $\epsilon > 0$ is the elasticity of substitution between varieties of goods which is assumed to be the same in both economies. The household's optimization problem is completed given the following flow budget constraint.

$$\int_0^1 \{P_{H,t}(i)C_{H,t}(i) + P_{F,t}(i)C_{F,t}(i)\}di + E_t[Q_{t,t+1}D_{t+1}] \leq D_t + W_tN_t + T_t$$

for all $t = 1, 2, \ldots, \infty$, where $P_{H,t}(i)$ and $P_{F,t}(i)$ denote the price of domestic and foreign produced good i, respectively, $Q_{t,t+1}$ is the stochastic discount factor and D_{t+1} denotes the payment arising from the portfolio held at the end of period t. W_t is nominal wage and T_t denotes lump-sum taxes and(or) transfers.

Given the aggregates of the domestic and foreign produced goods, household optimization problem requires the optimal allocation of expenditure. Optimal allocations for good i is achieved by following demand functions:

$$C_{H,t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon} C_{H,t} \quad and \quad C_{F,t}(i) = \left(\frac{P_{F,t}(i)}{P_{F,t}}\right)^{-\epsilon} C_{F,t}$$

for all i. Futher assuming symmetry of all i goods, optimal allocation for domestic and foreign goods is given by:

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \quad and \quad C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t$$

where $P_t = \{(1-\alpha)P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta}\}^{\frac{1}{1-\eta}}$ is the consumer price index. Total consumption expenditure for the domestic household is given by $\int_0^1 \{P_{H,t}(i)C_{H,t}(i) + P_{F,t}(i)C_{F,t}(i)\}di = P_{H,t}C_{H,t} + P_{F,t}C_{F,t} = P_tC_t$. Previous flow budget constraint is rewritten as

$$P_tC_t + E_t[Q_{t,t+1}D_{t+1}] \leq D_t + W_tN_t + T_t$$

Solving the household's maximization problem yields the following first-order conditions:

$$\lambda_t = \frac{1}{P_t}\epsilon_{g,t}(C_t - H_t)^{-\sigma}$$

$$N_t^{\varphi} = (C_t - H_t)^{-\sigma}\frac{W_t}{P_t} \tag{1}$$

$$1 = \beta R_t E_t\left[\frac{(C_{t+1} - H_{t+1})^{-\sigma}}{(C_t - H_t)^{-\sigma}}\frac{P_t}{P_{t+1}}\frac{\epsilon_{g,t+1}}{\epsilon_{g,t}}\right] \tag{2}$$

where $R_t = \frac{1}{E_t[Q_{t,t+1}]}$ is the gross nominal return on a risk free one-period bond maturing in $t+1$. Equation (1) is intratemporal optimality condition which describes the labor supply. Equation (2) forms Euler equation for intertemporal consumption. We assume the foreign economy has identical preferences with domestic economy. Thus, a similar set of optimality conditions holds, but the influence of domestic economy on foreign economy is negligible. Foreign consumption approximately contain only foreign produced goods, $C_t^* = C_{F,t}^*$ and $P_t^* = P_{F,t}^*$. Equation (1) and (2) also hold for foreign economy with superscript (*).

2.2 International Risk Sharing and Uncovered Interest Parity

To derive international risk sharing condition and uncovered interest parity in small open econonmy, we start defining the terms of trade as $S_t = \frac{P_{F,t}}{P_{H,t}}$ or in logs $s_t = p_{F,t} - p_{H,t}$. The lower case which has its corresponding upper case indicates logarithmic of the the upper case variable or log deviation from steady state value. The terms of trade is the price of foreign produced goods per unit of the price of home produced goods. In ohter words, an increase in s_t means improvement in competitiveness of domestic produced goods relative to foreign goods. Real exchange rate(ξ) and law of one price gap($\Psi_{F,t}$) are defined as follow

$$\xi_t \equiv \frac{\varepsilon_t P_t^*}{P_t} \quad and \quad \Psi_{F,t} \equiv \frac{\varepsilon_t P_t^*}{P_{F,t}}$$

where ε_t is nominal exchange rate, the price of foreign currency in terms of domestic currency. The rise of nominal exchange rate implies decrease in the value of domestic currency. If LOP holds, $\Psi_t = 1$, then import price index $P_{F,t}$ is the world price index multiplied by nominal exchange rate. LOP gap measures a discrepancy or inverse mark-up between the world price of foreign produced goods and the domestic price of imported foreign produced goods.

Representative household in the foreign economy confronts exactly the same optimization problem with identical preference with domestic household, and the influences from the domestic economy is negligible. Thus, intertemporal conditions which determine holdings of domestic and foreign bonds also satisfy for foreign economy. Under the assumption of complete international financial markets and perfect capital mobility, both intertemporal optimality condition must satisfy

$$\beta\frac{\lambda_{t+1}}{\lambda_t} \cdot \frac{P_t}{P_{t+1}} = Q_{t,t+1} = \beta\frac{\lambda^*_{t+1}}{\lambda^*_t} \cdot \frac{P^*_t}{P^*_{t+1}} \cdot \frac{\varepsilon_{t+1}}{\varepsilon_t}$$

Assuming two countries have the same habit formation parameter(h), following international risk sharing condition must hold in equilibrium,

$$C_t - hC_{t-1} = \vartheta(C^*_t - hC^*_{t-1})\xi_t^{-\frac{1}{\sigma}} \tag{3}$$

where ϑ is some constant depending on initial asset position.

The assumption of complete international financial markets yields another essential condition in international finance, the uncovered interest rate parity(UIP) condition which is given by

$$\frac{R_t}{R^*_t} = E_t[\frac{\varepsilon_{t+1}}{\varepsilon_t}] \tag{4}$$

UIP condition characterizes the relationship among the expected change of nominal exchange rate, domestic interest rate and foreign interest rate.

2.3 Firms

There is a continuum of identical firms in monopolistically-competitive markets. The jth firm produces a differentiated good, $Y(j)$, using a linear technology production fuction:

$$Y_t(j) = A_t N_t(j)$$

where $N_t(j)$ is the employment of jth firm in period t and $a_t \equiv logA_t$ represents the productivity which is assumed to be identical for all firms and follows an AR(1) process, $a_t = \rho_a a_{t-1} + \epsilon_{a,t}$. Aggregate output is written as

$$Y_t = \left[\int_0^1 Y_t(j)^{-(1-\nu)} dj\right]^{-\frac{1}{1-\nu}}$$

We assume aggregate employment by the sum of employment across firms as follows,

$$N_t = \int_0^1 N_t(i) di.$$

Log-linear approximation of aggregate production function assuming a symmetric equilibrium across all j firms is $y_t = a_t + n_t$. Given the technology and output, the real total cost is $TC_t = \frac{W_t Y_t}{P_{H,t} A_t}$ and the log of real marginal cost is $mc_t = w_t - p_{H,t} - a_t$, for all domestic firms.

In the domestic economy, we assume the monopolistic firms and they are assumed to set price with Calvo-style. In any period t, only a fraction $1 - \theta_H(\theta_H \in [0, 1])$ of firms have a chance to set its price optimally, while the other fraction θ_H cannot. Instead, a fraction θ_H of firms adjust the price according to the indexation rule,

$$P_{H,t}(j) = P_{H,t-1}(j) \left(\frac{P_{H,t-1}}{P_{H,t-2}}\right)^{\delta_H}$$

where the degree of indexation to the previous period's inflation rate is δ_H. Let's denote $\bar{P}_{H,t}$ is the price level that optimally set by firms who have opportunity to reset their prices in period t. The Dixit-Stiglitz aggregate price index evolves according to:

$$P_{H,t} = \left((1 - \theta_H)\bar{P}_{H,t}^{1-\epsilon} + \theta_H \left[P_{H,t-1} \left(\frac{P_{H,t-1}}{P_{H,t-2}}\right)^{\delta_H}\right]^{1-\epsilon}\right)^{\frac{1}{1-\epsilon}}$$

To set a new price, $\bar{P}_{H,t}$, a fraction $(1 - \theta_H)$ of firms maximize the present value of its profit stream subject to the sequence of demand schedule. Assuming symmetric problem, the maximization problem in aggregate terms is given by

$$\max_{\bar{P}_{H,t}} \sum_{k=0}^{\infty} (\theta_H)^k E_t Q_{t,t+k}(Y_{t+k}(\bar{P}_{H,t} - MC_{t+k}))$$

subject to

$$Y_{t+k} \leq \left(\frac{\bar{P}_{H,t}}{P_{H,t+k}}\right)^{-\epsilon} (C_{H,t+k} + C^*_{H,t+k})$$

where Y_{t+k} refers to the production in period $t+k$ for a firm that resets its price in period t. First-order condition of given optimization problem is

$$\sum_{k=0}^{\infty} \theta_H^k E_t \left[Q_{t,t+k} Y_{t+k}(\bar{P}_{H,t} - \frac{\epsilon}{\epsilon - 1} MC_{t+k})\right] = 0$$

where MC_{t+k} is the real marginal cost. Substituting intertemporal consumption euler equation into the previous equation gives

$$\sum_{k=0}^{\infty}(\beta\theta_H)^k E_t\left[C_{t+k}^{-\sigma}Y_{t+k}\frac{P_{H,t-1}}{P_{t+k}}\left(\frac{\bar{P}_{H,t}}{P_{H,t-1}}-\frac{\epsilon}{\epsilon-1}MC_{t+k}\frac{P_{H,t+k}}{P_{H,t-1}}\right)\right]=0$$

For retail firms, we assume the law of one price is valid at the dock(wholesale stage) for imports. However, retail firms behave like monopolistic firms and they are able to set prices over the marginal cost because of incomplete pass-through caused by inefficient distribution procedure. As a consequence, the price setting behavior of the domestic import retailers is structuralized by similar to previous equation and the marginal cost is replaced by law of one price gap.

2.4 Equilibrium Conditions

Goods market clearing condition in domestic economy meets when the domestic output is entirely consumed by domestic and foregin consumers.

$$y_t = (1-\alpha)c_{H,t} + \alpha c_{H,t}^{*} \tag{5}$$

The demands for domestic produced goods are

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta}C_t \quad and \quad C_{H,t}^{*} = \alpha\left(\frac{P_{H,t}}{\varepsilon_t P_t^{*}}\right)^{-\eta}C_t^{*}$$

and the log-linear approximation is given by

$$\begin{aligned} c_{H,t} &= -\eta(p_{H,t}-p_t)+c_t \\ &= \alpha\eta s_t + c_t \end{aligned}$$

$$\begin{aligned} c_{H,t}^{*} &= -\eta(p_{H,t}-e_t-p_t^{*})+c_t^{*} \\ &= \eta(p_{F,t}-p_{H,t}-\psi_{F,t})+c_t^{*} \\ &= \eta(s_t+\psi_{F,t})+c_t^{*}. \end{aligned}$$

Substituting previous equations into (5) yields goods market clearing condition for small open economy which is given by

$$y_t = (1-\alpha)c_t + \alpha c_t^{*} + (2-\alpha)\alpha\eta s_t + \alpha\eta\psi_{F,t}$$

where $\psi_{F,t} \equiv log(\Psi_{F,t})$.

The behavior of the domestic monetary authority is assumed to follow the Taylor rule

$$i_t = \rho_i i_{t-1} + \psi_\pi \pi_t + \psi_y y_t + \epsilon_{i,t}$$

the nominal interest rate is influenced by past interest rates, contemporaneous inflation, current and output. The last term, $\epsilon_{i,t}$ represents a monetary policy shock.

2.5 News Shocks

Based on the concept of news shock from Fujiwara et al. (2011) and Milani and Treadwell (2012), we assume that the agents are able to obtain the information of future change in technology and monetary policy.

To understand news shock and its information structure concisely, consider following arbitrary AR(1) process,

$$z_t = \rho_z z_{t-1} + \epsilon_{z,t}$$

where $\epsilon_{z,t} \sim i.i.d.N(0, \sigma_z^2)$ is an arbitrary shock. We write $\epsilon_{z,t}$ as a summation of the unanticipated(purely 'surprise', ν_t) and the anticipated component(news, ν_t^*), $\epsilon_{z,t} = \nu_t + \nu_t^*$. This generates different information structure to agents at the beginning of period t, where ν_t is unknown but ν_t^* is known. Allowing for the difference in arrival of the news, we write ν_t^* as a summation of news shocks, $\sum_{h=1}^{H} \nu_{t-h}$ where ν_{t-h} represents news of the change in h-period-ahead variable acquired at period $t-h$, where $0 < h \leq H$. News shock is identified with following assumption, $\nu_{t-h} \sim i.i.d.N(0, \sigma_{zh}^2)$ for $h = 0, 1, 2, \ldots, H$, which implies no correlation between news and surprise shock and zero correlation among news shock with different horizons. If agents are able to obtain news about future variable up to four-period-ahead($H = 4$), then the process is rewritten as

$$\begin{aligned} z_t &= \rho_z z_{t-1} + \nu_t + \nu_t^* \\ &= \rho_z z_{t-1} + \nu_t + \nu_{t-1} + \nu_{t-2} + \nu_{t-3} + \nu_{t-4}. \end{aligned}$$

The choice of appropriate news horizon is somewhat arbitrary. One way of choosing optimal news horizon is comparing marginal likelihood of the models with different news horizon. The specification of news in continuous period, like $1 \leq h \leq H$, significantly increases the number of parameters in the model if H is large. Considering the parsimony of the model, news shock can be embeded with a specific horizon each time. In this paper, we use relatively long news horizon, eight quarters($H = 8$). We choose discrete specific horizon only 4-quarter and 8-quarter for model parsimony. Hence, we consider the productivity shock and monetary policy shock as follows[2]

$$\begin{aligned} \epsilon_{a,t} &= \rho_a \epsilon_{a,t-1} + \nu_{a,t} + \nu_{a,t-4} + \nu_{a,t-8} \\ \epsilon_{i,t} &= \nu_{i,t} + \nu_{i,t-4} + \nu_{i,t-8} \\ \epsilon_{a,t}^* &= \rho_a^* \epsilon_{a,t-1}^* + \nu_{a,t}^* + \nu_{a,t-4}^* + \nu_{a,t-8}^* \\ \epsilon_{i,t}^* &= \nu_{i,t}^* + \nu_{i,t-4}^* + \nu_{i,t-8}^* \end{aligned}$$

where $\epsilon_{a,t}$ and $\epsilon_{i,t}$ represent technology shock and monetary policy shock. Superscript $(*)$ indicates the shocks from foreign economy. We set our baseline model with only domestic news shocks and extend the model including news transferred from foreign economy. The extended model enables the

[2]We restrict the news horizon only upto two-year-ahead news with the same reasons by Schmitt-Grohé and Uribe (2012). The optimal news horizon is also shown to be 4,8 quarters in the model by the similar methods of Fujiwara et al. (2011) and Milani and Treadwell (2012), which choose one maximizing marginal likelihoods calculated using Geweke's modifed harmonic mean approximation for alternative horizon for news shock within 8 quarters.

analysis of foreign news effect. If the model estimates and impulse response functions between baseline model and extended model are not considerably different, we are able to employ the extended model for further analyses in news-driven business cycle framework with small open economy.

2.6 Linearized System

Small open NK model consists of first-order conditions of optimization problems, equilibrium conditions, and monetary policy. These equations form a system of nonlinear equations. To do empirical analysis easily, we apply log-linearization on those equations using Taylor series approximation around non-stochastic steady state. Variables in the log-linearized equation can be interpreted as log deviations from their steady state values.

The intertemporal consumption Euler equation is given by

$$c_t - hc_{t-1} = E_t(c_{t+1} - hc_t) - \frac{1-h}{\sigma}(i_t - E_t\pi_{t+1}) + \frac{1-h}{\sigma}(\epsilon_{g,t} - E_t\epsilon_{g,t+1})$$

where π_t is CPI inflation rate.

Goods market clearing condition is given by

$$(1-\alpha)c_t = y_t - \alpha\eta(2-\alpha)s_t - \alpha\eta\psi_{F,t} - \alpha y_t^* \tag{6}$$

$\psi_{F,t}$ is the log of law of one price gap($\Psi_{F,t}$).

$$\psi_{F,t} \equiv log(\Psi_{F,t}) = (e_t + p_t^*) - p_{F,t}$$

The definition of terms of trade, $s_t = p_{F,t} - p_{H,t}$ gives the following equation with time differencing.

$$\triangle s_t = \pi_{F,t} - \pi_{H,t} \tag{7}$$

Using definition of terms of trade, CPI(p_t) is written as

$$\begin{aligned} p_t &= (1-\alpha)p_{H,t} + \alpha p_{F,t} \\ &= p_{H,t} + \alpha s_t \end{aligned}$$

This implies the CPI and home produced goods inflation rate are related according to

$$\pi_t = \pi_{H,t} + \alpha\triangle s_t \tag{8}$$

Next, given the previous results, following equation describes the relationship between real exchange rate and terms of trade with law of one price gap.

$$q_t = e_t + p_t^* - p_t = \psi_{F,t} + (1-\alpha)s_t \tag{9}$$

where $q_t \equiv log(\xi_t)$ is log of real exchange rate, and $e_t \equiv log(\varepsilon_t)$ is log of nominal exchange rate.

The assumption of complete international financial markets and intertemporal Euler equation imply the international risk sharing condition given by

$$c_t - hc_{t-1} = y_t^* - hy_{t-1}^* + \sigma^{-1}(1-h)[\psi_{F,t} + (1-\alpha)s_t] + \sigma^{-1}(1-h)\epsilon_{g,t} \tag{10}$$

Complete financial markets create the linkage between foreign and domestic consumption amounts. They differ when the law of one price does not hold and when there are changes in terms of trade and preference. Uncovered interest rate parity condition with risk premium shock, $\epsilon_{rp,t}$, is given by

$$(i_t - E_t\pi_{t+1}) - (i_t^* - E_t\pi_{t+1}^*) = E_t\triangle q_{t+1} + \epsilon_{rp,t} \tag{11}$$

The Calvo-style pricing behavior yields a New Keynesian Phillips Curve(hereafter NKPC). From domestic firm's price setting behavior, domestic inflation is described as follows,

$$\pi_{H,t} - \delta_H\pi_{H,t-1} = \theta_H^{-1}(1-\theta_H)(1-\theta_H\beta)mc_t + \beta E_t(\pi_{H,t+1} - \delta_H\pi_{H,t}) \tag{12}$$

and

$$mc_t = \varphi y_t - (1+\varphi)\epsilon_{a,t} + \alpha s_t + \sigma(1-h)^{-1}(c_t - hc_{t-1})$$

is the real marginal cost function.

Similarly, the import retailers' price setting optimal condition yields import inflation dynamics with import price shock, $\epsilon_{ip,t}$,

$$\pi_{F,t} - \delta_F\pi_{F,t-1} = \theta_F^{-1}(1-\theta_F)(1-\theta_F\beta)\psi_{F,t} + \beta E_t(\pi_{F,t+1} - \delta_F\pi_{F,t}) + \epsilon_{ip,t} \tag{13}$$

The model is ended with specification of monetary policy. I assume the monetary authority follows Taylor rule

$$i_t = \rho_i i_{t-1} + \psi_\pi\pi_t + \psi_y y_t + \epsilon_{i,t} \tag{14}$$

The nominal interest rate is affected by past interest rates, contemporaneous CPI inflation, and current output with weight ψ_π and ψ_y, individually. The term $\epsilon_{i,t}$ denotes a monetary policy shock.

2.7 Foreign Economy and Closed Counterpart

In Monacelli (2005), the foreign economy is specified as the closed economy without open economy characteristics of above-mentioned model. Justiniano and Preston (2010) chooses more flexible approach which assumes the foreign economy block $\{y_t^*, \pi_t^*, i_t^*\}$ follows VAR(1) or VAR(2) process. Latter specification has an advantage that identical preferences and technology are not strictly assumed in foreign economy. This paper, however, follows the approach of Monacelli (2005) because unless we restrict appropriate assumption on VAR structure of foreign economy, the VAR system cannot identify structural shocks of the economy. Instead, it is an innovation on each variable which is mixture of structural shocks. Since this paper embeds foreign news of monetary policy and productivity shock in extended model, the structural form of closed version of previous domestic economy facilitates the analysis.

The intertemporal euler equation and NKPC of foreign economy are given by

$$y_t^* - hy_{t-1}^* = E_t(y_{t+1}^* - hy_t^*) - \sigma^{-1}(1-h)(i_t^* - E_t\pi_{t+1}^*) + (1-h)\sigma^{-1}(\epsilon_{g,t}^* - E_t\epsilon_{g,t+1}^*) \tag{15}$$

and

$$\pi_t^* - \delta\pi_{t-1}^* = \beta E_t(\pi_{t+1}^* - \delta\pi_t^*) + \theta^{-1}(1-\theta)(1-\theta\beta)mc_t^* \tag{16}$$

where

$$mc_t^* = \varphi y_t^* - (1+\varphi)\epsilon_{a,t}^* - \sigma(1-h)^{-1}(y_t^* - hy_{t-1}^*)$$

where all parameter values are identical with domestic economy except for θ, a fraction of foreign firms that adjust their price according to indexation rule, and δ which measure the degree of indexation to the previous inflation rate. Since foreign economy is nearly closed economy, there is no gap between foreign CPI and foreign goods price, and foreign market clearing condition must be $y_t^* = c_t^*$. Interest rate in foreign economy evolves under Taylor rule.

$$i_t^* = \rho_i^* i_{t-1}^* + \psi_\pi^* \pi_t^* + \psi_y^* y_t^* + \epsilon_{i,t}^* \tag{17}$$

. The foreign block consist of the three equations (15)-(17) with three endogenous variables $\{y_t^*, \pi_t^*, i_t^*\}$ and three shocks, $\{\epsilon_{a,t}^*, \epsilon_{i,t}^* \epsilon_{g,t}^*\}$. Foreign economy has identical preference and habit formation, and is exogenous to the domestic economy.

For the comparison of the news shock effects between closed and small open environment, we define closed domestic economy by closed version of above-mentioned small open economy. We describe closed economy with small-scale NK model with intertemporal Euler equation, NK Phillips curve, and Taylor rule by monetary authority. The linearized equations for closed economy is identical to previous foreign economy without asterisk($*$) in variables.

3 Empirical Specification

The NK small open economy is described by linearized equations (6)-(14) in the endogenous variables $\{c_t, y_t, i_t, q_t, s_t, \pi_t, \pi_{H,t}, \pi_{F,t}, \psi_{F,t}\}$ including exogenous distrubances $\{\epsilon_{a,t}, \epsilon_{i,t}, \epsilon_{g,t}, \epsilon_{rp,t}, \epsilon_{ip,t}, \epsilon_{a,t}^*, \epsilon_{i,t}^*, \epsilon_{g,t}^*\}$ and foreign economy block $\{y_t^*, \pi_t^*, i_t^*\}$ with equations (15)-(17). The equations comprise a linear rational expectations model and it is solved by Blanchard and Kahn (1980) method or Sims (2002) method. The disturbances $\{\epsilon_{a,t}, \epsilon_{g,t}, \epsilon_{rp,t}, \epsilon_{ip,t}, \epsilon_{a,t}^*, \epsilon_{g,t}^*\}$ are assumed to be AR(1) processes allowing for persistency and $\{\epsilon_{i,t}, \epsilon_{i,t}^*\}$ are assumed to be i.i.d. processes. In estimation, I use only eight observable variables for $\{y_t, i_t, \pi_t, q_t, s_t, \pi_t^*, y_t^*, i_t^*\}$. Without news shock, $H = 0$, the model is exactly identified, and if we let $H > 1$, then the model is overidentified. The estimation techniques and data for empirical analysis are explained below.

3.1 Bayesian Approach

We apply Bayesian estimation technique since estimation of DSGE model with news shock is widely based on Bayesian approach. Schmitt-Grohé and Uribe (2012) compare maximum likelihood and Bayesian estimation in DSGE model with news shock and conclude that both are good in model fit and in replicating the second moments of data.

Typical Bayesian estimation follows these steps. First, we impose prior assumption on parameters of the model. Next, we construct likelihood function with observed data and compute posterior distribution based on Bayes' rule. If the posterior distribution do not have explicit(analytical) form, we are able to apply simulation-based methods such as Markov chain Monte Carlo.

In linear rational expectations model, likelihood function is computed with state-space representation with help of Kalman filter. Given model and data, the value of $\int p(Y^T|\theta)p(\theta)d\theta$ is constant, then the relationship between posterior distribution of parameter and its prior becomes according to

$$p(\theta|Y^T) \propto p(Y^T|\theta)p(\theta) \tag{18}$$

The posterior distribution is achieved by random walk Metropolis-Hastings algorithm of MCMC. Random walk Metropolis-Hastings algorithm implements the following steps. First we obtain mode $\tilde{\theta}$ which maximize the right hand side of equation (18) which is called posterior kernel, and compute inverse Hessian($\tilde{\Sigma}$). Second, assuming normal distribution $N(\tilde{\theta}, c^2\tilde{\Sigma})$ where c is some scale factor, select a θ^0 from the distribution for a starting point of MCMC simulation. Next, we choose θ^* from $N(\theta^{(s)}, c^2\tilde{\Sigma})$ and update $\theta^{(s)} = \theta^*$ with probability of $min\left[\frac{p(Y|\theta^*)p(\theta^*)}{p(Y|\theta^{(s-1)})p(\theta^{(s-1)})}, 1\right]$, otherwise remain previous value, $\theta^{(s)} = \theta^{(s-1)}$. Repeating previous procedure yields $\{\theta^{(s)}\}$ and as the number of simulations increases, $\{\theta^{(s)}\}$ converges to stationary distribution of Markov chain which at last becomes posterior distribution of θ.

In this paper, we generate two parallel and 1,000,000 replications of simulation for random walk Metropolis-Hastings algorithm. Each chain is initialized by randomly selected starting values. After burn-in phase of 400,000 draws, convergence of paramemters is checked using the convergence diagnostic of Brooks and Gelman (1998).

3.2 Data and Priors

Eight observable variables for estimation are all quarterly data on ouput, inflation, nominal interest rates, the real exchange rate and terms of trade. The cyclical part given by Hodrick-Prescott filter of log of real GDP per capita is used for output. The inflation is annualized quarterly log-differenced CPI. Certificate Deposit rates of 3-month expressed in annualized percentages are used for interest rate. We construct real exchange rate and terms of trade as definition given by model, and log-differenced them when taking the model to data. The sample period is from 1998:Q1 to 2018:Q1 and the data source is Bank of Korea, Federal Reserve Bank of St. Louis, and IMF. The beginning period, the first quarter of 1998, is when Korea starts to adopt free floating exchange rate system and the Bank of Korea sets policy goal as inflation targeting.

Foreign economy is proxied by US data. cyclical component of log of GDP per capita is used for output, annualized quarterly log-differenced CPI for inflation rate, and annualized percentages of certificate deposit rate of 3-month is used for interest rate. We demean the series before the estimation.

We calibrate $\beta = 0.99$, $\alpha = 0.40$. β is followed by Justiniano and Preston (2010) and the share of openness, α, is measured by the average share of imports to GDP during sample period. Based on Justiniano and Preston (2010), priors for parameter are selected and modified, and they are summarized in Table 1.

4 Estimation results

4.1 Posterior estimates

We calculate the posterior mode, mean, and the 90 percent highest posterior density interval for each parameters using two independent Markov chains. The parameter estimates are summarized in Table (1).

In extended model, the mean of h is 0.79 which is somewhat bigger than the results from Fujiwara et al. (2011) which analyze the US economy and similar to Lee (2016). The high value of habit formation parameter is in line with large value of σ. When σ is very large, the household wants comsumption, in expectation, to be very smooth. Hence, households in the Korean economy are shown to be largely stick to previous consumption. The low value of η which states the low substitutability between domestic and foreign goods reflects the fact that Korea imports mostly raw materials and export products by processing trade. The mean of inverse Frisch elasticity of labor supply, φ, is 6.42. Frisch elasticity($\frac{1}{6.42} = 0.16$) is consistent with the low elasticity result of micropanel anlaysis of the Korean economy.[3]

Price rigidities are represented by θ_H and θ_F. The mean of θ_H is 0.93 which is larger than θ_F, 0.25. Hence, the price of domestic goods is more likely to changes its price with indexation rule than foreign goods. The interest rate in domestic economy follows Taylor rule. The mean of ψ_π, 3.06, indicating the weight on inflation is larger than prior mean. The weight for output is 0.78. The monetary policy as described in Taylor rule responses more senstivie to inflation than orginal Taylor rule and less sensitive to output. The shocks $\{\epsilon_{a,t}, \epsilon_{g,t}, \epsilon_{rp,t}, \epsilon_{ip,t}, \epsilon^*_{a,t}, \epsilon^*_{g,t}\}$ are assumed to follow AR(1) process and its AR(1) coefficients are estimated. The persistence of risk premium shock is is 0.93 which is the highest value among the shocks. The other four shocks have the value of persistence coefficient around 0.5.

Compared to the estimates of open economy, elasiticity of intertemporal substitution in closed economy is shown to be larger value. The Frisch elasticity is estimated as $0.35 (= \frac{1}{2.89})$ which is larger than that of open economy model. Monetary authority in closed economy environment gives more weight on output variation and less on inflation than open economy. The other parameters are shown to be similar with open economy.

[3] Kim and Yie (2015) report as 0.18 with DSGE model embeded nominal wage rigidity and unemployment. Moon and Song (2016) show 0.23 by analyzing Korean Labor Panel data.

Coefficients		Prior			Posterior:Baseline Model			Extended Model			Closed		
		density	Mean	S.D.	Mode	Mean	90% interval	Mode	Mean	90% interval	Mode	Mean	90% interval
Inverse intertemporal elsticity of substitution	σ	Gamma	1.00	0.75	2.85	3.69	[3.27, 4.18]	3.23	3.21	[2.53, 3.84]	3.63	4.11	[1.93, 6.20]
Inverse Frisch	φ	Gamma	3.00	1.00	4.48	3.98	[3.00, 4.97]	6.07	6.42	[5.07, 7.27]	3.02	2.89	[1.43, 4.23]
Calvo domestic prices	θ_H	Beta	0.70	0.10	0.95	0.93	[0.91, 0.95]	0.93	0.93	[0.92, 0.95]	0.89	0.90	[0.87, 0.93]
Calvo retail prices	θ_F	Beta	0.70	0.10	0.39	0.36	[0.29, 0.43]	0.26	0.25	[0.20, 0.30]			
Elasticity H-F goods	η	Gamma	1.00	0.75	0.20	0.22	[0.07, 0.37]	0.04	0.05	[0.00, 0.09]			
Habit	h	Beta	0.50	0.10	0.34	0.34	[0.26, 0.43]	0.80	0.79	[0.75, 0.84]	0.82	0.79	[0.70, 0.87]
Indexation domestic	δ_H	Beta	0.50	0.25	0.02	0.07	[0.00, 0.14]	0.02	0.04	[0.00, 0.09]	0.03	0.07	[0.00, 0.15]
Indexation retail	δ_F	Beta	0.50	0.25	0.26	0.39	[0.14, 0.67]	0.87	0.81	[0.60, 0.98]			
Taylor rule, smoothing	ψ_i	Beta	0.50	0.25	0.94	0.93	[0.87, 1.00]	0.81	0.83	[0.74, 0.92]	0.74	0.79	[0.66, 0.92]
Taylor rule, inflation	ψ_π	Gamma	1.70	0.30	1.75	1.94	[1.68, 2.20]	2.77	3.06	[2.69, 3.36]	1.39	1.36	[0.99, 1.73]
Taylor rule, output	ψ_y	Gamma	0.40	0.20	2.27	2.39	[2.07, 2.95]	0.81	0.78	[0.56, 1.00]	0.86	1.35	[0.68, 2.04]
Technology	ρ_a	Beta	0.80	0.10	0.57	0.52	[0.40, 0.62]	0.66	0.64	[0.54, 0.75]	0.37	0.41	[0.26, 0.54]
Preference	ρ_g	Beta	0.80	0.10	0.54	0.56	[0.49, 0.64]	0.60	0.51	[0.35, 0.68]	0.96	0.94	[0.88, 0.99]
Risk Premium	ρ_{rp}	Beta	0.98	0.10	0.97	0.94	[0.90, 0.99]	0.96	0.93	[0.89, 0.98]			
Import cost-push shock	ρ_{ip}	Beta	0.80	0.10	0.26	0.27	[0.15, 0.39]	0.29	0.26	[0.16, 0.34]			
Foreign technology	ρ^*_a	Beta	0.80	0.10	0.64	0.47	[0.36, 0.57]	0.67	0.69	[0.60, 0.77]			
Taylor rule(Foreign), smoothing	ψ^*_i	Beta	0.50	0.25	0.30	0.48	[0.26, 0.68]	0.77	0.57	[0.36, 0.79]			
Taylor rule(Foreign), inflation	ψ^*_π	Gamma	1.80	0.30	1.32	1.36	[1.17, 1.53]	0.82	0.98	[0.73, 1.26]			
Taylor rule(Foreign), output	ψ^*_y	Gamma	0.50	0.20	0.70	1.10	[0.82, 1.46]	0.87	1.02	[0.89, 1.14]			
Indexation foreign	δ	Beta	0.50	0.25	0.11	0.19	[0.03, 0.36]	0.03	0.05	[0.00, 0.11]			
Calvo foreign prices	θ	Beta	0.80	0.10	0.92	0.88	[0.84, 0.93]	0.97	0.96	[0.95, 0.97]			
Foreign Preferences	ρ^*_g	Beta	0.80	0.10	0.96	0.91	[0.88, 0.94]	0.68	0.71	[0.56, 0.88]			
Unanticipated Shocks Volatility													
Technology	$\nu_{a,t}$	Inverse Gamma	0.50	∞	0.59	0.36	[0.16, 0.57]	0.18	0.19	[0.11, 0.28]	0.19	0.31	[0.12, 0.53]
Interest rate	$\nu_{i,t}$	Inverse Gamma	0.50	∞	0.07	0.07	[0.06, 0.08]	0.07	0.08	[0.06, 0.09]	0.07	0.08	[0.06, 0.09]
Preferences	$\epsilon_{g,t}$	Inverse Gamma	0.50	∞	0.13	0.16	[0.12, 0.20]	0.29	0.28	[0.19, 0.36]	2.03	2.47	[0.51, 5.24]
Risk premium	$\epsilon_{rp,t}$	Inverse Gamma	0.50	∞	0.08	0.08	[0.07, 0.09]	0.08	0.09	[0.07, 0.10]			
Import cost-push	$\epsilon_{ip,t}$	Inverse Gamma	0.50	∞	0.07	0.10	[0.07, 0.13]	0.15	0.16	[0.12, 0.20]			
Foreign technology	$\nu^*_{a,t}$	Inverse Gamma	0.50	∞	0.30	0.22	[0.11, 0.36]	1.08	0.77	[0.33, 1.28]			
Foreign interest rates	$\nu^*_{i,t}$	Inverse Gamma	0.50	∞	0.07	0.07	[0.06, 0.08]	0.07	0.07	[0.06, 0.08]			
Foreign preferences	$\epsilon^*_{g,t}$	Inverse Gamma	0.50	∞	0.21	0.17	[0.14, 0.21]	0.14	0.16	[0.11, 0.22]			
News Shocks Volatility													
4qt ahead interest rate	$\nu_{i,t-4}$	Inverse Gamma	0.35	∞	0.06	0.06	[0.05, 0.07]	0.06	0.06	[0.05, 0.08]	0.06	0.06	[0.05, 0.07]
8qt ahead interest rate	$\nu_{i,t-8}$	Inverse Gamma	0.35	∞	0.06	0.06	[0.05, 0.07]	0.06	0.06	[0.05, 0.08]	0.06	0.06	[0.05, 0.07]
4qt ahead productivity	$\nu_{a,t-4}$	Inverse Gamma	0.35	∞	0.14	0.16	[0.08, 0.23]	0.10	0.11	[0.07, 0.14]	0.10	0.13	[0.07, 0.18]
8qt ahead productivity	$\nu_{a,t-8}$	Inverse Gamma	0.35	∞	0.14	0.15	[0.08, 0.22]	0.10	0.11	[0.07, 0.15]	0.10	0.12	[0.07, 0.18]
4qt ahead foreign interest rate	$\nu^*_{i,t-4}$	Inverse Gamma	0.35	∞				0.05	0.06	[0.05, 0.07]			
8qt ahead foreign interest rate	$\nu^*_{i,t-8}$	Inverse Gamma	0.35	∞				0.05	0.06	[0.05, 0.07]			
4qt ahead foreign productivity	$\nu^*_{a,t-4}$	Inverse Gamma	0.35	∞				0.14	0.18	[0.07, 0.29]			
8qt ahead foreign productivity	$\nu^*_{a,t-8}$	Inverse Gamma	0.35	∞				0.14	0.17	[0.08, 0.27]			

[1] 'qt' is abbreviation of 'quarters'.

Table 1: Priors & Posterior distribution

4.2 Propagation of News Shocks

To verify the propagation of news shocks under small open environment, we compare the impulse responses to the results of closed economy. We decouple the effect of news shock from that of surprise shock like in Milani and Treadwell (2012). We provide Bayesian impulse response function(hereafter IRF) to domestic productivity and monetary policy shock. The Bayesian IRFs are the mean impulse response and the dotted line of the graph indicates the 90% highest posterior density interval. Responses from news shock are calculated as the sum of responses to 4-quarter-ahead news shock and 8-quarter-ahead news shock after the news is materialized.

4.2.1 Closed Economy

Figure (1) illustrates the effect of surprise shock and news shock of monetary policy and productivity on closed economy. News shocks have significant effect on all variables. Both response of output and inflation to monetary policy news are larger than those from surprise shock. The result is accordance with Milani and Treadwell (2012). If the central bank wants to enhance the policy effect, the communication such as forward guidance and education and transparency of the policy would enable larger influence on the economy. However, the above properties of news shock is only shown in output for productivity in closed economy. Inflation and hours worked does not have clear difference according to the kinds of shock. In contrast to Fujiwara et al. (2011) and Jaimovich and Rebelo (2008), hours worked drops in response to productivity shock. This does not generate the procycality of labor input, but is consistent with Hyun and Kim (2017).[4]

4.2.2 Small Open Economy

Compared to the closed economy, we analyze more propagations of news shocks because we use medium-scale DSGE model. These result would be more appropriate if an economy is small open economy. Figure (2) depicts the response of small open economy to monetary policy shock. Output and consumption respond to news with larger size and longer periods than surprise shock. Nominal interest rate, CPI, and import inflation does not show clear difference between anticipated and unanticipated shock. Only inflation of home produced goods shows separated pattern. By assuming open economy, we are able to observe CPI inflation of Korea fluctuates very similar with import inflation, and this is not revealed when we analyze with closed economy model. The response of real exchange rate and terms of trade also reflects larger and longer influences of news shock.

The influence of productivity news shows larger and remain longer in every variable except for domestic inflation and hours worked. The responses to news on productivity has more notable difference with surprise shock. Compared to the result of closed economy, news effect is larger in CPI inflation rate but hours worked shows similar amount of response to both news and surprise shock.

[4]Hyun and Kim (2017) investigate the relationship between labor productivity and total hours worked in OECD countries using Panel Vector autoregression model. They show labor productivity shock has negative effect on employment. This is related with Gali (1999) and the relationship between hours worked and productivity is not consistently positive or negative in other works. In recent article, the procycality of labor productivity is focused in Galí and Van Rens (2014) for the US economy case. The study about procycality of labor productivity in Korea is somewhat insufficient.

4.2.3 Discussion

The fluctuation of endogenous variables is decomposed by the percentage attributed to variation by each shock.[5] Forecast error variance decomposition of output and inflation is given in Table (2). In small open economy, anticipated change of domestic productivity accounts approximately a half of output variation in the long run. Domestic news shocks has larger influence as forecast horizon increases, which is consistent result with Fujiwara et al. (2011). Domestic monetary policy news has larger effect on inflation than productivity news and it increases with a longer forecast horizon. Foreign productivity news is negligible for both output and inflation. However, foreign monetary policy account for some of variations of domestic output and inflation, which implies international propagation of foreign monetary policy news can significantly be considered. the explanatory power of anticipated foreign monetary policy on output is about 6 percent and it attributes to variations of inflation about 8 percents in the long run.

The main differences of news shocks in open economy model are different size and persistence of responses. News of monetary policy has greater influence on inflation in open economy than closed economy, and output has reverse case. News of productivity improvement has greater influence on output and smaller effect on inflation in small open economy than in closed economy. The influence of news shock gives some issues of possible efforts to make monetary policy and productivity improvement potent. Central bank's communication(such as Forward guidance and education) and transparency of monetary policy which stimulate expectation channel would make news effect stronger. For industry sector, the efforts for accurate evaluation of technology and annoucement of technological development can contribute to enlarging information set of economic agents about the productivity improvement. Those policies or additional efforts activate the propagation channel of news shock and increase the effect of monetary policy and productivity improvement.

[5] note that our variance decomposition with news shock includes the period when the news shocks are not realized. The decrease proportion of shock in variation of output and inflation in longer horizon is because of weakening effect of 'pure news shock'. For further discussion about variance decomposition with news shock, see Sims (2016).

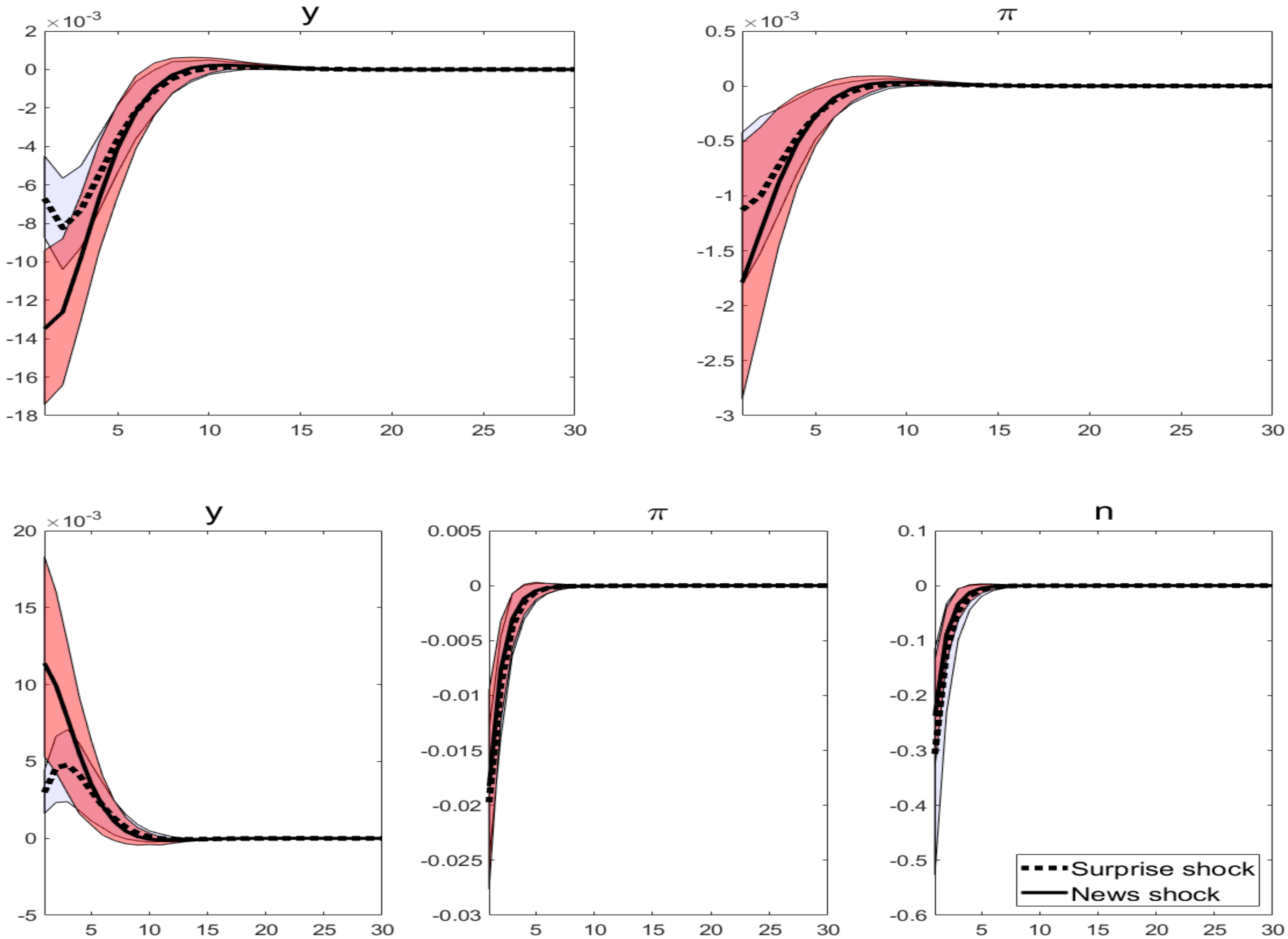

Figure 1: IRFs of closed economy to monetary policy(up) and productivity(down) shock

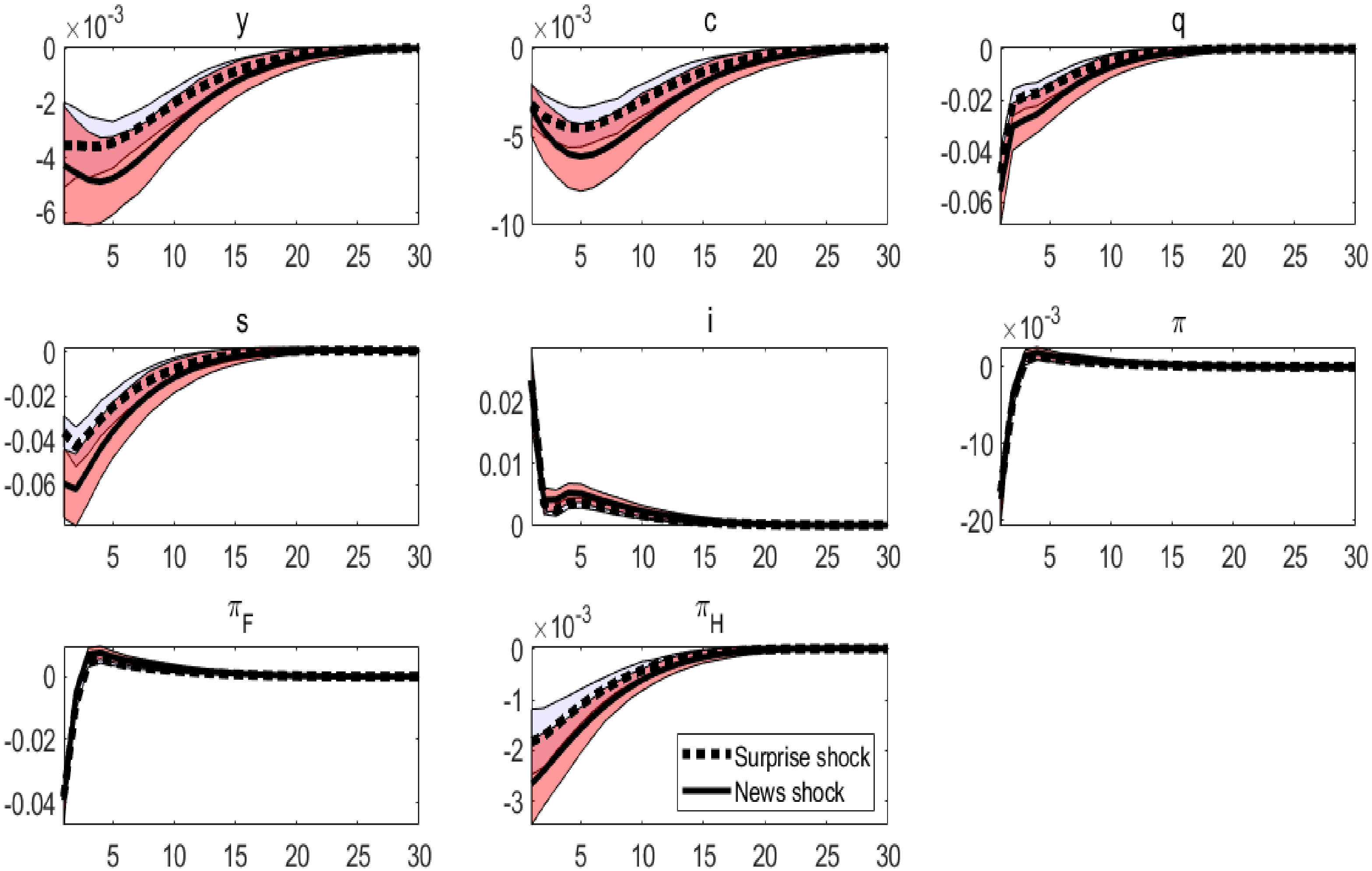

Figure 2: IRFs of small open economy to monetary policy shock

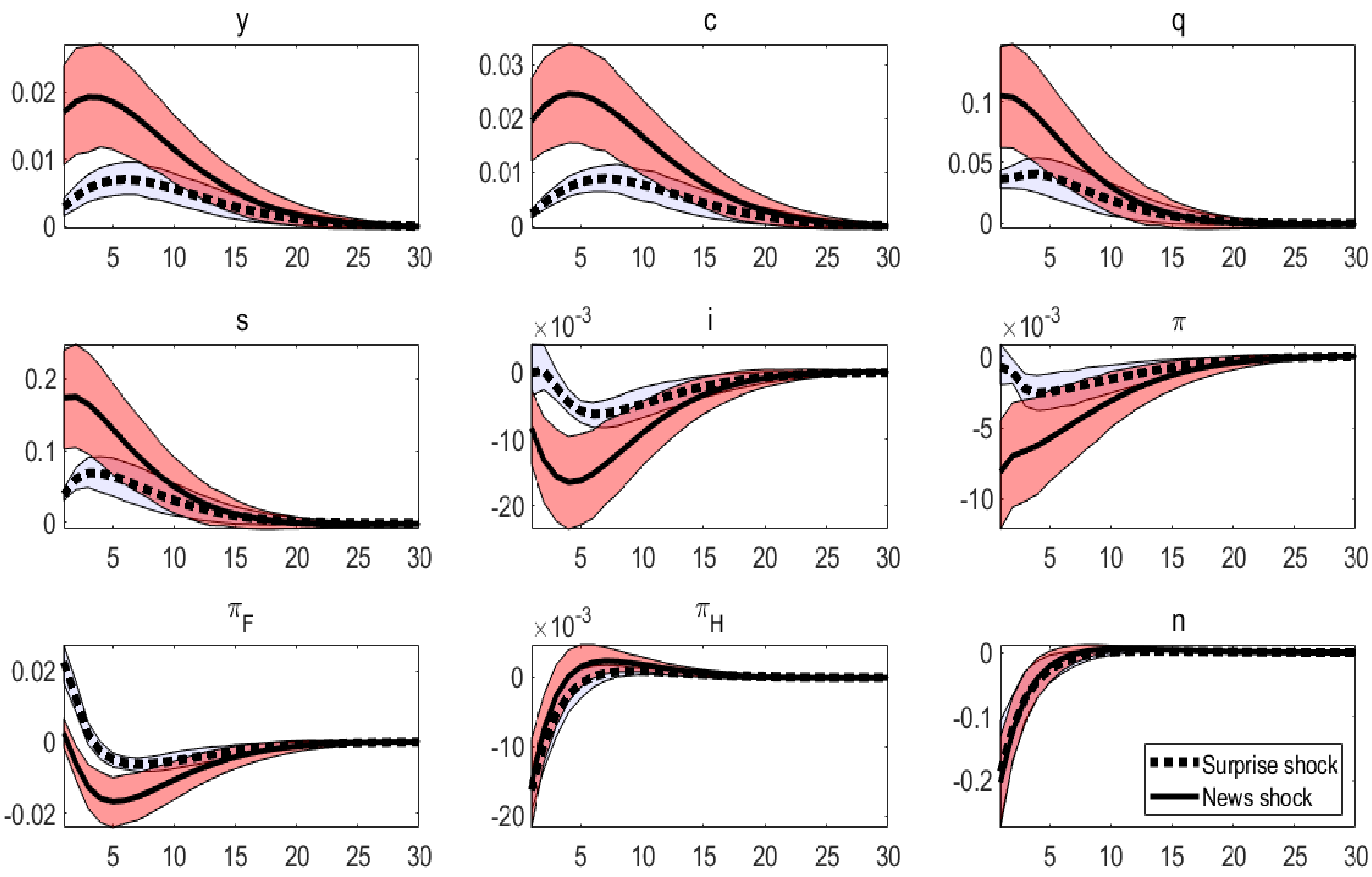

Figure 3: IRFs of small open economy to productivity shock

4.2.4 Sensitivity Test

As the time horizon for the economy becomes longer, the openness varies over time. In short-run, since the openness is assumed to be exogenous, we conduct sensitivity test for the openness. This test is to verify whether the result with IRFs is consistent across different degree of openness. In real economy, one of the arguable economic issues in open economy is whether openness and free trade are really beneficial or not for home country. Recent Brexit and trade conflict between China and US reflect that countries keep considering the merits and demerits of openning the door of the economy. As a result of uncertainty on trade environment, Korea as a small open economy which is highly dependent on export needs to predict the condition of international financial markets and trade more than any other countries. In the light of varying conditions of trade flow which affect the openness in previous model, we test with seven different value for openness of Korean economy, $\alpha = 0.1, 0.2, \ldots, 0.7$. The larger α is, the more domestic consumption is dependent on foreign economy. We investigate the relationship between the degree of openness and impulse responses. As in Bayesian IRFs, we sum the effect of two news shocks after they are realized. The test results are given by Figure (4) and (5)

The impulse response to monetary policy news shock is given by Figure (4). Negative response of output, consumption, real exchange rate, and terms of trade becomes large as the openness decreases. CPI inflation has bigger impact effect when the economy is highly dependent on foreign economy. Inflation of home produced goods persists longer with large alpha, and nominal interest rate rise greater when the economy becomes closer.

Figure (5) shows that productivity news has an influence on the economy with different degree of openness. Positive effect of productivity news shock on output, consumption, real exchange rate, and terms of trade have larger and longer effect when alpha is small. Decrease in CPI inflation, import inflation, and nominal interest rate looks more definite in the economy with low import share.

In summary, the degree of openness changes the size and persistence of impulse response function. The impulse responses have the same sign over different αs. Our small open economy model gives consistent explanation for news shock effect even if we consider the varying condition of the import share. This result also implies economic policies which we discussed has state dependent effect on enhancing monetary policy and productivity improvement shock.

Shocks / Horizon	Closed 1	Closed 4	Closed 8	Closed 12	Closed 20	Closed 40	Open 1	Open 4	Open 8	Open 12	Open 20	Open 40
Output												
Non-news Shock	96.26	89.38	79.27	75.46	76.50	77.19	96.45	85.67	63.83	49.80	42.61	42.23
News Shocks												
domestic MP	0.51	2.24	6.85	9.65	9.30	9.02	0.04	0.13	1.42	2.20	2.61	2.63
domestic Productivity	3.23	8.39	13.89	14.88	14.20	13.78	1.58	7.65	25.59	39.93	47.70	48.11
foreign MP							1.58	5.56	8.11	7.31	6.41	6.36
foreign Productivity							0.36	0.97	1.03	0.76	0.68	0.67
Inflation												
Non-news Shock	84.08	61.76	50.40	49.07	50.40	51.14	99.54	92.74	76.50	67.22	65.42	65.34
News Shocks												
domestic MP	0.36	0.76	0.90	0.89	0.87	0.86	0.03	4.08	12.26	15.61	15.24	15.20
domestic Productivity	15.55	37.48	48.70	50.03	48.74	47.99	0.36	0.83	4.49	8.64	10.99	11.13
foreign MP							0.02	2.11	6.46	8.26	8.08	8.06
foreign Productivity							0.04	0.23	0.27	0.27	0.28	0.28

Table 2: Forecast error variance decomposition of output and inflation

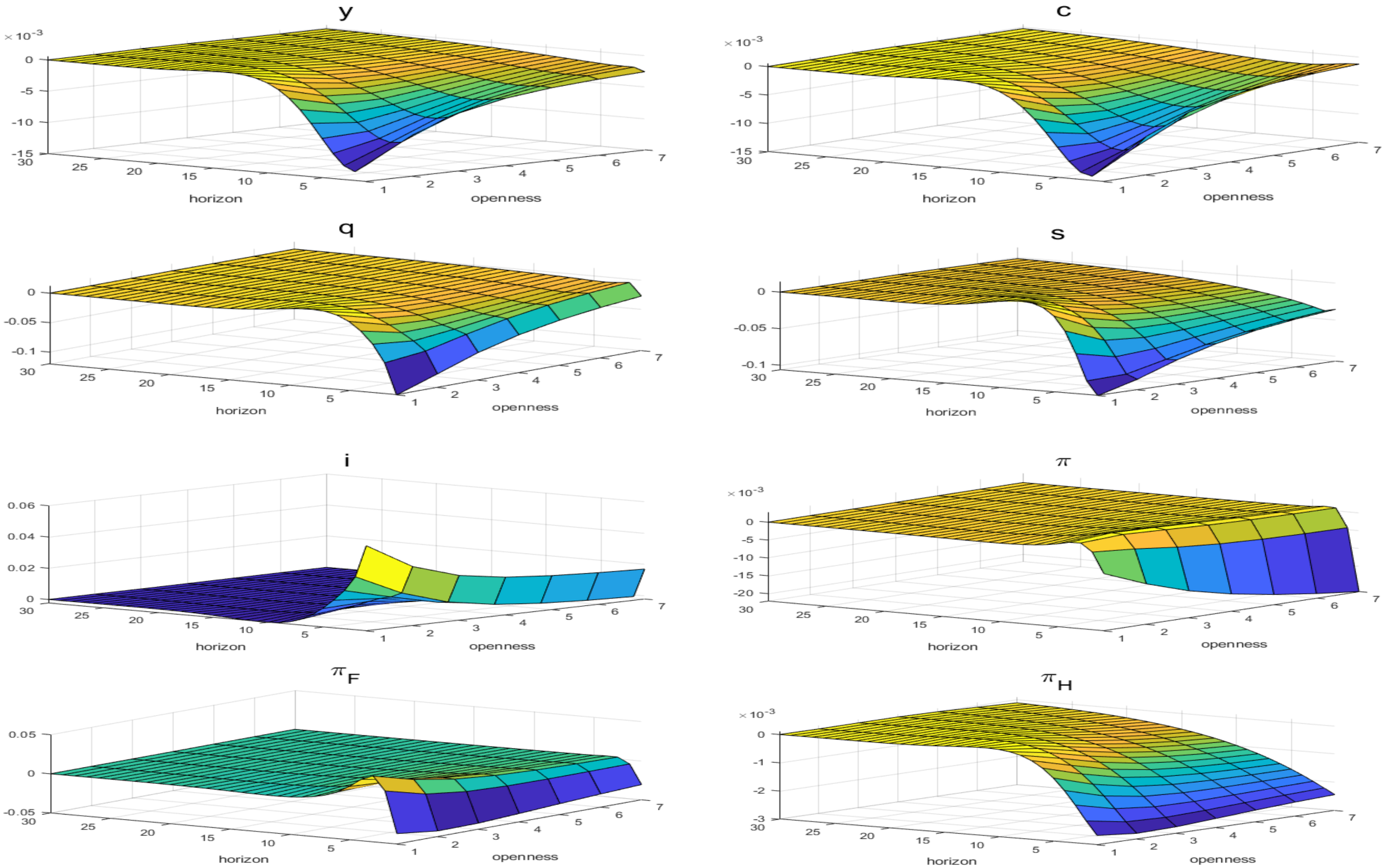

Figure 4: Sensitivity test for impulse response to monetary policy shock

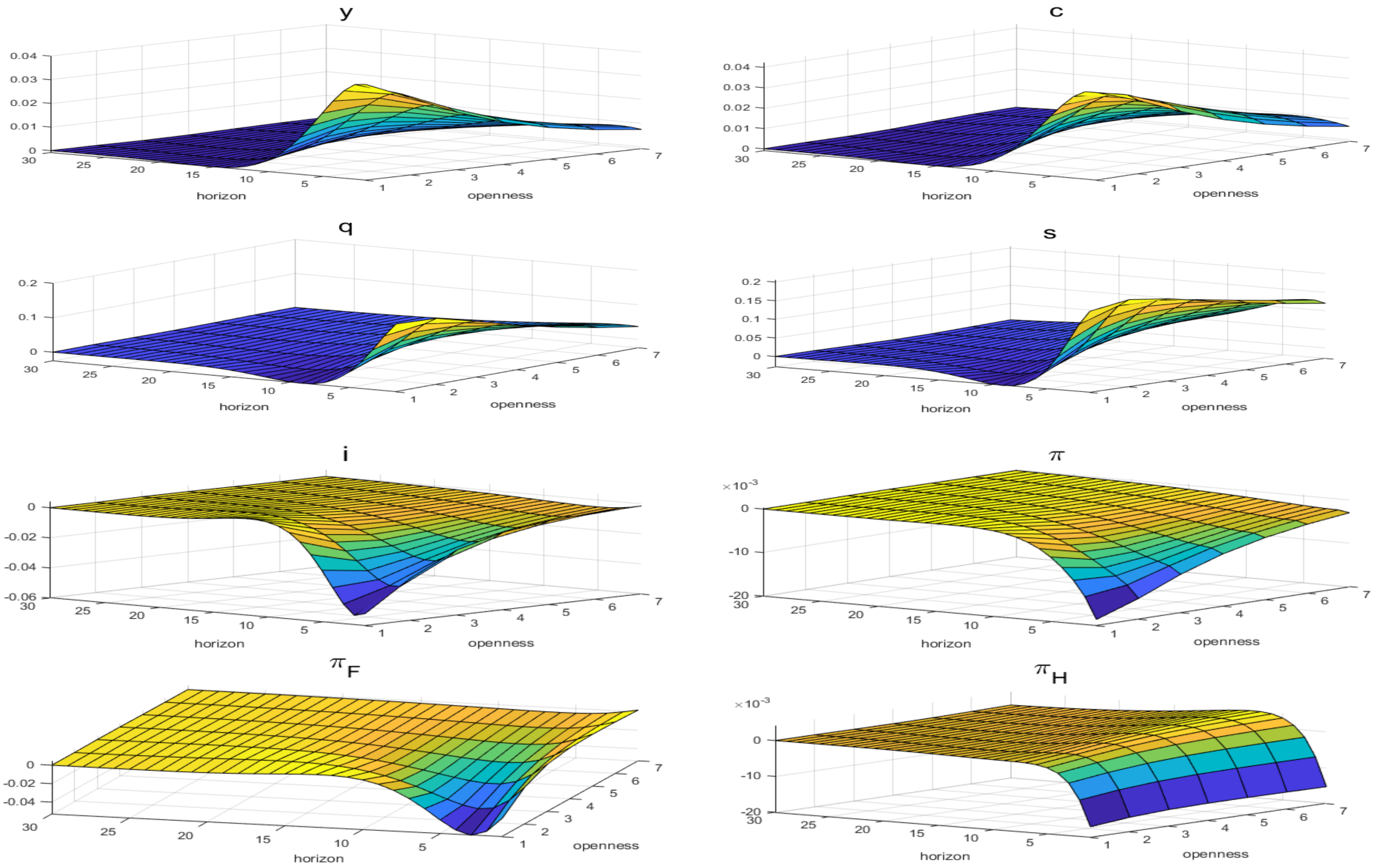

Figure 5: Sensitivity test for impulse response to productivity shock

5 Concluding Remarks

In this paper, we examine the propagation of news shocks in small open economy. Most of the empirical analysis of news shock in DSGE model is based on closed economy. The news-driven business cycle literature with small open economy focuses on generating major macroeconomic comovement such as procycality of labor supply to TFP news shock. Apart from previous open economy analysis in news-driven business cycle model, we investigate the influence of news shocks in small open NK model embeded foreign news shocks. Including monetary policy news both in domestic and foreign economy, we separate the effect of anticipated shock and unanticipated shock in small open economy.

Propagation of monetary policy and labor productivity news shock is investigated by Bayesian IRFs. In closed economy, both monetary policy and productivity news shock generate bigger influence on output and inflation than surprise shock, except for inflation to productivity shock. The result of Milani and Treadwell (2012) is confirmed in medium-scale small open economy DSGE model. Small open economy facilitates explaning more influence of news on economy than closed economy. Anticipated change of monetary policy has larger effect on real variables and domestic inflation. Conversely, except for domestic inflation, nominal variables do not show significantly different response to between news and surprise shock. Productivity news has larger effect on every variable than surprise shock, except for hours worked and domestic inflation. Variance decomposition verifies that domestic news shock has larger influence with longer forecast horizon as Fujiwara et al. (2011).

The effect of monetary policy and productivity improvement shock is strengthened because of significant effect of news shocks. This gives an evidence that the communication by central bank such as forward guidance help to activate expectation channel of monetary policy by providing future stance of monetary policy. The efforts for accurate evaluation of technology enable economic agents to achieve information about future technological change or productivity improvement. Those actions enlarge information set of economic agents and make influence of monetary policy and productivity shocks greater. Sensitivity test reveals that such actions have state dependent effect.

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