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Multipliers of expected vs. unexpected fiscal shocks: The case of Korea[☆]

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ABSTRACT

We compare the multipliers of expected and unexpected fiscal shocks. In doing so, we consider that the future path of fiscal policy is anticipated to some degree, and incorporate this characteristic into a *news* approach. We build a standard small open economy New-Keynesian DSGE model with a fully specified fiscal policy structure, and examine the Korean economy as an example of a small open emerging economy. We find that the present-value multiplier of the government consumption news shock in Korea is smaller than that of a corresponding surprise shock of the same magnitude, apart from the initial couple of years in the case of the output multiplier, and is consistently smaller in the cases of the consumption and investment multipliers. The present-value output multiplier of the government consumption news shock starts from about 0.72 and declines continuously to reach 0.16 after 40 years.

1. Introduction

It is widely recognized that fiscal policies are, in most cases, anticipated in advance of their execution, since they require legislative approval. This feature has been noticed by researchers such as Schmitt-Grohé and Uribe (2012), Kriwoluzky (2012), and Born et al. (2013). The main concern of these studies is estimating news shocks and their contributions to business cycle fluctuations.[1]

In contrast, we simply assert that the expected path of government spending is an example of a fiscal news shock, and we investigate the size of the government consumption multiplier in such an environment. More specifically, we compare the multiplier of the spending news shock with that of an equivalent surprise shock of the same magnitude. Graduate-level textbooks discuss at length the response of an economy to anticipated and/or unanticipated shocks (e.g. Romer, 2018). We believe that it would also be worthwhile to investigate the size of present-value fiscal multipliers when the future path of government consumption can be anticipated to some degree.

We take up this issue and analyze the effects of fiscal stimuli in Korea, a small open emerging economy.[2] Previous research on the effects of fiscal stimuli mainly focused on advanced economies with a few exceptions, notably Ilzetzki et al. (2013). They showed that the output multiplier at impact is larger in advanced countries (0.39) than in developing countries (−0.03), a statistically significant difference. However, it is surprising that there are few studies on the effects of fiscal stimuli in developing and/or emerging economies in view of the increasing number of studies on the differences in the characteristics of business cycles between advanced and emerging economies (Aguiar and Gopinath, 2007; Garcia-Cicco et al., 2010).

There are several reasons that the effects of fiscal stimuli are smaller in small open emerging economies than in advanced economies. Firstly, the effect of a fiscal stimulus is very small or nil under a flexi-

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1 A news shock is a shock about an event that has been known previously to occur immediately or after a short time lag following the news. News may also be interpreted as forward guidance. However, in a very restrictive sense, forward guidance is related to the zero lower bound, but news is not directly related to the zero lower bound. Thus, we can interpret forward guidance as a news shock at or near zero lower bound in a very restrictive sense.

2 We note that both the Ministry of Economy and Finance and National Assembly Budget Office of Korea publish medium-term fiscal projections every five years.

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ble exchange rate system as in the textbook Mundell-Fleming model. Secondly, emerging economies do not provide sufficient social safety nets, which results in a greater precautionary motive for saving in these economies. Thirdly, the execution of public expenditures is neither efficient nor transparent in these economies relative to advanced economies.

We adopt a medium-scale small open economy dynamic stochastic general equilibrium (DSGE) model to examine the size of the fiscal multiplier in Korea. We build a new Keynesian model where we introduce factors such as price and wage stickiness, rule-of-thumb consumers, habit formation, and investment adjustment costs. Similar models have been constructed by Drautzburg and Uhlig (2015) and Leeper et al. (2017), among others. These studies, however, focus on advanced economies within either a closed economy or a two-country open economy framework.

We find that the output multiplier of the news shock is lower than that of the surprise shock except during the initial couple of years. The present-value multiplier of the news shock starts from about 0.72 and continuously declines, reaching 0.16 after about 40 years, while that of the surprise shock starts from about 0.56, slightly increases to 0.64 over the next 7 years, and then declines slowly, reaching about 0.26 after 40 years. Both the consumption and investment multipliers of the spending news shock are negative, which is also the case for the surprise shock. These results seem reasonable given that the news shock is already expected and considered by private agents in their decision making, contrary to the equivalent surprise shock.

We also examine the size of government consumption multipliers both with and without a zero lower bound. The policy rate in Korea was at the historically low level of 1.25 percent in 2017; while not zero, it is expected that it could approach zero in the event of an adverse economic shock. Previous research has shown that the multipliers are bigger in the case of the zero lower bound (e.g. Woodford, 2011; Eggertsson, 2011; Christiano et al., 2011). We find that this is so in the case of Korea as well. The output multiplier with the zero lower bound is approximately one, and the consumption multiplier is positive and near one-tenth. The investment multiplier is near zero for about 20 years following the shock.

This paper proceeds as follows. In Section 2, we present a standard medium-scale small open economy DSGE model. The model has some new Keynesian features such as sticky price and wage determination and rule-of-thumb consumers, and includes specific fiscal policy structures along the lines of Leeper et al. (2017). In Section 3, we describe the data and the method of Bayesian estimation. We discuss the estimation results in Section 4. Section 5 briefly concludes.

2. The model

We build a small open New Keynesian DSGE model with a fully specified fiscal policy structure along the lines of Leeper et al. (2017).

2.1. Households

Households are composed of savers (Ricardian consumers) and non-savers (rule-of-thumb consumers). The measure of savers is 1-μ and the variable with the superscript S denotes that of savers. The measure of non-savers is μ and the variable with the superscript N denotes that of non-savers.

2.1.1. Savers

A representative saver household maximizes expected lifetime utility given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t u_t^b \left[\frac{\left(c_t^S(j) - \theta C_{t-1}^S\right)^{1-\sigma}}{1-\sigma} - \frac{l_t^S(j)^{1+\sigma^L}}{1+\sigma^L} \right], \tag{1}$$

where β is the subjective discount factor, σ is the inverse of intertemporal elasticity of substitution, σ^L is the inverse of Frisch elasticity of labor supply, C_{t-1} is one period lagged aggregate consumption, $c_t^S(j)$ and $l_t^S(j)$ are the consumption of final goods and labor hours, respectively, at time (t) by agent (j). The parameter θ denotes the degree of external habit formation, and u_t^b is a preference shock.

The budget constraint of a saver household j is given by:

$$\begin{aligned} & P_t^C(1+\tau_t^C)c_t^S(j) + P_t^I i_t^S(j) + B_t^S(j) + S_t F_t^S(j) \\ & = R_{t-1}B_{t-1}^S(j) + R_{t-1}^* S_t \left[1 - \Gamma_f(\cdot)\right] F_{t-1}^S(j) \\ & + (1-\tau_t^L)\int_0^1 W_t(l) l_t^S(j,l)dl + (1-\tau_t^K)R_t^K \nu_t(j)\bar{k}_{t-1}^S(j) \\ & - \Psi(\nu_t)P_t^I \bar{k}_{t-1}^S(j) + P_t^C Z_t^S(j) + D_t(j), \end{aligned} \tag{2}$$

where P_t^C denotes the price of consumption goods, S_t the nominal exchange rate, $\bar{k}_{t-1}^S$ physical capital, $\nu_t(j)$ the utilization rate of capital, and R_t and R_t^* the gross nominal interest rates on domestic (B_t) and foreign (F_t) one-period riskless bonds, respectively. R_t^K is the gross nominal rate of return on capital at time t, and τ_t^K, τ_t^L, and τ_t^C are tax rates on capital income, labor income, and consumption, respectively. P_t^I denotes the price of investment goods, $i_t(j)$ saver household j's gross investment, $W_t(l)$ the nominal wage for labor type l, $Z_t^S(j)$ government lump-sum transfers to j, and $D_t(j)$ the share of nominal firm profits distributed to j in the form of dividends. $\Psi(\nu_t)$ denotes the capital utilization cost, which will be discussed below.

Following Adolfson et al. (2007), we introduce a risk premium ($\Gamma_f(\cdot)$) on foreign bond holdings, and assume that it depends on the net foreign asset position ($\frac{s_t F_t}{Y_t}$) and an exogenous risk premium shock (ϕ_t). More specifically, $\Gamma_f\left(\frac{s_t F_t}{Y_t}, \phi_t\right) \equiv \gamma_f \left[\exp\left(\frac{s_t F_t}{Y_t}, \phi_t\right) - 1\right]$ with $\Gamma_f(0,0) = 0$. The exogenous risk premium shock is assumed to follow an AR(1) process. The variable s_t denotes the real exchange rate defined by $s_t \equiv S_t P_t^{C*}/P_t^C$. The variable P_t^{C*} is the foreign price level, and the foreign inflation rate is defined as $\pi_t^{C*} \equiv P_t^{C*}/P_{t-1}^{C*}$. If $F_t < 0$, the agent j is a net borrower, and if $F_t > 0$, she is a net lender.

A saver household owns physical capital, which evolves according to the following law of motion:

$$\bar{k}_t(j) = (1-\delta)\bar{k}_{t-1}(j) + \left[1 - \Gamma_i\left(\frac{u_t^i i_t(j)}{i_{t-1}(j)}\right)\right] i_t(j),$$

where $\Gamma_i(\cdot)$ is the investment adjustment cost function with the properties $\Gamma_i(1) = \Gamma_i'(1) = 0$ and $\Gamma_i''(1) > 0$ as in Christiano et al. (2005) and Smets and Wouters (2007). Effective capital, $k_t(j)$, is related to the physical capital stock by $k_t(j) = \nu_t(j)\bar{k}_{t-1}(j)$. Following Smets and Wouters (2007), we posit that capital utilization requires a cost of $\Psi(\nu_t)$ per unit of physical capital. In the steady state, $\nu = 1$ and $\Psi(1) = 0$. The capital utilization cost parameter, $\psi \in [0,1)$, satisfies $\frac{\Psi''(1)}{\Psi'(1)} = \frac{\psi}{1-\psi}$. The variable u_t^i is an investment-specific shock.

Saver households' first-order conditions for the maximization of expected lifetime utility (1) subject to (2) are given by:

$$\lambda_t^S(1+\tau_t^c) = \left(C_t^s - \theta C_{t-1}^s\right)^{-\sigma} \tag{3}$$

$$\lambda_t^S = \beta R_t E_t \left(\frac{\lambda_{t+1}^S}{\pi_{t+1}^c}\right) \tag{4}$$

$$1 = \beta R_t^* \left[1 - \Gamma\left(\frac{s_t F_t}{Y_t}\right)\right] E_t \left(\frac{\lambda_{t+1}^S s_{t+1}}{\lambda_t^S s_t \pi_{t+1}^{c*}}\right) \tag{5}$$

$$(1-\tau_t^k) r_t^K = \Psi'(\nu_t)\frac{P_t^I}{P_t^C} \tag{6}$$

$$q_t = \beta E_t \frac{\lambda_{t+1}^S}{\lambda_t^S}\left[(1-\tau_{t+1}^k) r_{t+1}^K \nu_{t+1} - \Psi(\nu_{t+1})\frac{P_{t+1}^I}{P_{t+1}^C} + (1-\delta) q_{t+1}\right] \tag{7}$$

$$\frac{P_t^I}{P_t^C} = q_t\left[1-\Gamma_i\left(\frac{I_t}{I_{t-1}}\right)-\Gamma_i'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}\right] + \beta E_t\left[q_{t+1}\frac{\lambda_{t+1}^S}{\lambda_t^S}\Gamma_i'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2\right] \tag{8}$$

where λ_t^S denotes the marginal utility of saver households' consumption, q_t Tobin's q, and r_t^K the gross real rate of return on capital at time t.

2.1.2. Labor agency and wage setting

Each household, both savers and non-savers, supplies a continuum of differentiated labor inputs indexed by l. A perfectly competitive hiring agency bundles the differentiated labor inputs into a composite labor service, L_t, according to the following CES aggregator:

$$L_t = \left[\int_0^1 l_t(l)^{\frac{\varepsilon_w-1}{\varepsilon_w}}dl\right]^{\frac{\varepsilon_w}{\varepsilon_w-1}}, \varepsilon_w > 1,$$

where ε_w denotes the elasticity of substitution among labor service type $l \in [0,1]$. Cost minimization given L_t leads to the demand for each type of labor service:

$$l_t(l) = L_t\left(\frac{W_t(l)}{W_t}\right)^{-\varepsilon_w},$$

where L_t represents the demand for composite labor services, W_t the aggregate nominal wage, and $W_t(l)$ the wage for the type l.

We assume that wages are reset according to Calvo (1983). Each period households reset their nominal wage ($\widetilde{W}_t(l)$) with a probability of $1-\xi_w$ to maximize their lifetime utility. If they cannot reoptimize, they index their wages to the wage inflation rate by setting $W_t(l) = W_{t-1}(l)\pi_{t-1}^W$, where $\pi_{t-1}^W \equiv W_{t-1}/W_{t-2}$. The nominal aggregate wage evolves according to

$$W_t = \left[(1-\xi_w)\widetilde{W}_t^{(1-\varepsilon_w)} + \xi_w\pi_{t-1}^W W_{t-1}^{(1-\varepsilon_w)}\right]^{\frac{1}{(1-\varepsilon_w)}}. \tag{9}$$

2.1.3. Non-savers

Following Galí et al. (2007), we introduce non-saver (rule-of-thumb) households, who do not save but rather consume every resource each period. Their budget constraint is given by:

$$P_t^C(1+\tau_t^C)c_t^N(j) = (1-\tau_t^L)W_t(l)l_t^N(j) + P_t^C Z_t^N(j). \tag{10}$$

2.2. Firms and price setting

There are two types of firms in the domestic goods producing sector. One is monopolistically competitive intermediate goods producers, which produce a continuum of differentiated inputs indexed $i \in [0,1]$. The other is competitive identical final goods producers, which combine domestically and foreign produced (imported) intermediate goods to produce final goods.

2.2.1. Domestic final goods producers

Following Leeper et al. (2017), we assume that a representative domestic final goods producer bundles domestically produced and imported intermediate goods into three types of final goods: a private consumption good, Q_t^C; a private investment good, Q_t^I; and a public consumption good, Q_t^G. Each type of final good is produced by the CES form:

$$Q_t^{\mathbb{Y}} = \left[(1-\nu_{\mathbb{Y}})^{\frac{1}{\eta_{\mathbb{Y}}}}(\mathbb{Y}_t^H)^{\frac{\eta_{\mathbb{Y}}-1}{\eta_{\mathbb{Y}}}} + \nu_{\mathbb{Y}}^{\frac{1}{\eta_{\mathbb{Y}}}}(\mathbb{Y}_t^F)^{\frac{\eta_{\mathbb{Y}}-1}{\eta_{\mathbb{Y}}}}\right]^{\frac{\eta_{\mathbb{Y}}}{\eta_{\mathbb{Y}}-1}}, \quad \eta_{\mathbb{Y}}'s > 0,$$

where $\mathbb{Y} = \{C, I, G\}$, $\eta_{\mathbb{Y}}'s$ are the elasticities of substitution between domestic and foreign goods of type $\mathbb{Y}$, and $\nu_{\mathbb{Y}}'s \in [0,1]$ are the shares of foreign goods in the bundles $\mathbb{Y}$. By definition, C_t^H, I_t^H, and G_t^H represent bundles of domestically produced intermediate consumption, investment, and government spending goods, respectively. Similarly, C_t^F, I_t^F, and G_t^F denote those for imported goods, respectively. Dixit-Stiglitz aggregation yields $\mathbb{Y}_t^H$ and $\mathbb{Y}_t^F$ as

$$\mathbb{Y}_t^H = \left[\int_0^1 \mathbb{Y}_t^H(i)^{\frac{\varepsilon_H-1}{\varepsilon_H}}di\right]^{\frac{\varepsilon_H}{\varepsilon_H-1}} \text{ and}$$

$$\mathbb{Y}_t^F = \left[\int_0^1 \mathbb{Y}_t^F(i^*)^{\frac{\varepsilon_F-1}{\varepsilon_F}}di^*\right]^{\frac{\varepsilon_F}{\varepsilon_F-1}}, \varepsilon_H, \varepsilon_F > 1$$

where ε_H and ε_F denote the elasticities of substitution among varieties $i \in [0,1]$ and $i^* \in [0,1]$, respectively. Price indices are given by

$$\mathbb{P}_t^H = \left[\int_0^1 \mathbb{Y}_t^H(i)^{1-\varepsilon_H}di\right]^{\frac{1}{1-\varepsilon_H}} \text{ and } \mathbb{P}_t^F = \left[\int_0^1 \mathbb{Y}_t^F(i)^{1-\varepsilon_F}di^*\right]^{\frac{1}{1-\varepsilon_F}}.$$

2.2.2. Domestic intermediate goods producers

Cost minimization given $\mathbb{Y}_t^H$ leads to the demand for each domestically produced intermediate good i,

$$y_t^H(i) = Y_t^H\left(\frac{P_t^H(i)}{P_t^H}\right)^{-\varepsilon_H}, \tag{11}$$

where $P_t^H(i)$ is the price of the variety i, and P_t^H is the price index of home goods. Each domestic intermediate goods producer $i \in [0,1]$ adopts the same production technology given by $y_t(i) = u_t^a k_t(i)^\alpha l_t(i)^{1-\alpha}$, where $k_t(i)$ and $l_t(i)$ denote the capital stock and the level of employment used by firm i, respectively, and $\alpha \in [0,1]$. The variable u_t^a is the technology shock.

Each period a monopolistically competitive domestic intermediate goods producer reoptimizes its price with a probability of $1-\xi_H$. If it cannot reoptimize, it indexes its price to the inflation rate by setting $P_t^H(i) = \pi_{t-1}^H P_{t-1}^H(i)$, where $\pi_{t-1}^H \equiv P_{t-1}^H/P_{t-2}^H$. Price resetting firms maximize the following expected present discounted value of profits subject to (11):

$$E_t\sum_{s=0}^{\infty}(\beta\xi_H)^s\frac{\lambda_{t+s}^S}{\lambda_t^S}\left[\left(\Pi_{j=0}^s\pi_{t-1+j}^H\right)P_t^H(i)y_{t+s}^H(i) - MC_{t+s}y_{t+s}^H(i)\right],$$

where MC_t denotes nominal marginal costs per unit of output. We deflate each nominal variable by P_t^C in order to get the corresponding real variable. From this optimization problem, we can derive the following new-Keynesian domestic Phillips curve:

$$\hat{\pi}_t^H = \frac{1}{1+\beta}\hat{\pi}_{t-1}^H + \frac{\beta}{1+\beta}E_t\hat{\pi}_{t+1}^H + \frac{(1-\beta\xi_p)(1-\xi_p)}{\xi_p(1+\beta)}(\widehat{mc}_t - \hat{p}_t^H), \tag{12}$$

where a hat (^) denotes the percentage deviation of a variable from its steady state, mc_t is the real marginal cost, and $\hat{p}_t^H \equiv \hat{P}_t^H - \hat{P}_t^C$.

2.2.3. Exports and imports

Exporting firms purchase a domestic final good at price P_t^H and turn it into a differentiated export good, $x_t(i)$. They then sell the good in a monopolistically competitive market. The differentiated export goods are aggregated by a CES composite $X_t = \left[\int_0^1 x_t(i)^{\frac{\varepsilon_x-1}{\varepsilon_x}}di\right]^{\frac{\varepsilon_x}{\varepsilon_x-1}}$, where X_t denotes exports and ε_x is the elasticity of substitution among variety i. Analogous to the domestic intermediate goods producers, the exporting firms reoptimize their prices each period with a probability of $1-\xi_x$ to maximize the present discounted value of profits. Firms that do not re-optimize in a given period simply index their prices to the export price inflation rate by setting $P_t^{H*}(i) = \pi_{t-1}^{H*}P_{t-1}^{H*}(i)$, where $\pi_{t-1}^{H*} \equiv P_{t-1}^{H*}/P_{t-2}^{H*}$. Solving their optimization problem and log-linearizing yields the following export price Phillips curve:

$$\widehat{\pi}_t^{H*} = \frac{1}{1+\beta}\widehat{\pi}_{t-1}^{H*} + \frac{\beta}{1+\beta}E_t\widehat{\pi}_{t+1}^{H*} + \frac{(1-\beta\xi_x)(1-\xi_x)}{\xi_x(1+\beta)}(\widehat{mc}_t - \widehat{s}_t - \widehat{p}_t^{H*}), \tag{13}$$

where P_t^{H*} is the price of exports in terms of foreign currency, and $\widehat{p}_t^{H*} \equiv \widehat{P}_t^{H*} - \widehat{P}_t^{C*}$. We posit that foreign demand for domestically produced goods is specified as

$$X_t = \left(\frac{P_t^{H*}}{P_t^{C*}}\right)^{-\eta_x} Y_t^*, \tag{14}$$

where Y_t^* denotes foreign output, P_t^{C*} foreign price level, and $\eta_x > 0$ the export elasticity with respect to the relative price of exports.

Cost minimization given $\mathbb{Y}_t^F$ leads to the demand for each foreign produced intermediate good i^* given as follows:

$$y_t^F(i^*) = Y_t^F\left(\frac{P_t^F(i^*)}{P_t^F}\right)^{-\epsilon_F}. \tag{15}$$

Foreign produced intermediate good importers reset their prices each period with a probability of $1-\xi_m$ to maximize the present discounted value of profits. Firms that do not reset their prices in a given period simply index their prices to the import price inflation rate by setting $P_t^F(i) = \pi_{t-1}^F P_{t-1}^F(i)$, where $\pi_{t-1}^F \equiv P_{t-1}^F/P_{t-2}^F$. Thus, $P_t^F = \left[\xi_m\left(P_{t-1}^F\pi_{t-1}^F\right)^{1-\epsilon_F} + (1-\xi_m)\left(\widetilde{P}_t^F\right)^{1-\epsilon_F}\right]^{\frac{1}{1-\epsilon_F}}$. Importers' optimization given (15) yields a new Keynesian Phillips curve for imported goods

$$\widehat{\pi}_t^F = \frac{1}{1+\beta}\widehat{\pi}_{t-1}^F + \frac{\beta}{1+\beta}E_t\widehat{\pi}_{t+1}^F + \frac{(1-\xi_m)(1-\beta\xi_m)}{\xi_m(1+\beta)}\left(\widehat{mc}_{m,t}\right), \tag{16}$$

where $\widehat{mc}_{m,t}$ $(= \widehat{s}_t - \widehat{p}_t^F)$ is the log-linearized real marginal cost of imports $\left(\frac{S_tP_t^{C*}}{P_t^F}\right)$.

2.3. Monetary and fiscal policy

The monetary authority adjusts the short-term policy rate according to the following Taylor-type rule:

$$\widehat{R}_t = \rho_r\widehat{R}_{t-1} + (1-\rho_r)\left(\varrho_\pi\widehat{\pi}_t + \varrho_y\widehat{Y}_t\right) + \sigma_m\epsilon_t^m, \epsilon_t^m \sim i.i.d\ \ N(0,1), \tag{17}$$

where ϵ_t^m is the monetary policy shock.

The fiscal authority's behavior is summarized as follows: Its outlays, which include government spending, G_t, and transfers, Z_t, are financed by levying proportional taxes on consumption, labor income, and capital returns, as well as by issuing one-period nominal debt. Accordingly, the nominal flow government budget constraint is given by:

$$B_t + \tau_t^K R_t^K \nu_t K_{t-1} + \tau_t^L W_t L_t + P_t^C\tau_t^C C_t = R_{t-1}B_{t-1} + P_t^G G_t + P_t^C Z_t, \tag{18}$$

where P_t^G denotes the prices of public consumption goods.

Following Leeper et al. (2017), each fiscal instrument evolves according to the following rules:

$$\widehat{G}_t = \rho_G\widehat{G}_{t-1} - (1-\rho_G)\left(\phi_G\widehat{Y}_t + \gamma_G\widehat{s}_{t-1}^b\right) + \sigma_G\epsilon_t^G, \tag{19}$$

$$\widehat{\tau}_t^K = \rho_K\widehat{\tau}_{t-1}^K + (1-\rho_K)\left(\phi_K\widehat{Y}_t + \gamma_K\widehat{s}_{t-1}^b\right) + \sigma_K\epsilon_t^K, \tag{20}$$

$$\widehat{\tau}_t^L = \rho_L\widehat{\tau}_{t-1}^L + (1-\rho_L)\left(\phi_L\widehat{Y}_t + \gamma_L\widehat{s}_{t-1}^b\right) + \sigma_L\epsilon_t^L, \tag{21}$$

$$\widehat{\tau}_t^C = \rho_C\widehat{\tau}_{t-1}^C + (1-\rho_C)\left(\phi_C\widehat{Y}_t + \gamma_C\widehat{s}_{t-1}^b\right) + \sigma_C\epsilon_t^C, \tag{22}$$

$$\widehat{Z}_t = \rho_Z\widehat{Z}_{t-1} - (1-\rho_Z)\left(\phi_Z\widehat{Y}_t + \gamma_Z\widehat{s}_{t-1}^b\right) + \sigma_Z\epsilon_t^Z, \tag{23}$$

where s_{t-1}^b denotes the debt-to-GDP ratio at time $t-1$ defined as $s_{t-1}^b \equiv B_{t-1}/Y_{t-1}$, and each of the ϵ's is distributed *i.i.d.* $N(0,1)$. The fiscal policy rules in (19) through (23) reflect three features. First, they include an autoregressive term to allow for serial correlation. Second, all instruments are allowed to react to the ratio of government debt to GDP for ensuring fiscal solvency, captured by the coefficients γ's. Third, there is an automatic stabilizer component in the fiscal variables to mitigate macroeconomic volatility. This is modeled as a contemporaneous response to deviations of output from the steady state, controlled by the coefficients ϕ's.

2.4. Market clearing conditions

The market clearing conditions in the final goods market are $Q_t^C = C_t$, $Q_t^I = I_t + \Psi(\nu_t)\overline{K}_{t-1}$ and $Q_t^G = G_t$. Domestic goods market clearing requires $Y_t^H = C_t^H + I_t^H + G_t^H + X_t$.

The law of motion for net foreign assets is given by

$$S_tF_t = R_{t-1}^* S_t\left[1-\Gamma_f(\cdot)\right]F_{t-1} + S_tP_t^{H*}X_t - P_t^F M_t, \tag{24}$$

where M_t denotes aggregate imports, and $M_t \equiv C_t^F + I_t^F + G_t^F$.

2.5. Shocks and foreign sector

Each shock follows an AR(1) process given by:

$$\log(u_t^b) = \rho_b\log(u_{t-1}^b) + \sigma_b\epsilon_t^b, \epsilon_t^b \sim N(0,1),$$

$$\log(u_t^i) = \rho_i\log(u_{t-1}^i) + \sigma_i\epsilon_t^i, \epsilon_t^i \sim N(0,1),$$

$$\log(u_t^\phi) = \rho_\phi\log(u_{t-1}^\phi) + \sigma_\phi\epsilon_t^\phi, \epsilon_t^\phi \sim N(0,1),$$

$$\log(u_t^a) = \rho_a\log(u_{t-1}^a) + \sigma_a\epsilon_t^a, \epsilon_t^a \sim N(0,1).$$

We further assume that the foreign nominal interest rate, R_t^*, inflation rate, π_t^{C*}, and output, Y_t^* follow an AR(1) process given by:

$$\log(R_t^*) = \rho_{r*}\log(R_{t-1}^*) + \sigma_{r*}\epsilon_t^{r*}, \epsilon_t^{r*} \sim N(0,1),$$

$$\log(\pi_t^{C*}) = \rho_{\pi C*}\log(\pi_{t-1}^{C*}) + \sigma_{\pi C*}\epsilon_t^{\pi C*}, \epsilon_t^{\pi C*} \sim N(0,1),$$

$$\log(Y_t^*) = \rho_{y*}\log(Y_{t-1}^*) + \sigma_{y*}\epsilon_t^{y*}, \epsilon_t^{y*} \sim N(0,1).$$

3. Inferences

3.1. Data and estimation procedure

The model is estimated using Bayesian inference.[3] We use 13 observables, which are quarterly time series data ranging from 2000:Q1 to 2016:Q4: (1) domestic real per capita output; (2) domestic real per capita consumption; (3) domestic real per capita investment; (4) domestic real per capita consumption tax revenue; (5) domestic real per capita labor tax revenue; (6) domestic real per capita capital tax revenue; (7) domestic real per capita government spending; (8) domestic real per capita transfers; (9) domestic CPI inflation rate; (10) domestic nominal interest rate; (11) foreign real per capita output; (12) foreign CPI inflation rate; and (13) foreign nominal interest rate. U.S. data are used for the foreign variables. We detrend the logarithm of each time series with its own linear trend, except for the domestic and foreign price indexes and interest rates, which are demeaned. Details of the data construction are provided in Appendix A.

[3] See An and Schorfheide (2007) for a survey.

Table 1
Prior and posterior distributions for model parameters. The parameters for the inverse gamma distribution correspond to s and v, where $f(x \mid s, v) = v^s \Gamma^{-1}(s) x^{-s-1} \exp^{(-v/x)}$.

Parameter		Prior				Posterior		
		Fnc.	Mean	Std.	[5%, 95%]	Mean	Median	[5%, 95%]
Preference								
σ	Risk aversion	G	2	0.5	[1.25, 2.89]	2.24	2.21	[1.54, 3.07]
σ^L	Inverse Frisch labor elasticity	G	1.5	0.5	[0.78, 2.41]	1.98	1.92	[1.15, 3.00]
θ	Habit formation in consumption	B	0.7	0.1	[0.52, 0.85]	0.77	0.78	[0.67, 0.86]
μ	Fraction of non-savers	B	0.2	0.1	[0.06, 0.39]	0.06	0.06	[0.02, 0.11]
Frictions								
ξ_w	Wage stickiness	B	0.5	0.1	[0.34, 0.66]	0.67	0.68	[0.56, 0.77]
ξ_p	Price stickiness	B	0.5	0.1	[0.34, 0.66]	0.66	0.67	[0.57, 0.75]
ψ	Capital utilization	B	0.6	0.15	[0.35, 0.85]	0.91	0.92	[0.86, 0.96]
κ_i	Investment adjustment cost	N	6	1.5	[3.5, 8.5]	7.30	7.28	[5.19, 9.47]
η_C	Elast. of subst. btw home and foreign C	G	1.5	0.25	[1.12, 1.93]	1.53	1.51	[1.13, 1.97]
η_I	Elast. of subst. btw home and foreign I	G	1.5	0.25	[1.12, 1.93]	1.51	1.50	[1.12, 1.95]
η_G	Elast. of subst. btw home and foreign G	G	1.5	0.25	[1.12, 1.93]	1.50	1.49	[1.12, 1.93]
Monetary policy								
ρ_r	Lagged interest rate response	B	0.5	0.2	[0.17, 0.83]	0.97	0.97	[0.96, 0.98]
ϱ_π	Interest rate response to inflation	G	1.5	0.15	[1.26, 1.75]	1.33	1.33	[1.11, 1.56]
ϱ_y	Interest rate response to output	G	0.25	0.13	[0.08, 0.49]	0.52	0.50	[0.28, 0.81]
Fiscal policy								
ϕ_K	Capital tax response to output	G	0.5	0.3	[0.13, 1.07]	0.58	0.52	[0.15, 1.23]
ϕ_L	Labor tax response to output	G	0.5	0.3	[0.13, 1.07]	0.43	0.39	[0.11, 0.90]
ϕ_C	Consumption tax response to output	G	0.5	0.3	[0.13, 1.07]	0.51	0.45	[0.13, 1.08]
ϕ_G	Govt. spending response to output	G	0.5	0.3	[0.13, 1.07]	0.78	0.73	[0.25, 1.45]
ϕ_Z	Transfers response to output	G	0.5	0.3	[0.13, 1.07]	0.37	0.33	[0.09, 0.80]
γ_K	Capital tax response to debt-to-GDP ratio	G	0.5	0.3	[0.13, 1.07]	0.35	0.33	[0.10, 0.68]
γ_L	Labor tax response to debt-to-GDP ratio	G	0.5	0.3	[0.13, 1.07]	0.35	0.34	[0.14, 0.60]
γ_C	Consumption tax response to debt-to-GDP ratio	G	0.5	0.3	[0.13, 1.07]	0.18	0.17	[0.06, 0.32]
γ_G	Govt. spending response to debt-to-GDP ratio	G	0.5	0.3	[0.13, 1.07]	0.30	0.29	[0.12, 0.52]
γ_Z	Transfers response to debt-to-GDP ratio	G	0.5	0.3	[0.13, 1.07]	0.31	0.29	[0.10, 0.60]
Serial correlation in disturbances								
ρ_a	Technology	B	0.5	0.2	[0.17, 0.83]	0.91	0.92	[0.86, 0.95]
ρ_b	Preference	B	0.5	0.2	[0.17, 0.83]	0.31	0.31	[0.14, 0.50]
ρ_i	Investment	B	0.5	0.2	[0.17, 0.83]	0.26	0.26	[0.11, 0.44]
ρ_ϕ	Risk premium	B	0.5	0.2	[0.17, 0.83]	0.89	0.91	[0.75, 0.97]
ρ_K	Capital tax rate	B	0.5	0.2	[0.17, 0.83]	0.10	0.09	[0.03, 0.21]
ρ_L	Labor tax rate	B	0.5	0.2	[0.17, 0.83]	0.10	0.09	[0.03, 0.21]
ρ_C	Consumption tax rate	B	0.5	0.2	[0.17, 0.83]	0.13	0.12	[0.04, 0.26]
ρ_G	Government spending	B	0.5	0.2	[0.17, 0.83]	0.18	0.18	[0.07, 0.33]
ρ_Z	Transfers	B	0.5	0.2	[0.17, 0.83]	0.45	0.45	[0.28, 0.62]
ρ_{y^*}	Foreign output	B	0.5	0.2	[0.17, 0.83]	0.91	0.91	[0.85, 0.96]
$\rho_{\pi C*}$	Foreign CPI inflation	B	0.5	0.2	[0.17, 0.83]	0.64	0.64	[0.52, 0.75]
ρ_{r^*}	Foreign interest rate	B	0.5	0.2	[0.17, 0.83]	0.96	0.96	[0.93, 0.99]
Std. of shocks								
σ_m	Monetary policy	IG	0.5	∞	[0.09, 2.07]	0.10	0.09	[0.08, 0.11]
σ_a	Technology	IG	0.5	∞	[0.09, 2.07]	1.03	1.01	[0.76, 1.38]
σ_b	Preference	IG	0.5	∞	[0.09, 2.07]	11.35	10.91	[7.33, 16.84]
σ_i	Investment	IG	0.5	∞	[0.09, 2.07]	15.97	15.78	[10.87, 21.72]
σ_ϕ	Risk premium	IG	0.5	∞	[0.09, 2.07]	1.82	1.74	[1.09, 2.76]
σ_K	Capital tax rate	IG	0.5	∞	[0.09, 2.07]	29.37	29.19	[25.47, 33.87]
σ_L	Labor tax rate	IG	0.5	∞	[0.09, 2.07]	13.62	13.53	[11.78, 15.80]
σ_C	Consumption tax rate	IG	0.5	∞	[0.09, 2.07]	7.87	7.82	[6.83, 9.07]
σ_G	Government spending	IG	0.5	∞	[0.09, 2.07]	9.69	9.62	[8.37, 11.22]
σ_Z	Transfers	IG	0.5	∞	[0.09, 2.07]	11.09	11.00	[9.66, 12.78]
σ_{y^*}	Foreign output	IG	0.5	∞	[0.09, 2.07]	0.60	0.60	[0.52, 0.69]
$\sigma_{\pi C*}$	Foreign CPI inflation	IG	0.5	∞	[0.09, 2.07]	0.81	0.80	[0.70, 0.93]
σ_{r^*}	Foreign interest rate	IG	0.5	∞	[0.09, 2.07]	0.13	0.13	[0.11, 0.15]
Import sector								
$\xi_{p,m}$	Price stickiness	B	0.5	0.1	[0.34, 0.66]	0.72	0.72	[0.65, 0.79]
Export sector								
$\xi_{p,x}$	Price stickiness	B	0.5	0.1	[0.34, 0.66]	0.40	0.40	[0.28, 0.52]
ε_x	Elasticity w.r.t. foreign output	G	1.5	0.75	[0.51, 2.91]	3.19	3.07	[1.75, 5.00]
ζ	UIP condition scaling parameter	U	[Min: 0.0001, Max: 0.4]			0.25	0.25	[0.11, 0.38]

In order to initiate the estimation procedure, we solve the log-linearized system of the model by using Sims's (2002) *gensys* algorithm. Sims's optimization routine *csminwel* is then used to maximize the log posterior function. We take a million draws from the posterior distribution using the random walk Metropolis-Hastings algorithm. Finally, we discard the first 400,000 draws and keep 1 out of 20 draws, which leaves a final sample size of 30,000.

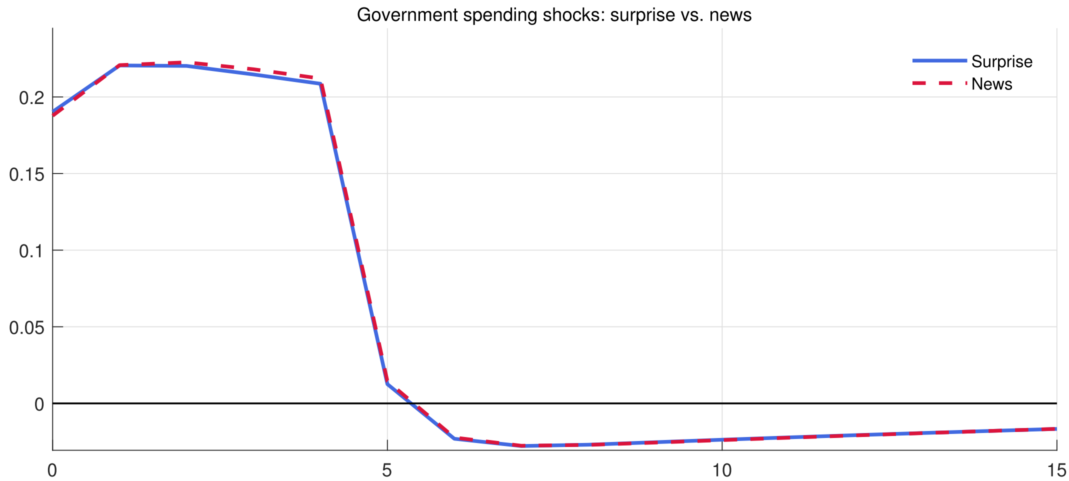

Fig. 1. Shock paths of a news shock (dashed line) and the equivalent surprise shock (solid line). Posterior median estimates are reported. The x-axis measures years.

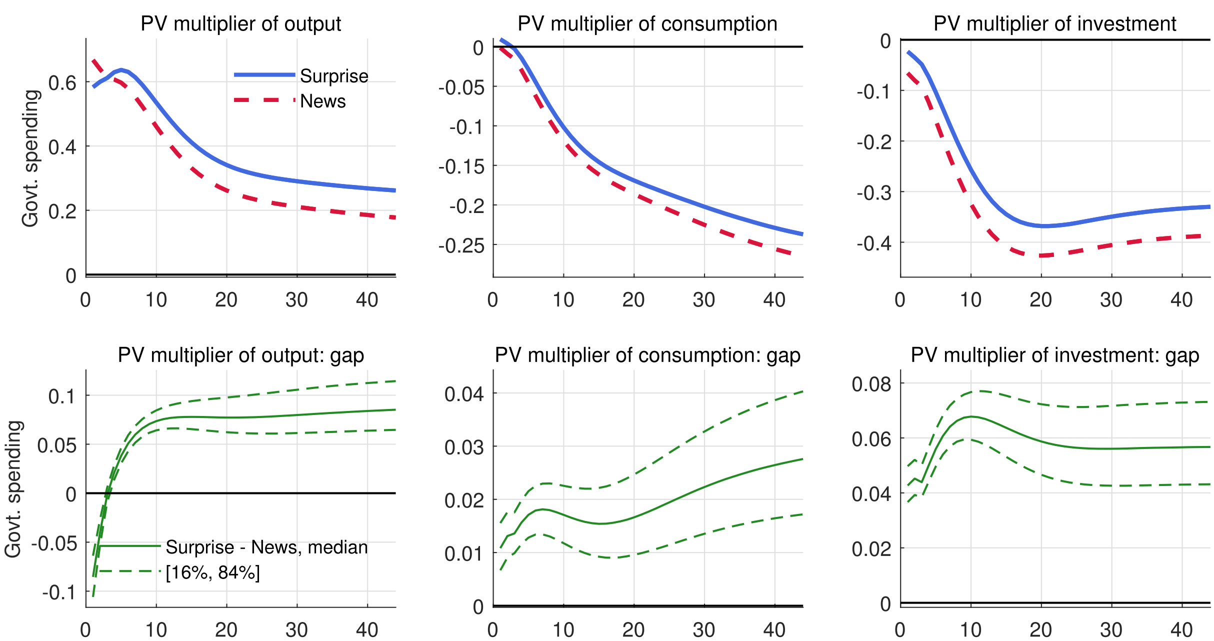

Fig. 2. Present-value multipliers from the model with the fraction of non-savers (μ) estimated from the data. **[Upper panels]** Median present-value multipliers of output, consumption and investment to a government spending news shock (dashed lines), compared to the case in which government spending shocks with comparable size at each horizon perturb the economy (solid lines). **[Lower panels]** Median (solid lines) and 68% error band (dashed lines) estimates of the gap between the present-value multipliers associated with the surprise and news cases. The x-axes measure years.

3.2. Calibrated parameters

We calibrate the parameters that are difficult to identify from the data. We set the discount factor, β, to be 0.99 so that the annual steady-state real interest rate becomes 4 percent. The quarterly depreciation rate for capital, δ, is set at 0.025, implying an annual depreciation rate of 10 percent. As far as the markups in the Korean economy are concerned, they range from about 10 to 32 percent, depending on the estimation methods, and there is no consensus about the average. We set the steady-state price and wage markups to be 14.3 percent, which is close to the value of 15 percent used in Smets and Wouters (2007).

The rest of the calibrated parameters are drawn from the means of the data over the sample period. The capital income share of total output is set at 0.4. The ratio of government spending to output is 0.15, while the share of quarterly government debt to output is set to be 1.082. According to the National Assembly Budget Office of Korea (2015), the average marginal labor, capital, and consumption tax rates during the sample period are 0.10, 0.19, and 0.10, respectively. Lastly, we assign the average share of imports to absorption using national accounts data for the shares of imports in private consumption, investment and government spending. The sample mean value is 0.442.

3.3. Prior distribution

Columns 3 through 5 in Table 1 show the prior distribution of the estimated parameters. Our priors for the household preference and friction parameters are similar to those in Justiniano and Preston (2010), Traum and Yang (2015), and Leeper et al. (2017).

Regarding the parameters governing monetary policy behavior, our priors are set to be broadly consistent with those in Justiniano and Preston (2010). The priors for the monetary policy smoothing and for its

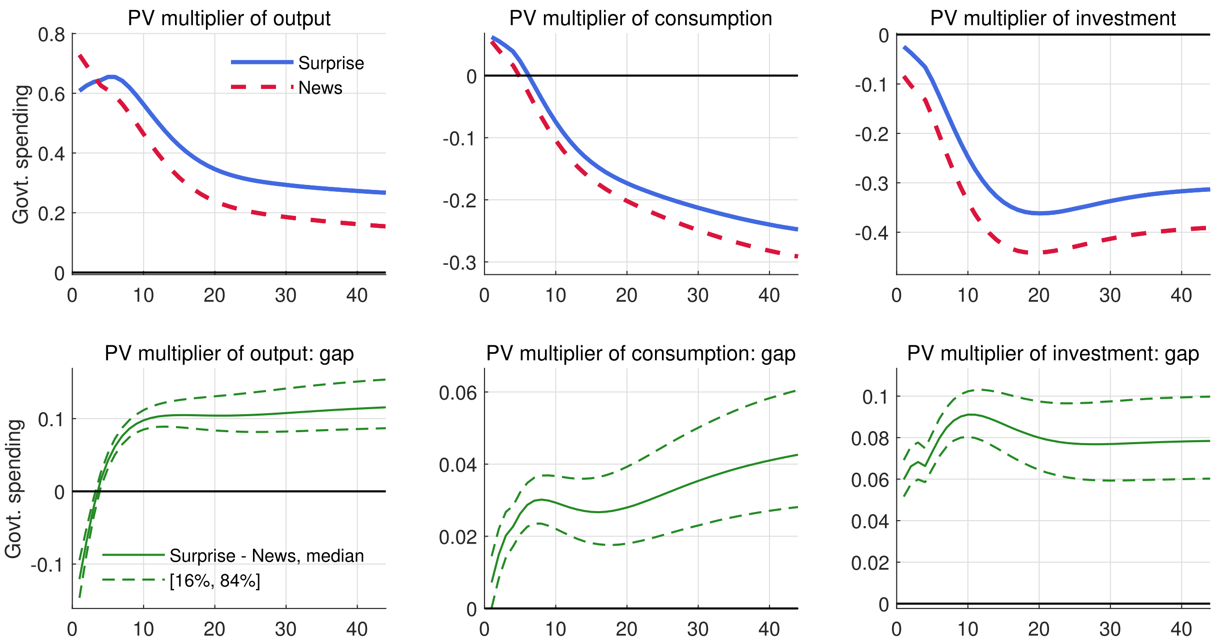

Fig. 3. Present-value multipliers from the model with the fraction of non-savers (μ) fixed at 0.2. **[Upper panels]** Median present-value multipliers of output, consumption and investment to a government spending news shock (dashed lines), compared to the case in which government spending shocks with comparable size at each horizon perturb the economy (solid lines). **[Lower panels]** Median (solid lines) and 68% error band (dashed lines) estimates of the gap between the present-value multipliers associated with the surprise and news cases. The x-axes measure years.

responses to inflation parameters are similar to those values in Justiniano and Preston (2010), but with slightly smaller means and/or standard deviations. For the parameter capturing interest rate response to output, we assign a prior identical to that used in their analysis.

The priors for the fiscal parameters are chosen to cover a reasonably large range of the parameter space. We assume gamma distributions for the fiscal instruments' responses to debt (γ's) and output (ϕ's) with a mean of 0.5 and a standard deviation of 0.3. We assume gamma distributions for these parameters in order to avoid negative estimates for them, in which case the model economy may be unstable.

Identical priors are imposed on the persistence and standard deviation parameters of the shock processes. We follow Smets and Wouters (2007) and adopt a beta distribution with a mean of 0.5 and a standard deviation of 0.2 for the shock AR(1) coefficients. We further assume that the priors for the shock standard deviations follow an inverse gamma distribution with a mean of 0.5 and a standard deviation of infinity.

The priors for the price stickiness parameters in the import and exports sector are set to be identical to their domestic counterparts; that is, beta distribution with a mean and standard deviation of 0.5 and 0.1, respectively. The export elasticity with respect to the relative price of exports, ε_x, is assumed to follow a gamma distribution with a mean of 1.5 and a standard deviation of 0.75. Finally, we set a uniform prior ranging from 0.0001 to 0.4 for the scaling parameter in the uncovered interest rate parity condition, ζ.

4. Empirical results

4.1. Posterior estimates

The last three columns in Table 1 report the mean, median, and 90th percentiles from the posterior distributions. With the exceptions of the elasticities of substitution between the home and foreign goods parameters (η's) and consumption tax rate response to the debt-to-GDP parameter (γ_C), the data seem to be informative in identifying the structural parameters as their 90-percent posterior intervals deviate from those implied by the prior distributions.

Most median parameter estimates are not very far from the estimates in previous studies. However, several of the parameter estimates are noteworthy. Firstly, the median estimate for the fraction of rule-of-thumb consumers (non-savers) is 0.06, which is at the low end of the prior distribution.[4] This may be due to the fact that the Korean savings rate is high relative to other countries with similar income levels.[5] This small estimate suggests that the present-value multiplier of government consumption may not be very large. Secondly, the median estimate for the policy rate response to output is 0.5, slightly larger than U.S. estimates but very close to the estimates in many Korean studies. This implies that the Bank of Korea takes output fluctuations seriously even though its mandates are price and financial stability. Thirdly, all the fiscal policy parameters are estimated to be positive and between zero and one. This result critically depends on the prior of our gamma distribution. If we set it to be a normal distribution with a mean of zero, most median estimates are slightly negative or near zero. Since we do not have any persuasive empirical and/or theoretical evidence that the prior of the gamma distribution is not appropriate, we will stick to it.

4.2. Impulse responses

We combine the fully specified government consumption structure of (19) with the news specification of Walker and Leeper (2011) as follows:

$$\widehat{G}_t = \rho_G \widehat{G}_{t-1} - (1-\rho_G)\left(\phi_G \widehat{Y}_t + \gamma_G \widehat{s}^b_{t-1}\right) + \theta^G_0 u^G_t + \theta^G_1 u^G_{t-1} + \theta^G_2 u^G_{t-2} + \cdots + \theta^G_4 u^G_{t-4}, \tag{25}$$

where θ^G_i denotes the relative importance of u^G_{t-i}, which is the news that arrives at t with i periods of foresight. The simulation results may

[4] We estimated various specifications of the Korean economy, and found that $\mu < 0.1$ was fairly robust across model specifications.

[5] The total and private savings rates in Korea are approximately 34 percent and 25 percent, respectively, for the sample period.

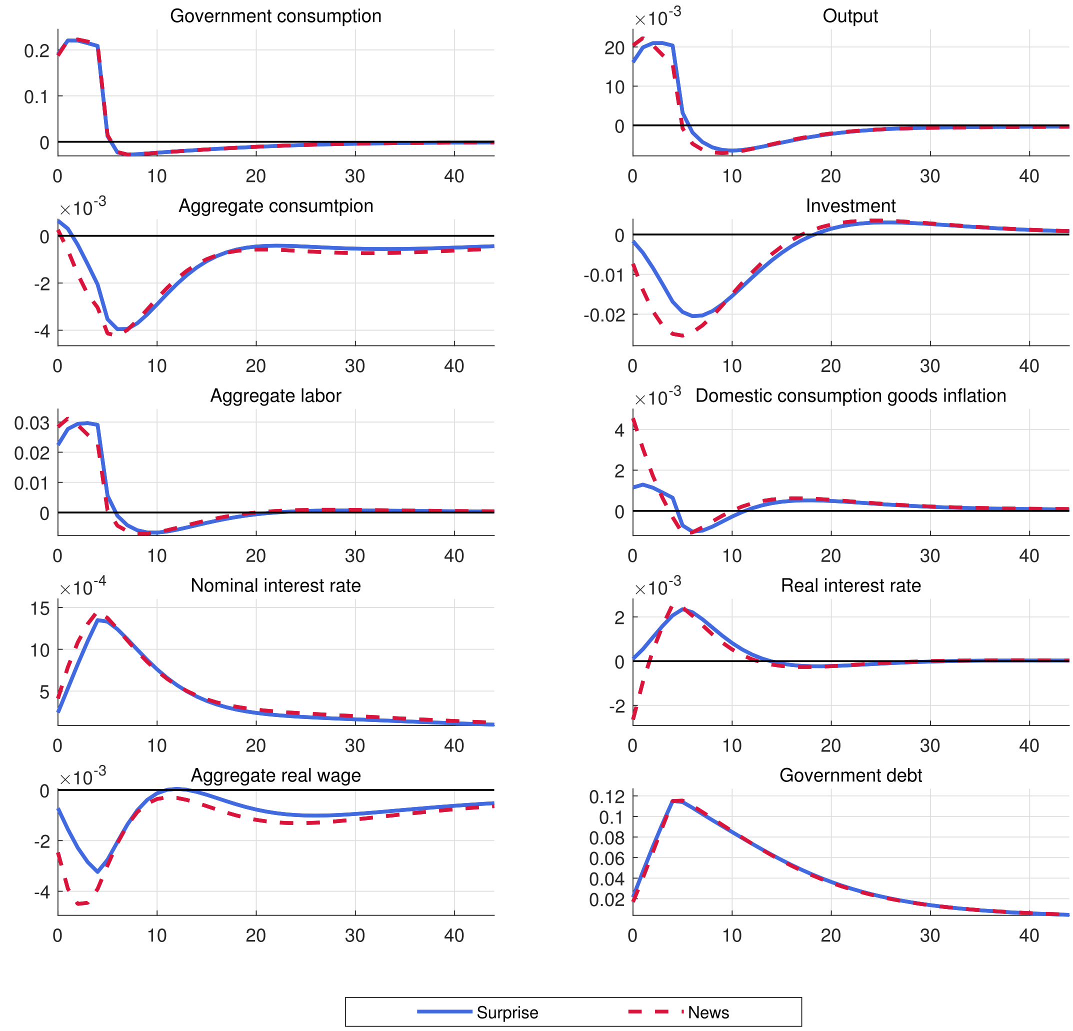

Fig. 4. Impulse responses to a government spending news shock (dashed lines), compared to the case in which government spending shocks with comparable size at each horizon perturb the economy (solid lines). Posterior median estimates are reported. The x-axes measure years.

critically depend on the values of the weight parameters, θ_i^G. However, previous studies provide no clear guidance for the choice of values. We assign an equal weight to each θ_i^G of 0.2.[6] We consider the period of foresight to be five years because that is the interval at which the Korean Statistical Information Service publishes population estimates and the Ministry of Economy and Finance publishes medium-term fiscal projections. Thus, we can assume that private agents can have well-formed opinions about the future path of government spending four to five years in advance. Please note here that we perform simulations with annual frequencies after annualizing the quarterly estimates of the relevant variables.

Fig. 1 shows the shock paths of the news and equivalent surprise shocks. As the figure shows, both shocks are the same in terms of size, but they differ as to whether they are expected in advance or not. The news shock is anticipated, while the surprise shock is completely unexpected. The shock path moves around 0.2 for the first five years (including the current period, t), then drops to near zero as specified in (25).

Fig. 2 shows the present-value multipliers of both the government consumption news and surprise shocks. The present-value output multiplier of government consumption is defined as follows:

$$\text{Present Value Multiplier}(k) = \frac{E_t \sum_{j=0}^{k} \left(\prod_{i=0}^{k} (1 + r_{t+i})^{-1} \right) \Delta Y_{t+j}}{E_t \sum_{j=0}^{k} \left(\prod_{i=0}^{k} (1 + r_{t+i})^{-1} \right) \Delta G_{t+j}} \tag{26}$$

where r_{t+i} is the model-implied real interest rate. The present-value consumption and/or investment multiplier of government consumption is similarly defined. The upper panel shows the median present-value multipliers on output, consumption, and investment of the government consumption news and surprise shocks. The lower panel shows the median (solid lines) and 68 percent error band (dashed lines) estimates of the gap between the present-value multipliers associated with the surprise and news shocks. The gap is positive apart from the initial couple of years in the case of the output multiplier, and consistently positive for the consumption and investment multipliers. The present-value multiplier of the government consumption news shock starts from about 0.72 and then declines continuously, reaching 0.16 after 40 years. On the other hand, the present-value multiplier of the surprise shock starts from 0.56, rises to 0.64 over the next 7 years, and then declines contin-

[6] We also tried different values for θ_i^G. For example, we first set $\theta_i^G = R^i$ for each $i = 0, \ldots, 4$, in order to reflect the idea that the more recent the news, the larger the weight. We then divided each θ_i^G by the sum of all θ_i^G's, so that the sum of the weights equaled one. However, the simulation results were not qualitatively different.

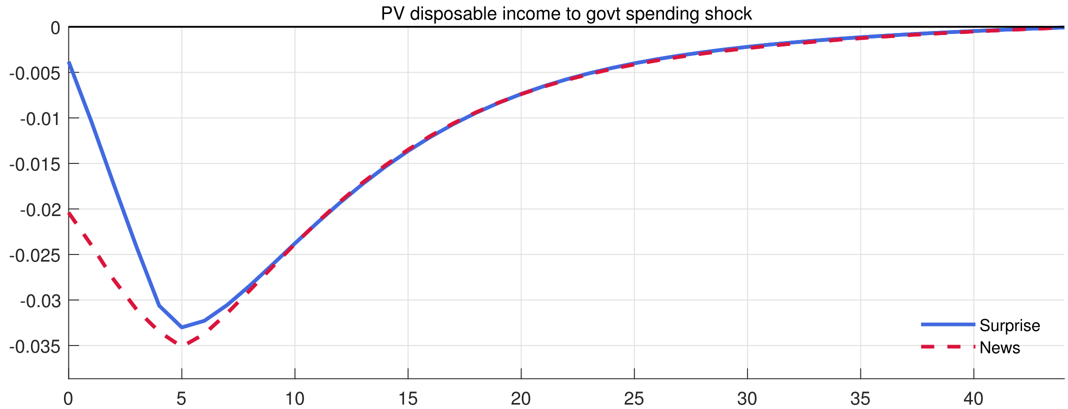

Fig. 5. Present-value disposable income from horizon *h* and onward to a news shock on the corresponding variable (dashed lines), compared to that associated with the case in which the corresponding fiscal shocks with comparable size at each horizon perturb the economy (solid line). Posterior median estimates are reported. The x-axis measures years.

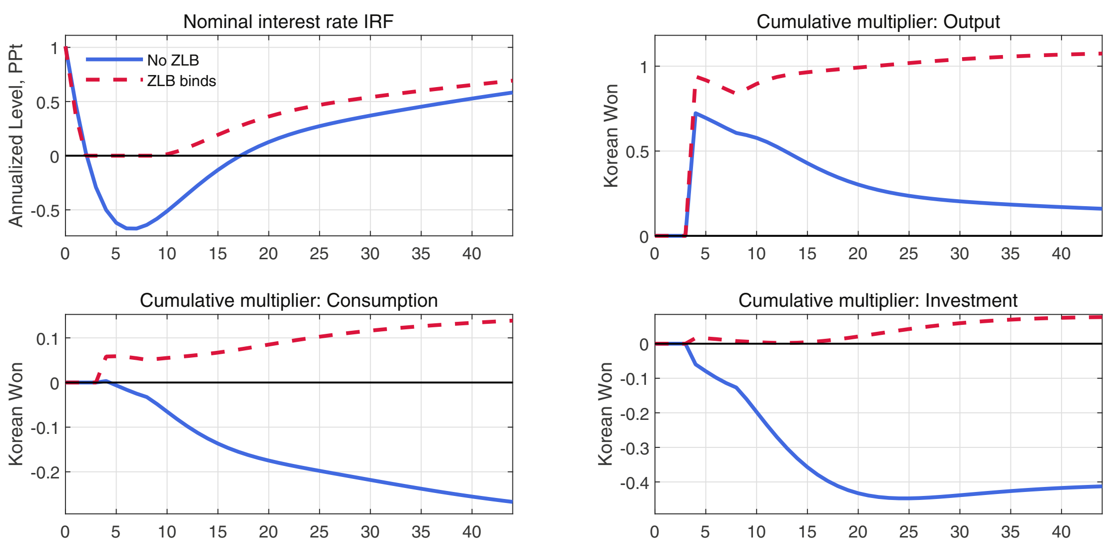

Fig. 6. Present-value multipliers of output, consumption and investment incurred by a government spending news shock, with (dashed lines) and without (solid lines) the zero lower bound constraint. The x-axes measure years.

uously, reaching 0.26 after 40 years.[7]

Neoclassical theory predicts negative comovements between output and consumption and between output and investment in response to a government consumption shock, whereas the textbook IS-LM model predicts a positive comovement between output and consumption and a negative comovement between output and investment in response to the government consumption shock. Fig. 2 shows that our results are more consistent with the forward-looking theory of consumption and investment. As the news shock occurs, the behavior of economic agents is more Ricardian, since they expected the news shock and considered it in making decisions. In the case of a surprise shock, the consumption multiplier is initially positive, but immediately becomes negative, and the investment multiplier is negative from the beginning.

Galí et al. (2007) introduce both rule-of-thumb consumers and new-Keynesian features in a DSGE model, and generate a positive comovement between output and consumption. Our model also includes the combination of new-Keynesian features and rule-of-thumb consumers, but it generates a negative comovement between them. This may be due to the fact that the median estimate of the share of rule-of-thumb consumers turns out to be 0.06, which is not large by any standard.[8]

In order to see if introducing a large enough share of rule-of-thumb consumers into the model generates a positive comovement between output and consumption, we set the share parameter, μ, at 0.2 and do the Bayesian estimation again. Fig. 3 shows that the consumption multiplier is positive for the first 5 (7) years in the case of news (surprise) shock. Accordingly, the output multiplier increases by about 0.05. It starts from 0.77 in the case of a news shock, and 0.59 in the case of a surprise shock. However, the marginal likelihood of the model is in favor the DSGE model with the share parameter, μ, free to be estimated. Geweke's modified harmonic mean estimator is -1951.0 for the model with the share parameter free to be estimated, whereas it is -1959.2 for the model with the share parameter fixed at 0.2.

Fig. 4 shows the impulse responses of major macroeconomic variables to a government consumption news shock and to a corresponding surprise shock. There are couple of things to note. Firstly, for the initial 12 years, output responds less to the government consumption

[7] Conventionally, researchers analyze the (present-value) multiplier of the "one-time one-percent" surprise shock to government spending instead of what we call the equivalent (multi-period) surprise shock reported in Fig. 1. However, the simulation results show that the two multipliers from both one-time and the equivalent (multi-period) surprise shocks are almost the same.

[8] Performing the same simulations with the share of rule-of-thumb consumers being zero while all other parameter values remain the same does not change the results qualitatively.

news shock than to the corresponding surprise shock, with the exception of the initial couple of years. This is due to the fact that both consumption and investment respond more negatively to the government consumption news shock than to the corresponding surprise shock for the period. Secondly, consumption falls more in response to the government consumption news shock than to the corresponding surprise shock.

The two most important variables that affect consumption are the present value of future income and real interest rates. The present value of future income falls more in the case of the news shock than the corresponding surprise shock as can be seen in Fig. 5. This is exactly what we expect when private agents take the government consumption news into consideration when they make decisions. Real interest rates also falls more in response to the government consumption news shock than to the corresponding surprise shock. This is because inflation rates rise far more despite the higher nominal interest rates in response to the government consumption news shock than to the corresponding surprise shock.[9] This is reminiscent of the results in forward guidance literature.[10] Expected future fiscal shocks have a very large effect on current inflation in most New Keynesian models.

In sum, consumption responds more negatively to the government consumption news shock than to the corresponding surprise shock, since the negative wealth effect dominates the intertemporal substitution effect of the lower real interest rates.

The same mechanism seems to work for investment. Both the present value of future income and real interest rates are lower in the case of the government consumption news shock. If we interpret the present value of future income as a proxy for future profits, and if expectations of lower future profits> dominate lower real interest rates, Tobin's q will be smaller in the case of the government consumption news shock than the corresponding surprise shock, and investment falls more.

4.3. Impulse responses with zero lower bound

Fig. 6 shows the present-value government consumption multipliers on output, consumption, and investment both with and without a zero lower bound. For the simulation, we used Guerrieri and Iacoviello's (2015) OccBin. We introduced a very large negative taste shock into the model so that the economy plunges and the policy rate hits the zero lower bound. More specifically, a negative preference shock, six standard deviations away from the steady state, hits the economy, causing it to plunge into a deep recession, and the policy rate hits the zero lower bound. Three periods after the preference shock, a government consumption shock of one standard deviation away boosts the economy. For details about the OccBin toolkit, see Guerrieri and Iacoviello (2015).

In every case, the present-value multipliers are larger when the policy rate hits the zero lower bound. The output multiplier with the news shock starts from 0.94 on impact, then rises to 1 after about 20 years, and stays slightly above 1 throughout the whole simulation period of 40 years. The consumption multiplier is negative without the zero lower bound. In contrast, the consumption multiplier is positive, though not large, when the zero lower bound is allowed. It starts at about 0.05, then increases continuously to above 0.1 after about 20 years. The investment multiplier is virtually zero up until 15 years, and stays slightly above zero throughout the whole simulation period with the zero lower bound. These results are in line with the previous research.

5. Conclusion

We build a standard small open economy New-Keynesian DSGE model with a fully specified fiscal policy structure for the Korean economy. In addition, we consider that the future path of fiscal policy is anticipated to some degree, and incorporate this characteristic of fiscal policy into a *news* approach.

We compare the present-value multipliers of government consumption when it is anticipated with that of unexpected surprise spending of the same magnitude. We find that the present-value multiplier of the government consumption news shock in Korea is smaller than that of the corresponding surprise shock, apart from the initial couple of years in the case of the output multiplier. It is consistently smaller in the cases of the consumption and investment multipliers. The present-value output multiplier of the government consumption news shock starts from about 0.72 and declines continuously to reach 0.16 after 40 years. On the other hand, the present-value multiplier of the surprise shock starts from 0.56, rises to 0.64 for the next 7 years, and then declines continuously to reach 0.26 after 40 years.

A. Data

Korean data from 2000:Q1 to 2016:Q4 are used for the estimation of the model. In addition, we use the U.S. quarterly GDP, CPI inflation rate, and nominal interest rate as the proxy for the world economy. Detailed data descriptions are as follows:

$$
\begin{aligned}
\text{GDP} &= \log(\text{Domestic Real Per Capita GDP/Linear Trend}) \times 100,\\
\text{Consumption} &= \log(\text{Domestic Real Per Capita Consumption/Linear Trend}) \times 100,\\
\text{Investment} &= \log(\text{Domestic Real Per Capita Investment/Linear Trend}) \times 100,\\
\text{Consumption Tax Revenue} &= \log(\text{Domestic Real Per Capita Consumption Tax Revenue/Linear Trend}) \times 100,\\
\text{Labor Tax Revenue} &= \log(\text{Domestic Real Per Capita Labor Tax Revenue/Linear Trend}) \times 100,\\
\text{Capital Tax Revenue} &= \log(\text{Domestic Real Per Capita Capital Tax Revenue/Linear Trend}) \times 100,\\
\text{Government Spending} &= \log(\text{Domestic Real Per Capita Government Spending/Linear Trend}) \times 100,\\
\text{Transfers} &= \log(\text{Domestic Real Per Capita Transfers/Linear Trend}) \times 100,\\
\text{Inflation Rate} &= \log(\text{Domestic CPI/Domestic CPI}(-1)) \times 100,\\
\text{Nominal Interest Rate} &= \text{Overnight Call Rate (per annum)}/4,
\end{aligned}
$$

[9] Although not reported herein, we find that the impulse responses of marginal costs to both shocks are almost identical.

[10] Please see, for example, Farhi and Werning (2016) and Canzoneri et al. (2018).

$$\text{World GDP} = \log(\text{U.S. Real Per Capita GDP/Linear Trend}) \times 100,$$

$$\text{World Inflation} = \log(\text{U.S. CPI/U.S. CPI}(-1)) \times 100,$$

$$\text{World Nominal Interest Rate} = \text{U.S. Federal Funds Rate (per annum)}/4,$$

where all the level data are nominal values. In order to construct real per capita variables, domestic nominal data are divided by the GDP deflator and population. The original series for the Korean fiscal variables are not seasonally adjusted, and thus we deseasonalize them by using the X-13-ARIMA procedure. U.S. GDP uses the real series. The sources of the original data are given as follows:

- Domestic Nominal GDP: Nominal gross domestic product, seasonally adjusted, the Bank of Korea's Economic Statistics System database (BOK-ECOS)
- Domestic Nominal Consumption: Nominal gross consumption expenditure by households, seasonally adjusted, BOK-ECOS
- Domestic Nominal Investment: Nominal gross fixed capital formation, seasonally adjusted, BOK-ECOS
- Domestic Nominal Consumption Tax Revenue: Taxes on goods and services, Taxes on International trade and transactions, Korean Statistical Information Service (KOSIS)
- Domestic Nominal Labor Tax Revenue: Taxes on individual income, profits and capital gains, Social security contributions, KOSIS
- Domestic Nominal Capital Tax Revenue: Taxes on corporate income, profits and capital gains, Taxes on property, KOSIS
- Domestic Nominal Government Spending: Expenditure on goods and services, Current expenditure of enterprise special accounts, Capital expenditure, KOSIS
- Domestic Nominal Transfers: Subsidies and other current transfers, KOSIS
- Domestic CPI: Consumer price indexes, 2010 = 100, seasonally adjusted, BOK-ECOS
- Domestic Nominal Interest Rate: Overnight call rate, uncollateralized, percent per annum, averages of daily figures, BOK-ECOS
- Domestic GDP Deflator: GDP deflator, 2010 = 100, seasonally adjusted, BOK-ECOS
- Domestic Population: Total population, annual, KOSIS
- U.S. Real GDP: Real gross domestic product, billions of chained (2009) dollars, seasonally adjusted at annual rates, NIPA Table 1.1.6, Line 1.
- U.S. CPI: Consumer price index for all urban consumers, all items, 1982–1984 = 100, seasonally adjusted, Federal Reserve Economic Data
- U.S. Federal Funds Rate: Averages of daily figures, percent, Board of Governors of the Federal Reserve System
- U.S. Population: Civilian noninstitutional population, ages 16 years and over, seasonally adjusted, U.S. Department of Labor, Bureau of Labor Statistics

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.econmod.2019.05.021.

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