Double Drain, Risk of Recession and Monetary Policy in Small Open Economies

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Abstract. This paper examine the monetary policy implications for emerging economies experiencing double drains, that is, credit crunches in both the global and their domestic financial markets. We construct a two-sector small open economy model with features such as original sin and dollar pricing, which are relevant to emerging markets. Our results imply that in deciding its policy stance the monetary authority should consider the extent to which international shocks are transmitted in the domestic credit markets. When international financial shocks hit the economy without spreading by contagion to domestic financial intermediation, the policy interest rate increases and the economy reduces its external debts and expands its net exports, while the contraction in real economic activities is mitigated by reallocation of input resources into the traded sector. However, if the international shock is contagious, and domestic financial markets hence dip into a credit crunch, the policy interest rate may be lowered to buffer the common negative impacts in both the traded and non-traded sectors, depending upon the degree of contagion. To minimize the cost of recession following an international financial shock, a passive stance for an external drain without contagion, and an active stance under a double drain with contagion are desirable.

Keywords: External Drain; Double Drain; Recession; Monetary Policy; Small Open Economy
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1. INTRODUCTION

The recent financial turmoil originating from the U.S. sub-prime mortgage crisis has been affecting many emerging economies especially, those with heavy dependence on external borrowings. Financing from international capital markets gives these emerging countries opportunities to achieve higher economic growth, but, excessive dependence on this external source of funding also entails some risk of economic destabilization. Capital inflows may suddenly turn into capital outflows, which can easily cause instability of the financial and real sectors in these emerging economies[1]. As shown in Figure 1, during a period of sudden capital flow reversal, emerging economies are likely to experience a rapid deterioration in conditions for obtaining new foreign loans or rolling over existing borrowings. In this situation, they need to reduce their outstanding stock of foreign debts by running current account surpluses, generally accompanied by sharp reductions in output and employment.

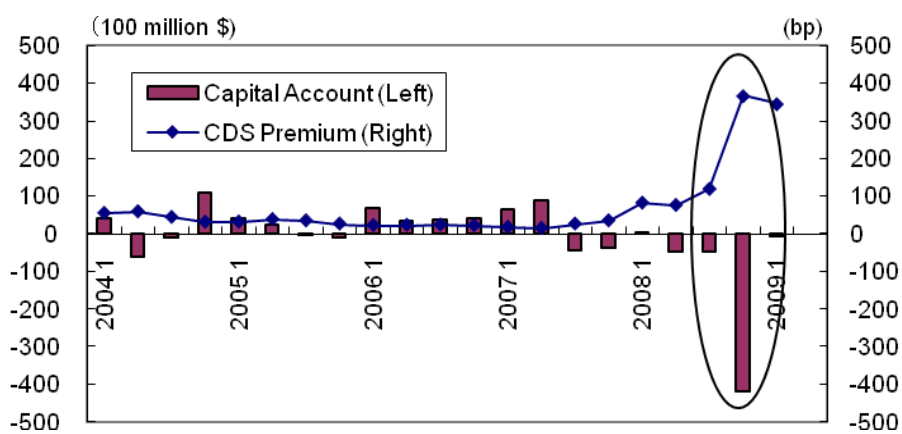

Figure 1. Sudden Stop and CDS Premium in Korea.

The design of optimal policy responses to adverse external financial shocks during a period of global capital market turmoil, represented by a sudden increase in premiums on international borrowing with a sharp retrenchment in capital

[1] Calvo (1998) used the term 'sudden stop' for this phenomenon of capital reversal. Some people differentiate between 'sudden flights', which means surging investment abroad by domestic residents, and 'sudden stops' in capital inflows by foreign investors. Deterioration in the capital account in a country can be caused by these two effects together.

inflows, has been an important issue particularly since global financial instability swept across the world economy recently. The main question for the policy authority is "Should a country facing a financial shock on foreign borrowing tighten its monetary policy?" Or "Should it relax its policy stance in order to attenuate the contraction in output?" There are two possible but opposite views. The first view is that monetary policy in the aftermath of a large external shock in capital inflows should become tighter in order to avoid potential macroeconomic and financial instability and restore credibility. In the second view, others have argued that monetary policy should be expansionary under a sudden stop shock, in order to buffer against a severe economic downturn.

There are several theoretical papers on optimal monetary policy during a period of financial turmoil. Braggion, Christiano and Roldos (2007) construct a model where an initial tightening followed by a later loosening is optimal. Their argument relies on the need to avoid currency mismatches in the very short run, while easing them in the medium term. Hevia (2007) suggests that a contractionary monetary policy is welfare improving. He mentions that when there is financial tightening on a country's foreign borrowing, the country is required to run a current account surplus. In his model there are declines in the production of final goods, consumption and investment, and a reallocation of inputs to the tradable sector. The optimal drop in consumption and the rigidity of prices imply that money supply should be tightened. Cúrdia (2007) also shows that optimal monetary policy induces an interest rate hike and an exchange rate depreciation. The interest rate hike discourages borrowing and consumption, mitigating the impact of the increased cost of borrowing. The exchange rate depreciation provides a boost to export revenues, reducing the need for a domestic recession. Some authors examine empirically the effectiveness of monetary policy during periods of sudden reversal in capital flows. Hutchison et al. (2007) investigate 83 sudden stop crises in 77 countries over 1982~2003 and find that monetary and fiscal tightening at the time of a sudden stop crisis significantly worsens output losses. Ortiz et. al. (2007) also analyze the fiscal and monetary policy responses and their effects on output in a set of 22 external financial crisis episodes occurring since 1990. They find similar evidence that countries which tightened monetary and fiscal policy during these crises experienced larger output contractions than countries that followed looser policy stances.

In this paper, we argue that in exploring the desirable monetary policy stance in response to an external shock with substantial deterioration in the cost of foreign borrowing, it might be important to distinguish two possible situations; an *external drain case,* in which the cost of borrowing from abroad surges, and a *double drain case,* in which an international financial shock is contagious, thus causing an internal drain with a domestic credit crunch. Although there is no ex-ante reason to expect occurrence of such a domestic credit crunch following an global financial shock, domestic market financing conditions tend to tighten under this external shock in many emerging economies. This double drain – a combination of the external drain caused by deteriorated foreign borrowing conditions and the internal drain stemming from domestic credit crunch - is an interesting feature in emerging markets during periods of financial turmoil[2]. In Figure 2, we can observe that Korea experienced this double drain phenomenon recently.

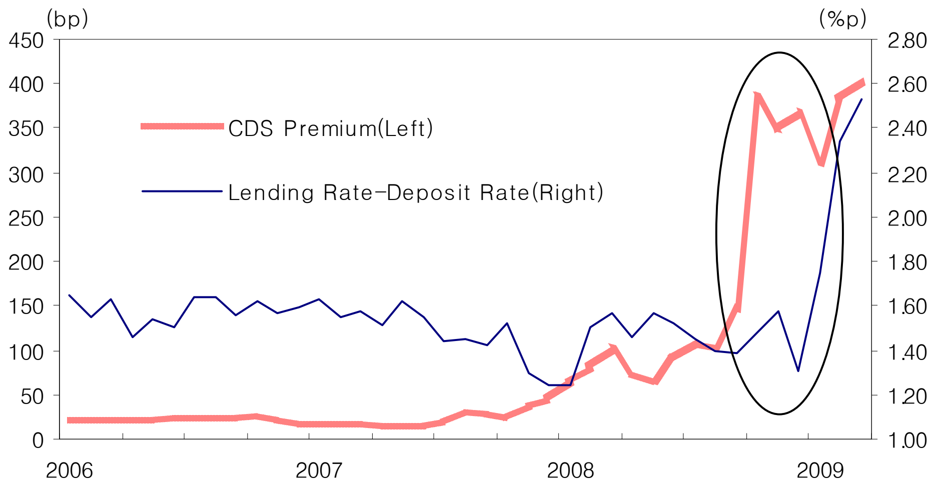

Figure 2: Empirical Evidence of Double Drain in Korea.

We focus on this double drain aspect in the recent financial turmoil and examine its implications for monetary policy. We construct a small open dynamic general equilibrium model which includes a banking sector and the features of emerging economies - original sin, dollar pricing in external trade, and working capital constraints. We then compare two cases: an external drain case without contagion and a double drain case with contagion, focusing on the monetary policy responses in terms of reducing the cost of recession. Under a double drain, the productivity of a bank's intermediation technology is affected by international shocks, so that its interest rate on deposits (borrowing rate) may differ from the interest rate on its loans (lending rate), generating an interest rate spread.

The main findings are as follows: If there is no contagion effect from international financial shock on domestic financial intermediation, the policy interest rate must rise under an external premium shock with a decrease in foreign debts and improvement of net exports, while real output contracts less owing to reallocation of input from the non-traded sector to the traded sector. However, in the case of a

[2] The term 'double drain' was used in Miller (1996, 1998), to refer to a situation in which a currency (banking) crisis can cause a banking (currency) crisis when banking system is weak.

double drain with a domestic credit crunch, it might be desirable for the monetary authority to respond by lowering the policy interest rate, depending upon the size of the contagion effects. In order to mitigate the cost of contraction in output, therefore, a passive (active) stance in monetary policy is desirable for the external drain (double drain) case.

The paper proceeds as follows: Section 2 describes the model, after which the equilibrium conditions are derived in Section 3. In Section 4, the main results of monetary policy implications under the two cases together with robustness analysis and some discussions are presented. Section 5 concludes.

2. THE MODEL

We consider a small open economy model, augmented with financial friction in the form of a debt-elastic risk premium on external funds and productivity in bank financial intermediation. This economy borrows from international capital markets in foreign currency subject to a country risk premium. Unexpected financial shocks originating from the international capital markets may affect the domestic real and financial economies. The economy contains five types of agents: a representative household, a finished goods-producing firm, a continuum of intermediate goods-producing firms indexed by $j \in [0,1]$, a representative bank, and a monetary authority.

2.1. *The Representative Household*

Each household is infinitely lived and has identical preferences defined over consumption of a basket of final goods and leisure at every date. A representative household is assumed to maximize the following intertemporal lifetime utility function:

$$Max\, E_0 \sum_{j=0}^{\infty} \beta^j U(C_{t+j}, N_{t+j})$$

$$U_t(C_t, N_t) = \frac{(C_t - N_t^{\varphi})^{1-\sigma} - 1}{1-\sigma} \tag{1}$$

where E_0 is the expectation operator at time 0, $\beta \in (0,1)$ is the subjective discount factor, C_t denotes a composite consumption index, N_t denotes labor effort, $\frac{1}{\sigma}$ is the intertemporal elasticity of substitution in consumption, and $\varphi > 0$ is the elasticity of substitution between consumption and leisure.

The household is assumed to consume traded and non-traded final goods. The composite consumption index is defined as

$$C_t \equiv [(1-\alpha)^{\frac{1}{\eta}}(C_{N,t})^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}}(C_{T,t})^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \tag{2}$$

where $\eta > 0$ measures the elasticity of substitution between traded and non-traded goods, and $\alpha \in [0,1]$ measures the share of traded goods in the composite consumption index.

The two consumption sub-indexes of traded and non-traded goods, $C_{T,t}$ and $C_{N,t}$, are symmetric, and they are given by the CES function:

$$C_{T,t} \equiv \{\int_0^1 C_{T,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\}^{\frac{\varepsilon}{\varepsilon-1}}$$

$$C_{N,t} \equiv \{\int_0^1 C_{N,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\}^{\frac{\varepsilon}{\varepsilon-1}}$$

where $\varepsilon > 1$ is the price elasticity of demand, $j \in [0,1]$ denotes the variety of goods, and $C_{T,t}(j)$ and $C_{N,t}(j)$ are the quantities purchased by home agents of traded goods and non-traded goods, respectively.

The overall price index (CPI) is defined as

$$P_t \equiv [(1-\alpha)(P_{N,t})^{1-\eta} + \alpha(P_{T,t})^{1-\eta}]^{\frac{1}{1-\eta}} \tag{3}$$

where $P_{T,t} \equiv (\int_0^1 P_{T,t}(j)^{1-\varepsilon} dj)^{\frac{1}{1-\varepsilon}}$, and $P_{N,t} \equiv (\int_0^1 P_{N,t}(j)^{1-\varepsilon} dj)^{\frac{1}{1-\varepsilon}}$ are the traded goods and the non-traded goods price indexes in the domestic currency, respectively. Households' optimal allocation within each category of goods is given by the following demand functions:

$$C_{T,t}(j) = \left(\frac{P_{T,t}(j)}{P_{T,t}}\right)^{-\varepsilon} C_{T,t}$$

$$C_{N,t}(j) = \left(\frac{P_{N,t}(j)}{P_{N,t}}\right)^{-\varepsilon} C_{N,t}$$

Using the definition of total consumption in (2), we can derive the optimal allocation of expenditures between traded and non-traded goods:

$$C_{T,t} = \alpha\left(\frac{P_{T,t}}{P_t}\right)^{-\eta} C_t \quad , \qquad C_{N,t} = (1-\alpha)\left(\frac{P_{N,t}}{P_t}\right)^{-\eta} C_t \tag{4}$$

Total consumption is then reduced as follows:

$$P_{T,t}C_{T,t} + P_{N,t}C_{N,t} = P_t C_t \tag{5}$$

The household owns the domestic final goods producers and accumulates physical capital. The laws of motion of the capital stock in the two sectors are given by:

$$K_{T,t+1} = K_{T,t}(1-\delta) + I_{T,t}\,, \quad K_{N,t+1} = K_{N,t}(1-\delta) + I_{N,t} \tag{6}$$

where I_t is the gross investment and $\delta \in (0,1)$ is the rate of capital depreciation.

The household begins the period t with M_{t-1} unit of money and must decide how to divide its funds into an amount D_t to be deposited in the representative bank and an amount M_{t-1} - D_t to be used to facilitate goods purchases. Representative agent faces the following budget and cash in advance (CIA) constraints:

$$\begin{aligned} &P_t(C_t + I_{T,t} + I_{N,t}) + M_t + D_t + F_{t-1}S_t(1+i^*_{t-1} + \Psi_{t-1}) \\ &\leq S_t F_t + M_{t-1} + (1+i^d_t)D_t + W_t N_t + Q_{T,t}K_{T,t} + Q_{N,t}K_{N,t} + \Pi^F_t + \Pi^B_t \end{aligned} \tag{7}$$

$$P_t C_t \leq M_{t-1} - D_t + W_t N_t \tag{8}$$

The right hand side of equation (7) represents the resources the consumer has at his disposal at the beginning of period t. These consist of wage earnings $W_t N_t$, obtained by supplying his labor services to the firm, rental earnings $Q_t K_t$ on capital in both sectors, the shares of profits Π_t from firms and banks and the amount of foreign currency-denominated debt F_t. $\mathbf{S_t}$ is the nominal exchange rate defined as units of the home currency per unit of foreign currency and i^d_t denotes the nominal interest rate earned on deposits. We assume the deposits are paid back in the same period in order to avoid real balance frictions related to consumption in the money market. The left hand side corresponds to the uses of these resources. The household can use these to consume goods, accumulate capital, pay back the external debt(F_t) borrowed, and deposit D_t with the financial intermediary. Ψ_t is the country risk premium on external borrowings, and $\mathbf{i^*_t}$ is the foreign interest rate. The CIA constraint (8) imposes the condition that the household need to allocate money balances and labor earnings for consumption net of deposits it has decided to allocate to the financial intermediary.

Consumption and investment are defined as a nested CES combination of domestically produced non-traded goods $\mathbf{A_{N,t}}$ and domestically produced traded goods $\mathbf{A_{T,t}}$. Traded and non-traded goods are combined into a quantity of goods absorbed, $\mathbf{A_t}$:

$$C_t + I_{T,t} + I_{N,t} = A_t = [(1-\alpha)^{\frac{1}{\eta}}(A_{N,t})^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}}(A_{T,t})^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \tag{9}$$

$$A_{T,t} = \alpha\left(\frac{P_{T,t}}{P_t}\right)^{-\eta} A_t \quad , \qquad A_{N,t} = (1-\alpha)\left(\frac{P_{N,t}}{P_t}\right)^{-\eta} A_t \tag{10}$$

The household chooses the paths of $\{C_t, N_t, K_{T,t+1}, K_{N,t+1}, M_t, D_t, F_t\}$ to maximize its expected lifetime utility. The first-order conditions can be summarized by :

$$1 = \frac{W_t}{P_t}\varphi N_t^{1-\varphi} \tag{11}$$

$$1 = \beta E_t[(\frac{P_t(1+i_t^d)}{P_{t+1}})\left(\frac{(C_{t+1} - N_{t+1}^{\varphi})}{(C_t - N_t^{\varphi})}\right)^{-\sigma}] \tag{12}$$

$$1 = E_t \frac{S_{t+1}}{S_t}\frac{(1+i_t^* + \Psi_t)}{(1+i_t^d)} \tag{13}$$

$$1 = E_t \frac{1}{P_t(1+i_t^d)}[Q_{T,t+1} + P_{t+1}(1-\delta)] \tag{14}$$

$$1 = E_t \frac{1}{P_t(1+i_t^d)}[Q_{N,t+1} + P_{t+1}(1-\delta)] \tag{15}$$

2.2. *The Representative Bank*

The role of the bank is to take deposits from households and lend to firms. The banking industry is assumed to be perfectly competitive. At the beginning of period t, the representative bank accepts deposits D_t from the representative household and provides lending service L_t to each domestic intermediate goods and non-trade goods producing firm, subject to the linear production function:

$$L_t \le \phi_t(D_t) \tag{16}$$

where ϕ_t represents efficiency in banking technology.

The bank collects $(1+i_t^l)L_t^s$ of principal and interest from each intermediate goods-producing firm and repays the interest for the money deposits by the household at the end of period t. The bank's problem is:

$$\underset{D_t,\ L_t}{Max}\, E_t \sum_{j=0}^{\infty} \Lambda_{t,t+j}\Pi_{t+j}^B$$

$$s.t.\, L_t \le \phi_t(D_t)$$

where

$$\Pi_t^B = D_t - (1+i_t^d)D_t - L_t + (1+i_t)L_t \tag{17}$$

The optimality conditions for the bank's deposits and loans are as follow:

$$i_t^d = \phi_t i_t^l \tag{18}$$

$$L_t = \phi_t (D_t) \tag{19}$$

for all $t = 0,1,2,...$

As long as the net nominal interest rate i_t^l is positive, the bank will lend all of its funds and eq.(16) will hold with equality, but it faces uncertainty in the productivity of financial intermediation. Therefore, if there is a negative shock to productivity of credit services, the total amount of liquidity supplied by banks will decrease and the lending rate will exceed the deposit rate.

2.3. *Firms*

2.3.1. Traded goods sector

Focusing on a small open economy which depends on both its exports of final goods and imports of intermediate goods[3], it is assumed that firm j transforms domestic and imported intermediate goods bundles into a differentiated traded good j using a CES technology:

$$Y_{T,t}(j) = [(1-\gamma)^{\frac{1}{\tau}} IMD_t(j)^{\frac{\tau-1}{\tau}} + \gamma^{\frac{1}{\tau}} IMR_t(j)^{\frac{\tau-1}{\tau}}]^{\frac{\tau}{\tau-1}}, \quad 0 < \tau, \quad 0 < \gamma < 1 \tag{20}$$

Where $IMD_t(j)$ and $IMR_t(j)$ represent the domestic and imported intermediate goods, respectively.

Domestic intermediate goods are produced using capital and labor inputs with a Cobb-Douglas production function:

$$IMD_t(j) = K_{T,t}(j)^{\alpha_T} N_{T,t}(j)^{1-\alpha_T}, \quad 0 < \alpha_T < 1 \tag{21}$$

where $K_{T,t}(j)$ and $N_{T,t}(j)$ denote the amounts of capital and labor used by the firm in the traded sector.

We have two assumptions as to the firm's production: the working capital constraint and original sin, expressed as follows:

[3] In many previous works, it is assumed that a small open economy imports and also exports intermediate goods, but our structure is more realistic for the analysis of many export-led developing countries. McCallum and Nelson (2000) also pointed out that treating imports as intermediate inputs rather than final consumption goods improves the empirical fit of open-economy models.

$$W_t N_{T,t}(j) + Q_{T,t} K_{T,t}(j) \le L_{T,t}(j) \tag{22}$$

$$P^*_{F,t} IMR_t(j) \le F_t(j) \tag{23}$$

It is assumed that the firm must borrow funds $L_t(j)$ from banks to pay its wages and rental on capital. The marginal costs of employing additional units of labor and capital are then $(1+i^l_t)W_t$ and $(1+i^l_t)Q_t$. When the net nominal interest rate i^l_t is positive, this financial constraint holds with equality. In this case, if the firm chooses the optimal amounts of labor and capital inputs, the amount of borrowing demand from the bank L_t is determined, given the wage and the rental rate.
Furthermore, this economy cannot borrow in its own currency and so must borrow foreign currency debt to purchase the imported intermediate goods, a constraint commonly known as 'original sin' of emerging economies[4]. The manufacturer purchase the imported materials with foreign currency borrowed at the rate of $(1+i^*_t+\Psi_t)$; hence, the marginal cost of employing an additional unit of the imported intermediate goods is $(1+i^*_t+\Psi_t)S_t P^*_{F,t}$, in which a higher external risk premium will adversely affect the purchases of imported materials.
The first-order conditions of the firm's problem are:

$$\frac{(1-\alpha_T)K_{T,t}(j)}{\alpha_T N_{T,t}(j)} = \frac{W_t}{Q_{T,t}} \tag{24}$$

$$\gamma^{\frac{1}{\tau}}[PPI_{T,t}\left(\frac{IMD_t(j)}{Y_{T,t}(j)}\right)^{\frac{1}{\tau}}] = (1+i^*_t+\Psi_t)P^*_t S_t \tag{25}$$

$$PPI_{D,t} = (1+i^l_t)Q_{T,t}[W_t(1+i^l_t)]^{1-\alpha_T}\alpha_T^{-\alpha_T}(1-\alpha_T)^{\alpha_{T-1}} \tag{26}$$

$$PPI_{T,t} = \{(1-\gamma)PPI^{1-\tau}_{D,t} + \gamma[(1+i^*_t+\Psi_t)P^*_t S_t]^{1-\tau}\}^{\frac{1}{1-\tau}} \tag{27}$$

where $PPI_{T,t}$ *and* $PPI_{D,t}$ are the producer prices of traded goods and of domestic intermediate goods, respectively and $P^*_{F,t}$ is the foreign currency price of imported materials.

2.3.2. Non-traded goods sector

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[4] The term 'original sin' was used firstly in Eichengreen and Hausmann(1999), who refer to two types of original sin: International original sin - the inability to borrow in terms of the domestic currency - and domestic original sin - inability to borrow long term domestically. Reference to original sin in most of the recent literature usually implies the first meaning.

Price-taking non-traded goods producers use labor and capital to produce goods $Y_{N,t}$ sold at price $PPI_{N,t}$:

$$Y_{N,t}(j) = K_{N,t}(j)^{\alpha_N} N_{N,t}(j)^{1-\alpha_N} \tag{28}$$

with the same working capital constraint:

$$W_t N_{N,t}(j) + Q_{N,t} K_{N,t}(j) \leq L_{N,t}(j) \tag{29}$$

The first-order conditions of the firms' profit-maximization problem, for the choices of labor and capital, are:

$$\frac{(1-\alpha_N)K_{N,t}(j)}{\alpha_N N_{N,t}(j)} = \frac{W_t}{Q_{T,t}}$$

$$(30)\ PPI_{N,t} = (1+i_t^l)Q_{T,t}[W_t(1+i_t^l)]^{1-\alpha N} \alpha_T^{-\alpha_N} (1-\alpha_n)^{\alpha_{N-1}} \tag{31}$$

2.3.3. Nominal Rigidity

Regarding the firm's pricing behavior, empirical research on many small open economies shows that most firms set their prices in terms of a major currency (e.g., the U.S. dollar, euro or yen) in both imports and exports. In order to incorporate this real feature, in our model we consider asymmetric pricing behavior, i.e., local currency pricing (LCP) in the export sector and producer currency pricing (PCP) in the import sector.

There are three types of sticky prices: the retail prices of non-traded goods, the domestic retail prices of traded goods, and the foreign currency prices of exported goods. The dynamics of each of these prices follow a similar framework. For each, there is a range of monopolistically competitive retailers who purchase an undifferentiated input good item (i.e. traded or non-traded) from manufacturers, and face a constant elasticity demand curve. Following Calvo (1983), each retailer is assumed to face a constant probability $(1-\theta_i), i = T, N, X$ in every period of resetting its prices $\overline{P}_{T,t}(j), \overline{P}_{N,t}(j), \overline{P}_{X,t}(j)$ in the domestic and foreign markets. Under this price setting structure, $P_{i,t+k}(j)$ equals $\overline{P}_{i,t}(j)$ with probability θ_i^k, $i = T, N, X$, $k = 0, 1, 2, ..$. When setting a new price in period t, retailer j seeks to maximize the expected discounted value of profits. The expected profit of domestic traded goods retailers is:

$$\underset{\overline{P}_{T,t}}{Max} E_t \sum_{k=0}^{\infty} \theta_H^k \Lambda_{t,t+k} \{(\overline{P}_{T,t}(j) - MC_{T,t+k})Y_{T,t+k}(j)\}$$

$$s.t. Y_{T,t+k}(j) = \left(\frac{\overline{P}_{T,t}(j)}{P_{T,t+k}} \right)^{-\varepsilon} (A_{T,t+k})$$

where $\Lambda_{t,t+k}$ is the ratio of marginal utility between periods t and $t+k$.
By the first order condition and imposition of symmetry, the optimal price for domestic markets $\overline{P}_{T,t}$ must satisfy the following condition:

$$\sum \theta_T^k E_t \{\Lambda_{t,t+k} Y_{T,t+k} (\overline{P}_{T,t} - \frac{\varepsilon}{\varepsilon - 1} MC_{T,t+k})\} = 0$$

Rewriting this in terms of optimal price, we obtain

$$\overline{P}_{T,t} = (\frac{\varepsilon}{\varepsilon - 1}) \frac{E_t \sum_{k=0}^{\infty} \theta_T^k \Lambda_{t,t+k} Y_{T,t+k} MC_{T,t+k}}{E_t \sum_{k=0}^{\infty} \theta_T^k \Lambda_{t,t+k} Y_{T,t+k}}$$

$$where\, Y_{T,t+k} = (\frac{\overline{P}_{T,t}}{P_{T,t+k}})^{-\varepsilon} (A_{T,t+k})$$

Substituting the discount factor $\Lambda_{t,t+k} = \beta^k (U_{C,t+1} / U_{C,t})(P_t / P_{t+k})$, the optimal price for domestic markets is as follows:

$$\overline{P}_{T,t} = \frac{\varepsilon}{(\varepsilon - 1)} \frac{E_t \sum_{k=0}^{\infty} (\theta_T \beta)^k Y_{T,t+k} MC_{T,t+k}}{E_t \sum_{k=0}^{\infty} (\theta_T \beta)^k Y_{T,t+k}} \tag{32}$$

which implies that the new price set by firm j, at period t, is a markup over the expected future marginal costs. If prices are perfectly flexible $(\theta_T = 0)$, the markup is a constant and equal to $\dfrac{\varepsilon}{\varepsilon - 1}$. With sticky prices, the markup becomes variable over time when the economy is hit by exogenous shocks. The definition of the price index $P_{T,t} \equiv (\int_0^1 P_{T,t}(j)^{1-\varepsilon} dj)^{\frac{1}{1-\varepsilon}}$ implies that its law of motion is given by

$$P_{T,t} = [(1 - \theta_T)(\overline{P}_{T,t})^{1-\varepsilon} + \theta_T (P_{T,t-1})^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{33}$$

Analogously, we can obtain a similar optimal price equation for the non-traded goods:

$$\overline{P}_{N,t} = \frac{\varepsilon}{(\varepsilon-1)} \frac{E_t \sum_{k=0}^{\infty} (\theta_N \beta)^k Y_{N,t+k} MC_{N,t+k}}{E_t \sum_{k=0}^{\infty} (\theta_N \beta)^k Y_{N,t+k}} \tag{34}$$

$$where\, Y_{N,t+k} = (\frac{\overline{P}_{N,t}}{P_{N,t+k}})^{-\varepsilon} (A_{N,t+k})$$

$$P_{N,t} = [(1-\theta_N)(\overline{P}_{N,t})^{1-\varepsilon} + \theta_N (P_{N,t-1})^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{35}$$

In the export markets, exporting retailers purchase domestically produced goods and sell them as differentiated export goods in foreign markets by setting their prices in foreign currency. The optimization problem of the exporting retailers is

$$\underset{\overline{P}_{X,t}}{Max} E_t \sum_{k=0}^{\infty} \theta_i^k \Lambda_{t,t+k} (S_t \overline{P}_{X,t}(j) - MC_{T,t+k}) Y^*_{T,t+k}(j)\}$$

$$subject\ to\ \ Y^*_{T,t+k}(j) = \left(\frac{\overline{P}_{X,t}(j)}{P^*_{X,t+k}} \right)^{-\varepsilon} (X_{t+k})$$

The new optimal export price at period t charged in the foreign market is:

$$\overline{P}_{X,t} = \frac{\varepsilon}{(\varepsilon-1)} \frac{E_t \sum_{k=0}^{\infty} (\theta_x \beta)^k Y^*_{T,t+k} MC_{T,t+k}}{E_t \sum_{k=0}^{\infty} (\theta_x \beta)^k Y^*_{T,t+k} S_{t+k}} \tag{36}$$

$$where\, Y^*_{H,t+k} = (\frac{\overline{P}_{X,t}}{P^*_{X,t+k}})^{-\varepsilon} (X_{t+k})$$

The price index of export goods is:

$$P_{X,t} = [(1-\theta_x)(\overline{P}_{X,t})^{1-\varepsilon} + \theta_x (P_{X,t-1})^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{37}$$

If some firms cannot change their price $(\theta_x > 0)$, which means exchange rate pass-through is imperfect, the export price will adjust only gradually to deviation from the law of one price. We assume in the import sector that the domestic price of imported intermediate goods is the foreign currency price, which is determined exogenously to this economy, times the nominal exchange rate.

2.4. The Central Bank's Monetary Policy

Monetary policy formulation by the domestic central bank follows a generalized rule, in which deviations of inflation and gross domestic product $(GDP = P_T A_T + S_t P_{X,t} X_t + P_{N,t} A_N - S_t P^*_{F,t} IMR_t)$ from their long-run targets have

a feed-back on short-run movements of the nominal interest rate[5].
The following equation describes the target for the nominal deposit interest rate:

$$\log\frac{(1+i_t^d)}{(1+\bar{\imath})} = \mu\log\frac{(1+i_{t-1}^d)}{(1+\bar{\imath})} + (1-\mu)[\Phi_{\pi}\log(\frac{\pi_t}{\bar{\pi}}) + \Phi_{y}\log(\frac{GDP}{\overline{GDP}})] \qquad (38)$$

where $\mu, \bar{\pi}$, and $\overline{GDP}$ are the interest rate smoothing parameter, the target level of the inflation rate $(\pi_t = \frac{P_t}{P_{t-1}})$ and GDP, respectively.

3. AGGREGATION AND EQUILIBRIUM CONDITIONS

3.1. *Goods Markets*

Aggregating over all firms yields:

$$K_t = \int_0^1 K_t(j)dj\,,\quad N_t = \int_0^1 N_t(j)dj\,,$$

$$IMD_t = \int_0^1 IMD_t(j)dj\,,\quad IMR_t = \int_0^1 IMR_t(j)dj$$

and the production technology in each sector is:

$$Y_{T,t} = [(1-\gamma)^{\frac{1}{\tau}} IMD_t^{\frac{\tau-1}{\tau}} + \gamma^{\frac{1}{\tau}} IMR_t^{\frac{\tau-1}{\tau}}]^{\frac{\tau}{\tau-1}},\ \ 0<\tau,\ \ 0<\gamma<1 \qquad (39)$$

$$IMD_t = K_{T,t}^{\alpha_T} N_{T,t}^{1-\alpha_T},\quad 0<\alpha_T<1 \qquad (40)$$

$$Y_{N,t} = K_{N,t}^{\alpha_N} N_{N,t}^{1-\alpha_N},\quad 0<\alpha_N<1 \qquad (41)$$

In a symmetric equilibrium, we have

$$\frac{(1-\alpha_T)K_{T,t}}{\alpha_T N_{T,t}} = \frac{W_t}{Q_{T,t}} \qquad (42)$$

$$\frac{(1-\alpha_N)K_{N,t}}{\alpha_N N_{N,t}} = \frac{W_t}{Q_{N,t}} \qquad (43)$$

$$\gamma^{\frac{1}{\tau}}[PPI_{T,t}\left(\frac{IMD_t}{Y_{T,t}}\right)^{\frac{1}{\tau}}] = (1+i_t^* + \Psi_t)P_t^* S_t \qquad (44)$$

$$PPI_{D,t} = (1+i_t^l)Q_{T,t}[W_t(1+i_t^l)]^{1-\alpha_T}\,\alpha_T^{-\alpha_T}\,(1-\alpha_T)^{\alpha_{T-1}} \qquad (45)$$

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[5] Instead of this Taylor type policy rule, we may consider alternative monetary targeting rule in which central bank decides the growth rate of money supply. Here we consider deposit interest rate as a monetary policy instrument, and money supply just meets money demand given the level of the interest rate.

$$PPI_{T,t} = \{(1-\gamma)PPI_{D,t}^{1-\tau} + \gamma[(1+i_t^* + \Psi_t)P_t^* S_t]^{1-\tau}\}^{\frac{1}{1-\tau}} \quad (46)$$

$$PPI_{N,t} = (1+i_t^l)Q_{T,t}[W_t(1+i_t^l)]^{1-\alpha N}\alpha_T^{-\alpha_N}(1-\alpha_n)^{\alpha_{N-1}} \quad (47)$$

The demand for good j is the sum of the demand from domestic and foreign consumers:

$$Y_{T,t}(j) = C_{T,t}(j) + I_{T,t}(j) + X_t(j) = \left(\frac{P_{T,t}(j)}{P_{T,t}}\right)^{-\varepsilon}[A_{T,t}] + \left(\frac{P_{X,t}(j)}{P_{X,t}}\right)^{-\varepsilon} X_t$$

Aggregating over monopolistic domestic goods retailers yields the overall domestic final goods market equilibrium equation:

$$Y_{T,t} = \Delta_{T,t}(A_{T,t}) + \Delta_{X,t} X_t \quad (48)$$

$$Y_{N,t} = \Delta_{N,t}(A_{N,t}) \quad (49)$$

$$Y_t = Y_{T,t} + Y_{N,t} \quad (50)$$

where $\Delta_{i,t} = \int_0^1 (\frac{P_{i,t}(j)}{P_{i,t}})^{-\varepsilon} dj, i = T, N, X$ is a measure of relative price dispersion in the domestic and export goods sectors, indicating that purchases of good j must depend only upon the price $P_{i,t}(j)$ charged on those goods and the overall distribution of prices charged. We can rewrite the price dispersion indexes[6] in terms of Calvo relative prices as the following law of motion:

$$\Delta_{i,t} = (1-\theta_i)\frac{\overline{P}_{i,t}}{P_{i,t}} + \theta_i(\frac{P_{i,t}}{P_{i,t-1}})^{\varepsilon}\Delta_{i,t-1},\ i = T, N, X \quad (51)$$

Recalling that $P_{i,t}^{1-\varepsilon} = [(1-\theta_i)(\overline{P}_{i,t})^{1-\varepsilon} + \theta_i(P_{i,t-1})^{1-\varepsilon}]$ and dividing both sides by $P_{i,t}^{1-\varepsilon}$, we have

$$1 = (1-\theta_i)(\frac{\overline{P}_{i,t}}{P_{i,t}})^{1-\varepsilon} + \theta_i(\frac{P_{i,t-1}}{P_{i,t}})^{1-\varepsilon} \quad (52)$$

which implies

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[6] Woodford defined a measure of price dispersion in the Calvo model as a cross-section variance of logarithms of individual prices, i.e, $\Delta_t \equiv \mathrm{var}_i \log p_t(i)$. For a detailed discussion, see Woodford (2003), ch.6, p.399.

$$(\frac{\overline{P}_{i,t}}{P_{i,t}}) = \left(\frac{1-\theta_i (\frac{P_{i,t-1}}{P_{i,t}})^{1-\varepsilon}}{(1-\theta_i)} \right)^{\frac{1}{1-\varepsilon}} \tag{53}$$

By plugging eq. (53) into eq. (51), we obtain

$$\Delta_{i,t} = (1-\theta_i)\left(\frac{1-\theta_i (\pi_{i,t})^{\varepsilon-1}}{(1-\theta_i)} \right)^{\frac{1}{1-\varepsilon}} + \theta_i (\pi_{i,t})^{\varepsilon} \Delta_{i,t-1}, \tag{54}$$

$$where\ \pi_{i,t} = \frac{P_{i,t}}{P_{i,t-1}}$$

which implies that the current level of the measure of relative price distortion depends upon the current rate of inflation and the previous level of the measure of relative price distortion.
By substituting profits from the bank and firms into household budget constraint eq. (7) and rearranging it, we obtain the country's resources constraint as follows:

$$\begin{aligned} &P_t(C_t + I_{T,t} + I_{N,t}) + F_{t-1}S_t(1+i_{t-1}^* + \Psi_{t-1}) \\ &\leq S_t F_t + P_{T,t}A_{T,t} + S_t P_{X,t} X_t + P_{N,t}A_{N,t} - S_t P_{F,t}^*(1+i_t^*)IMR_t \end{aligned} \tag{55}$$

3.2. *External Sector*

It is assumed that exports are linked to relative prices and the rest of the world's income by the following law of motion.

$$X_t = \overline{X}(\frac{P_{X,t}}{P_{X,t}^*})^{\vartheta_1}(Y_t^*)^{\vartheta_2} \tag{56}$$

where $\overline{\mathbf{X}}$ is the steady-state value of exports, $P_{X,t}$ is the export price of domestic goods, and $P_{X,t}^*$ is the export price set by foreign competitors.

Net exports in real terms NX_t can be expressed as:

$$\begin{aligned} NX_t \equiv \{&P_{T,t}A_{T,t} + P_{N,t}A_{N,t} + S_t P_{X,t} X_t - P_t(C_t + I_t) \\ &- S_t P_t^*(1+i_t^* + \Psi_t)IMR_t\} / P_{T,t} \end{aligned} \tag{57}$$

Substituting eq. (57) into the country's resources constraint, we get the following balance of payments equation which states that the net foreign assets (F_t) position changes with accruing interest and the net exports :

$$-F_t = -F_{t-1}(1 + i^*_{t-1} + \Psi_{t-1}) + \frac{P_{T,t} NX_t}{S_t} \tag{58}$$

3.3. *Credit Markets*

In the credit market, demand for loans and supply of loans should be equal in equilibrium:

$$L_t = L_{T,t} + L_{N,t} = W_t N_{T,t} + W_t N_{N,t} + Q_{T,t} K_{T,t} + Q_{N,t} K_{N,t} \tag{59}$$

$$L_{T,t} = \int_0^1 L_{T,t}(j)dj\,, \quad L_{N,t} = \int_0^1 L_{N,t}(j)dj$$

3.4. *Exogenous Shocks*

We assume that a risk premium Ψ_t is composed of a variable component and an exogenous shock to the risk premium ν_t following an AR(1) process:

$$\Psi_t = k \exp(S_t F_t - \overline{SF}) + \nu_t \tag{60}$$

Data on bond yields show that the premiums on bonds issued by emerging market countries rise dramatically during the period associated with reversals in capital inflows to these economies. Following Cook and Devereux (2006), we model sudden financial turmoil originating from global financial markets as unexpected exogenous shocks to the country risk premium on borrowing from abroad ν_t, following an AR(1) process:

$$\nu_t = (1-\rho_\nu)\nu + \rho_\nu \nu_{t-1} + \varepsilon^\nu_t\,, \quad \varepsilon^\nu_t \sim iid(0, \sigma^2_\nu) \tag{61}$$

We assume that external disturbances caused by risk premium shocks can affect the efficiency of financial intermediation. In practice, banks must carry out a variety of costly activities (evaluating creditors, managing deposits, renting buildings, maintaining ATMs, etc.) to maintain a given level of loans and deposits, and the costs of these activities tend to be higher (efficiency tends to be lower) in a period of financial turmoil[7] which can be expressed as:

$$\phi_t = (1-\rho_\phi)\phi + \rho_\phi \phi_{t-1} - \omega(\varepsilon^\nu_t), \quad \omega'(\cdot) \geq 0 \tag{62}$$

It is assumed that the share of the small economy's goods consumed in the rest of the world is negligible, which implies that a small open economy cannot affect the

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[7] Refer to Edwards and Vizgh (1997): *"During financial crisis, banks are required to spend more efforts to monitor their customer firms, so productivity tends to be lower than in normal economic conditions"*.

world price $(P^*_{F,t} = P^*_t)$ and demand. Hence, the two foreign aggregates Y^*_t and P^*_t are assumed to be exogenously given:

$$\log Y^*_t = (1-\rho_{Y^*})\log Y^* + \rho_{Y^*}\log Y^*_{t-1} + \varepsilon^{Y^*}_t$$
$$\log P^*_t = (1-\rho_{p^*})\log P^* + \rho_{p^*}\log P^*_{t-1} + \varepsilon^{p^*}_t$$

where $\varepsilon^{Y^*}_t$ and $\varepsilon^{p^*}_t$ are independent white noises with finite standard deviations.

3.5. *Equilibrium for the Model*

Given the above equilibrium conditions, we transform all nominal variables into real terms by dividing by $P_{T,t}$. An equilibrium for this model is a sequence of prices and allocations $\{P_t, \overline{P}_{T,t}, \overline{P}_{N,t}, P_{N,t}, \overline{P}_{X,t}, \pi_t, \pi_{T,t}, \pi_{N,t}, \Psi_t, W_t, i^d_t, i^l_t, PPI_{T,t}, PPI_{N,t}, PPI_{D,t}, \Delta_{i,t}, S_t, Q_{T,t}, Q_{N,t}, C_t, C_{T,t}, C_{N,t}, N_{T,t}, N_{N,t}, F_t, L_t, L_{T,t}, L_{N,t}, X_t, K_{T,t}, K_{N,t}, I_{T,t}, I_{N,t}, IMR_t, IMD_t, NX_t\}^{\infty}_{t=0}$ such that, for each time period, the optimality conditions of the representative household, bank and firm hold and all markets clear.

4. RESULTS: IMPLICATIONS FOR MONETARY POLICY

4.1. *Transmission channel*

When a shock to the risk premium on external borrowing hits the economy, domestic financial markets may or may not face credit crunches, in accordance with the overall soundness of the banking industry, macroeconomic conditions, expectation of the severity of the shock, etc. We distinguish a double drain case with a domestic credit crunch from the external drain case without contagion (sudden stop shock only); that is, productivity in the bank's financial intermediation technology is assumed to be affected by the shock from international capital markets under a double drain as follows[8]:

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8 As well summarized in Adrian and Shin (2008), the literature has identified two distinct channels associated with the shock transmission. The first is the increased credit that operates through the borrower's balance sheet, where increased lending comes from the greater creditworthiness of the borrower (Bernanke and Gertler (1989)). The second is the channel that operates through the banks' balance sheets, either through the liquidity structure of their balance sheets (Bernanke and Blinder (1988), Kashyap and Stein (2000)), or through the cushioning effect of their capital (Van den Heuvel (2002)). During the recent global financial crisis, Korean domestic banks suffered from foreign currency funding liquidity shortage due

$$\omega(\varepsilon_t^v) = z \cdot (\varepsilon_{t-i}^v),\ i \geq 0 \tag{63}$$

if $z > 1$*: double drain case*
$z = 0$*: external drain case*

where z is the degree of contagion parameter and *i* is the time lag.[9]

4.1.1. External Drain Case without Contagion

Under the case of no contagion, there are two effects of the risk premium shock on this small open economy. Under a shock to the risk premium, domestic interest rates may rise or drop depending upon the effects of the shock on inflation and output gap. The exchange rate can also either appreciate or depreciate in line with the relative adjustment in the domestic interest rate. If the domestic interest rate increases less (more) than the external funding cost, the exchange rate should depreciate (appreciate), which can be seen from the risk premium augmented uncovered interest parity (UIP) condition. This economy must import intermediate goods from abroad with foreign currency (original sin), so an increase in the cost of foreign borrowing and exchange rate depreciation can reduce the amount of imported intermediate goods through increasing in the unit cost for the additional foreign input. In the traded goods sector, a decrease in imported intermediate input causes a decline in production of traded goods, even though there might be some substitution effects of reallocating capital and labor inputs into the traded sector from the non-traded sector. This case of no contagion is similar to the situations described in Elekdag and Tchakrov (2007) and Gertler, Gilchrist and Natalucci (2007).

4.1.2. Double Drain Case with Contagion

What if the domestic financial conditions are tightened due to a sudden capital reversal shock? When productivity in the financial intermediation function

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to maturity and currency mismatches and tightened their domestic lending stances in consideration of the necessity of buffering against these liquidity shortages for repaying foreign currency debt and against the possibility of balance sheet deterioration of firms using foreign borrowings. Hence, the first and second channels might both be relevant together.

[9] We set the size of the domestic credit crunch shock when we examine the baseline double drain case (i.e., z = 1), so that the depth in the response of output at the trough to a one standard deviation credit crunch shock is equal to that under the external drain case. The time lag parameter *i* is set to zero in our quarterly model, because the contagion actually tends to occur in a short period.

deteriorates, the loan interest rate is higher than the deposit rate; i.e., there are additional effects caused by the spread between loan and deposit interest rates as well as the effects in the external drain case alone. Hence, the cost of hiring labor and capital input in both the traded and the non-traded sectors increase, and outputs in both sectors then decrease. This credit crunch shock under a double drain is common to both the traded and the non-traded sectors.

■ External Drain Case (ED) :

$$\varepsilon_t^{\Psi} \uparrow \Rightarrow \begin{cases} \nearrow \Delta i_t \lesseqgtr \Delta \Psi_t \uparrow \Rightarrow S_t \uparrow\downarrow \\ \searrow P_t^{*}(1 + i_t^{*} + \Psi_t) S_t \uparrow \Rightarrow IMR \downarrow \Rightarrow L_t \uparrow, L_N \downarrow, Y_T \downarrow, Y_N \downarrow \end{cases}$$

■ Double Drain Case (ED + additional internal drain channel) :

$$\varepsilon_t^{\Psi} \uparrow \Rightarrow \phi_t \downarrow \Rightarrow i_t^L \uparrow \Rightarrow L_T \downarrow, L_N \downarrow \Rightarrow Y_T \Downarrow, Y_N \Downarrow$$

Figure 3. ***Shock Transmission Channel under Two Cases.***

4.2. *Parameterization*

We assign a value of 0.99 to the subjective discount factor β, 2.0 to the intertemporal elasticity of substitution of consumption σ, and 1.5 to the elasticity of labor supply parameter φ. It is assumed that the annual depreciation rate is 10%, which makes $\delta = 0.025$. These values are commonly used in the literature. We calibrate the values of other parameters to match Korean economic data. We have chosen 10 as the price elasticity of demand ε, which implies a price mark-up of 11%. The elasticity of substitution between home and foreign goods η is set to 5, and the coefficient of the risk premium k is set to 0.04. For the parameters ϑ_1 and ϑ_2 in the rest of world demand for domestic goods, the share of imported consumption goods α, the capital shares in the traded and non-traded sectors α_T and α_N, and the degree of interest rate smoothing μ are also set to match the data. We set 0.75 as the degree of price stickiness parameter in the domestic and export markets $\theta_T, \theta_N, \theta_X$. We choose the parameter λ so that a one standard deviation shock to the risk premium and a domestic credit crunch can induce the same depth in response of output at the trough in the baseline stance.

Table 1. Parameters of the Model.

Parameter	Value	Parameter	Value
β	0.99	σ	2
δ	0.025	φ	1.5
$\theta_T, \theta_N, \theta_X$	0.75	ε	10
α	0.3	η	5
ϑ_1	-0.88	ϑ_2	1.5
α_T	0.3	α_N	0.25
κ	0.04	τ	0.5
μ	0.69	ρ_v	0.9
ρ_ϕ	0.9	σ_v	0.002

4.3. *Monetary Policy Stance*

In this section, we compare five cases with different sets of policy parameters being able to represent key monetary policy stances. We consider a baseline stance in which the policy parameters $(\phi_\pi = 1.5, \phi_y = 0.5)$ are taken from the values in the previous literature,[10] as well as four other different policy stances: an anti-inflation stance (1.75, 0.25), an anti-output gap stance (1.25, 0.75), an active response stance (3.0, 1.0), and a passive response stance (1.25, 0.25). By comparing these policy stances, we determine which monetary policy stance is desirable under two different cases - an external drain and a double drain - in terms of minimizing output loss.[11]

Table 2. Representative Monetary Policy Stances.

MP stance	(Base)	(Active)	(Passive)	(Anti-Infla)	(Anti-Ygap)
Φ_π	1.50	3.00	1.25	1.75	1.25

[10] For example, Cook and Devereux (2007) and Elekdag and Tchakarov (2007).

[11] Our approach is different from most of the previous literature on optimal monetary policy, in which the goal of the monetary authority is to search for a welfare maximizing policy rule under uncertainty due to exogenous shocks. We focus on output loss, because the risk of recession tends to be the main concern for policymakers in most countries after global financial turmoil has once erupted.

Φ_y	0.50	1.00	0.25	0.25	0.75

4.4. Output Costs with Various Monetary Policy Stances

External drains in emerging markets appear to have been triggered by substantial deteriorations in external debt premiums and massive capital outflows, and these external drains tend to be followed by contractions in the real sector in many cases. For example, Hutchison and Noy (2006) investigate whether sudden-stop crises are unique phenomena and whether they entail especially large and abrupt patterns of output collapse, using a panel data set over 1975~1997 covering 24 emerging-market economies, and find that sudden-stop crises have a large negative, but short-lived, impact on output growth. If an external drain causes a credit crunch in the domestic credit sector, this may lead to a further contraction in output. Hence, when international capital inflows suddenly stop and the cost of foreign borrowing rises sharply, one of the main concerns of policymakers is how to prevent or mitigate the severity of contraction (or recession) in real economic activities. If the main objective of the monetary authority is to mitigate the negative impacts of an external risk premium shock on output, the more effective policy stance might differ depending upon the possibility of contagion.

4.4.1. External Drain Case

In <Table 3>, we compare the output costs of different monetary policy stances in the case of external drain without contagion. The output cost of a specific case is calculated as the mean level of real output for three years after a one standard deviation external risk premium shock hits the economy.[12] Under the baseline stance, average output cost is -0.08% of the steady state output level. The passive monetary policy stance with weaker policy parameters $(\phi_\pi = 1.25, \phi_y = 0.25)$ is preferable to the active policy stance in terms of output cost (-0.07%). The active policy stance leads to the largest output losses (-0.10%), with big drops in imported intermediate goods and domestic loans. Between the anti-inflation and anti-output stances, the anti-inflation stance produces a little less output cost. In the passive stance, the average level of the policy interest rate is higher and the real exchange rate is slightly lower, implying that the cost of financing imported

[12] We choose three years for calculation of output cost because in most cases, it takes three years for the economy to recover from contractions due to the impact of a shock. We also conducted robustness checks with different time horizons.

intermediate goods increase less. As a result, the average level of domestic loans and imported inputs decrease to lesser extents, and the impact of the external risk premium shock on real output is mitigated.

Table 3. Output Costs under Various Policy Stances: External Drain Case.

	ED (BASE)	ED (ACTIVE)	ED (PASSIVE)	ED (Anti-Infla)	ED (Anti-Ygap)
Φ_π	1.50	3.00	1.25	1.75	1.25
Φ_y	0.50	1.00	0.25	0.25	0.75
Mean (%)					
R	0.0111	0.0138	0.0083	0.0086	0.0125
INF	0.0013	0.0014	0.0013	0.0013	0.0014
Y	-0.0760	-0.0991	-0.0664	-0.0737	-0.0834
C	0.0022	-0.0101	0.0065	0.0016	-0.0003
INV	-0.1231	-0.1255	-0.1073	-0.1010	-0.1311
Loans	-0.0812	-0.1096	-0.0749	-0.0863	-0.0877
N	0.2234	0.0174	0.6394	0.7041	0.0237
NX/Y	0.0418	0.0454	0.0379	0.0378	0.0442
F/Y	-0.8107	-0.8076	-0.8040	-0.7972	-0.8179
RER	-0.0002	-0.0026	-0.0008	-0.0022	-0.0003
S.D. (%)					
R	0.0359	0.0441	0.0246	0.0230	0.0436
INF	0.0219	0.0207	0.0193	0.0181	0.0217
Y	0.1367	0.2335	0.0197	0.0175	0.2214
C	0.1019	0.1759	0.0606	0.0674	0.1627
INV	0.1372	0.1138	0.2284	0.2386	0.1094
Loans	0.1763	0.2952	0.1123	0.1240	0.2747
N	0.8844	0.2986	2.4943	2.7663	0.2840
NX/Y	0.2094	0.1709	0.2812	0.2901	0.1785
F/Y	0.1380	0.1615	0.1546	0.1555	0.1677
RER	0.0135	0.0262	0.0038	0.0050	0.0244

4.4.2. Double Drain Case

If the domestic credit markets are affected directly by an international risk premium shock, the implications of a particular policy stance may differ from those under the external drain case. <Table 4> indicates that an active policy stance, in which the monetary authority responds to inflation and the output gap more aggressively, leads to the best outcome (-0.23% of output loss), although under all policy scenarios the degree of output contraction expands more than under the external drain case. An anti-inflation stance brings about the largest output loss (-0.38%), while an anti-output gap stance has the second best outcome. Under both the active and anti-output gap stances, the average policy interest rate level is lower, and domestic loans and imported intermediate goods decrease less.

Table 4. Output Costs under Various Policy Stances: Double Drain Case.

	DD (BASE)	DD (ACTIVE)	DD (PASSIVE)	DD (Anti-Infla)	DD (Anti-Ygap)
Φ_π	1.50	3.00	1.25	1.75	1.25
Φ_y	0.50	1.00	0.25	0.25	0.75
MEAN (%)					
R	-0.0276	-0.0330	-0.0207	-0.0208	-0.0311
INF	0.0005	0.0009	0.0003	0.0004	0.0007
Y	-0.2821	-0.2270	-0.3686	-0.3769	-0.2398
C	-0.1086	-0.0388	-0.2040	-0.2092	-0.0597
INV	-0.1849	-0.2835	-0.0511	-0.0422	-0.2547
Loans	-0.4365	-0.3511	-0.5707	-0.5847	-0.3697
N	-3.8568	-3.8732	-3.6088	-3.4652	-4.0087
NX/Y	0.0664	0.0748	0.0568	0.0564	0.0719
F/Y	-1.1908	-1.2711	-1.0818	-1.0733	-1.2532
RER	0.0617	0.0719	0.0455	0.0436	0.0698
S.D. (%)					
R	0.0420	0.0526	0.0263	0.0231	0.0536
INF	0.0421	0.0409	0.0389	0.0368	0.0423
Y	0.3463	0.4570	0.2001	0.1757	0.4605
C	0.2329	0.3131	0.1474	0.1397	0.3137
INV	0.1474	0.1548	0.2170	0.2396	0.1490
Loans	0.4653	0.6100	0.2980	0.2790	0.6089
N	1.6110	1.8515	1.9501	2.3500	2.0616
NX/Y	0.2758	0.2587	0.3237	0.3424	0.2567
F/Y	0.2081	0.2567	0.1745	0.1715	0.2737
RER	0.0141	0.0267	0.0133	0.0156	0.0270

4.5. Impulse Responses under Policy Stance Minimizing Output Loss

In this section, we compare the impulse responses of the macro variables under two cases – those of the optimal policy stances which can minimize output losses in the external and the double drains scenarios. The overall patterns of impulse responses in the model coincide with those of empirical analysis with Korean data[13], implying that our theoretical model is valid.

4.5.1. External Drain Case without Contagion

When the economy is hit by an external risk premium shock, the policy interest rate increases and the real economy contracts, while net exports improve and foreign debt decreases. The reasoning behind the policy responses is as follows. The external risk premium shock is a negative shock in that it increases the cost of acquiring imported intermediate goods necessary for production, by the assumption of original sin. This implies that there is a contraction in the financial account that needs to be matched with an increase in the current account. In this case, the exogenous shock is sector specific; i.e., it mainly affects the traded good sector. Higher interest rates play a role in giving the economy a buffer against the shock by reallocating input resources from the non-traded to the traded goods sector. This result is on the same lines as Hevia (2007) and Curdia (2007). It is noteworthy that the bigger the size of the risk premium shock, the higher the interest rate response, as shown in Figure 4. In contrast to Curdia (2007), the real exchange rate appreciates slightly in the present model, and the adverse effect caused by a bigger burden of imports can hence be suppressed, while exports are not so much affected given the assumption of local currency pricing in the export sector.

[13] See appendix for the results of empirical impulse response analysis.

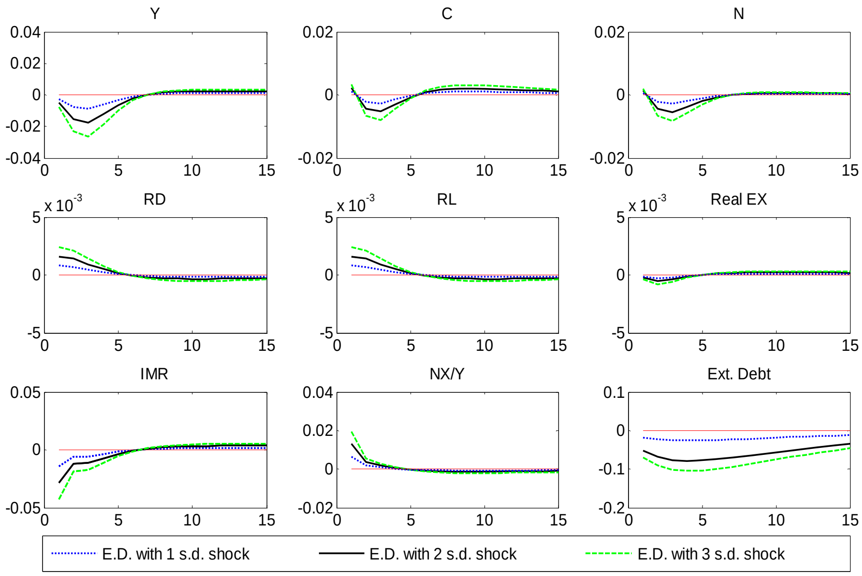


Figure 4. Impulse Responses under External Drain Case.

4.5.2. Double Drain Case with Contagion

What if the international shock is contagious to the domestic credit markets? In Figure 5, we compare the impulse responses of three different cases in terms of the degree of contagion from international risk premium shocks causing domestic credit crunch. The more the efficiency of financial intermediation is affected by an exogenous risk premium shock, the more likely it is that real economic variables contract, net exports improve and external debt is repaid. However, the policy interest rate moves lower with stronger contagion effects, in contrast to the case with no contagion.

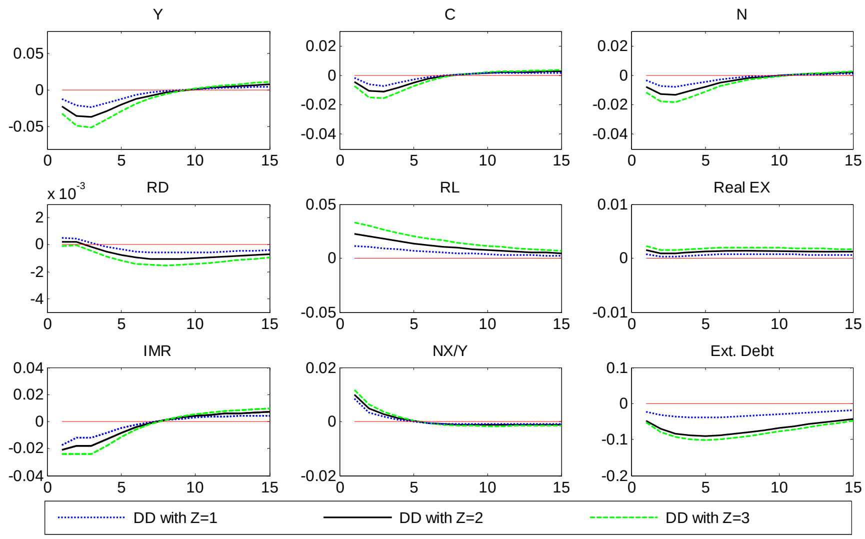


Figure 5. Impulse Responses under Double Drain Case.

4.6. Robustness of Results

In this section, we examine the robustness of the results in terms of two aspects - the net foreign asset position, which would have important implications for small open economies, and the role of the time horizon in comparison of policy stances.

4.6.1. Role of net foreign asset position

In the baseline scenario, we assign 0.0217 for the steady-state value of net foreign assets, following the fact that Korea remained a creditor until eruption of the global financial crisis. We change the value in two directions, so that we can verify whether the results formed above change in a case with higher net foreign assets or net foreign debt.

As shown in <Table 5>, our previous results remain, in which a passive stance is desirable in the external drain case, and an active stance in the double drain case, even though the output loss becomes larger with higher (lower) net foreign debt (assets). This implies that the adjustment mechanism of this economy does not change fundamentally due to variation in the level of net foreign assets, under either the external drain or the double drain case.

Table 5. Robustness with Different Net Foreign Asset Positions

ED	**(BASE)**	**(ACTIVE)**	**(PASSIVE)**	**(Anti-Infla)**	**(Anti-Ygap)**
Φπ	1.50	3.00	1.25	1.75	1.25
Φy	0.50	1.00	0.25	0.25	0.75
Mean (%)			**Higher NFA (Fss = 0.0217 → 0.0414)**		
INF	0.0008	0.0009	0.0007	0.0007	0.0009
Y	-0.0686	-0.1025	**-0.0381**	-0.0420	-0.0859
C	-0.0111	-0.0280	-0.0019	-0.0067	-0.0161
N	0.2192	0.0011	0.6437	0.7076	0.0110
Loans	-0.0593	-0.1024	-0.0238	-0.0302	-0.0796
Mean (%)			**Net Foreign debt (Fss= 0.0217 → -0.0178)**		
INF	0.0013	0.0014	0.0013	0.0013	0.0014
Y	-0.0864	-0.1142	**-0.0707**	-0.0776	-0.0975
C	-0.0108	-0.0282	0.0006	-0.0038	-0.0174
N	0.1884	-0.0024	0.5930	0.6575	0.0039
Loans	-0.1021	-0.1389	-0.0865	-0.0977	-0.1148

DD	**(BASE)**	**(ACTIVE)**	**(PASSIVE)**	**(Anti-Infla)**	**(Anti-Ygap)**
Φπ	1.50	3.00	1.25	1.75	1.25
Φy	0.50	1.00	0.25	0.25	0.75
Mean (%)			**Higher NFA (Fss = 0.0217 → 0.0414)**		
INF	-0.0007	0.0000	-0.0014	-0.0013	-0.0003
Y	-0.6013	**-0.4166**	-0.8494	-0.8604	-0.4750
C	-0.2694	-0.0685	-0.5289	-0.5348	-0.1377
N	-10.4690	-10.190 0	-10.4740	-10.1910	-10.5710
Loans	-0.9823	-0.7138	-1.3456	-1.3647	-0.7956
Mean (%)			**Net Foreign debt (Fss= 0.0217 → -0.0178)**		
INF	-0.0014	-0.0010	-0.0017	-0.0018	-0.0011
Y	-0.6623	**-0.4854**	-0.8899	-0.8894	-0.5539
C	-0.2447	-0.0357	-0.5179	-0.5258	-0.1077
N	-11.0250	-10.7250	-11.0790	-10.8190	-11.0730
Loans	-1.0829	-0.8130	-1.4348	-1.4387	-0.9131

4.6.2. Time dimension of output loss

In the previous section, we calculated output losses over three years in consideration of the impulse responses in which the main macro variables return to the steady state value about three years after the shock hits the economy. Basically, the proper time horizon for the monetary authority would be related to the persistence of the shock; i.e, the more persistent the shock is, the longer the time horizon that should be considered, as it will take more time for the economy to recover from a more persistent external shock. For robustness check, we recalculate the output cost over two different horizons – two years, and two and one half years – in consideration of the facts that key variables such as output and labor seem to return to the steady state in shorter periods than three years depending upon the monetary policy stance. We find that the main results do not change, i.e., the best monetary policy stance remains as shown in Table 6:

Table 6. Robustness with Different Time Horizons

ED	**(BASE)**	**(ACTIVE)**	**(PASSIVE)**	**(Anti-Infla)**	**(Anti-Ygap)**
Φπ	1.50	3.00	1.25	1.75	1.25
Φy	0.50	1.00	0.25	0.25	0.75
Mean (%)	**(Time Horizon = Two Years)**				
INF	0.0016	0.0017	0.0016	0.0016	0.0018
Y	-0.1342	-0.1957	**-0.0740**	-0.0767	-0.1727
C	-0.0309	-0.0745	0.0126	0.0103	-0.0572
N	0.3046	-0.0341	0.9753	1.0788	-0.0202
Loans	-0.1411	-0.2221	-0.0672	-0.0731	-0.1892
	(Time Horizon = Two and one-half Years)				
INF	0.0016	0.0017	0.0016	0.0016	0.0017
Y	-0.0995	-0.1378	**-0.0701**	-0.0758	-0.1185
C	-0.0098	-0.0341	0.0094	0.0051	-0.0208
N	0.2564	-0.0018	0.7727	0.8525	0.0079
Loans	-0.1049	-0.1539	-0.0723	-0.0819	-0.1267
DD	**(BASE)**	**(ACTIVE)**	**(PASSIVE)**	**(Anti-Infla)**	**(Anti-Ygap)**
Φπ	1.50	3.00	1.25	1.75	1.25
Φy	0.50	1.00	0.25	0.25	0.75
Mean (%)	**(Time Horizon = Two Years)**				

INF	0.0001	0.0007	-0.0005	-0.0005	0.0006
Y	-0.4533	**-0.4443**	-0.4760	-0.4732	-0.4541
C	-0.2130	-0.1740	-0.2673	-0.2651	-0.1924
N	-4.6534	-4.7588	-4.1699	-3.9418	-4.9433
Loans	-0.6631	-0.6388	-0.7147	-0.7148	-0.6521
(Time Horizon = Two and one-half Years)					
INF	0.0007	0.0011	0.0002	0.0002	0.0010
Y	-0.3570	**-0.3199**	-0.4190	-0.4234	-0.3304
C	-0.1522	-0.0933	-0.2333	-0.2360	-0.1126
N	-4.2289	-4.2793	-3.8895	-3.7128	-4.4338
Loans	-0.5362	-0.4743	-0.6391	-0.6482	-0.4894

4.7. Discussion: Why Are Different Policy Responses Required?

In the previous section, we found that the question of whether financial intermediation of domestic banks is affected by an international financial shock or not could be important in deciding the stance of monetary policy. Under an external drain without contagion, the policy interest rate rises in response to a country risk premium shock. The bigger the international financial shock, the higher the target interest rate must rise. However, under a double drain with contagion to domestic financial intermediation, the policy interest rate may either rise or fall following an international risk premium shock, depending upon the severity of contagion. The more severe the contagion from a global financial shock to a domestic credit crunch, the lower the policy interest rate should be.

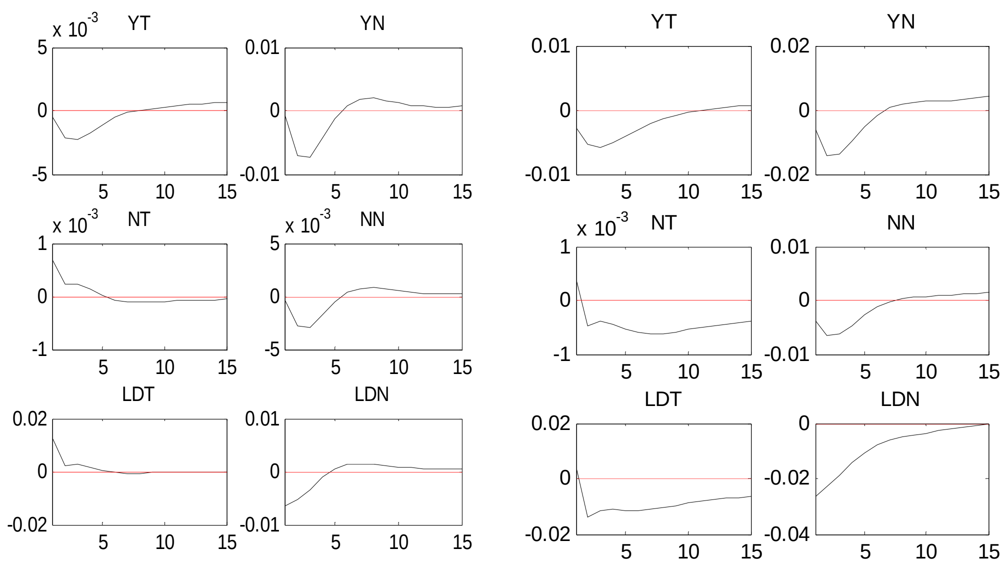
The reason for this difference comes from the nature of the two types of external shocks – sudden stop and double drain. A higher domestic interest rate is helpful for mitigating the pressure of exchange rate depreciation and the negative effects on the cost of importing intermediate goods under the original sin assumption. Furthermore, an increase in lending interest rates plays a role in reallocating input resources from the non-traded sector into the traded sector, which is desirable under an external drain, because traded goods are more valuable to this economy for repaying foreign debt and expanding net exports in response to an international financial shock.

Unlike the risk premium shock, a domestic credit crunch shock directly affects both the traded and non-traded sectors. Hence the negative impacts on the traded and non-traded sectors are stronger, the need to reallocate input resources into the traded sector hit by a sector specific external risk premium shock weakens, and the policy response to deterioration of the output gap dominates the movement of the policy interest rate under this double drain case.

In Figures 7 and 8, bank loans as well as labor inputs to the traded goods sector increase with the higher domestic interest rate after a risk premium shock hits the economy, and so the sharp contraction in the traded goods sector can be mitigated. However, in the double drain case, the non-traded goods sector also faces the (higher) pressure of contraction in output, the monetary authority is hence required to support the production activities in both sectors together, which leads to the validity of lowering the policy interest rate. In a double drain case, an external risk premium shock has *relatively* less impact on the traded good sector, because the domestic credit crunch also raises the costs of financing common inputs used in both sectors. As a result, in a double drain case there is less pressure for the economy to move into a new contractionary equilibrium following a sudden reversal in capital.

Table 7. Output Responses in Two Sectors to a Risk Premium Shock.

External Drain		Double Drain	
Y_T	Y_N	Y_T	Y_N
-1.3	-0.4	-4.2	-4.1



(External Drain) *(Double Drain)*

Figure 6. Impulse Responses in the Traded and Non-traded Sectors.

5. CONCLUDING REMARKS

Most emerging economies face the risk of sudden reversals in capital inflows. A sharp surge in the cost of international borrowing in a foreign currency tends to trigger instability of the domestic financial markets and contractions in real economic activities in these economies.

In this paper, we examine the monetary policy implications of such an external shock with focus on its contagion effects on domestic financial intermediation. Our results indicate that the monetary authority should consider to what extent international shocks are transmitted to the domestic credit markets when it decides its policy stance. If there is no contagion and external funding cost shocks are restrained in the traded goods sector, an appropriate response would be to increase the policy interest rate. However, if the tightening of international credit conditions spreads into the domestic credit markets (that is, a double drain occurs), monetary easing may be desirable, in line with the degree of contagion.

If the main objective of the monetary authority is to prevent severe contractions in real economic activities following external financial shocks, a relatively passive stance is more desirable for an external drain without contagion. In contrast, under a double drain, a more active monetary policy stance is required to minimize the output cost. Our key results are robust to different levels of steady-state net foreign assets and time horizons in calculation of output loss.

We do not include an endogenous mechanism for amplification of international shocks explicitly in the model. The inclusion of any amplification mechanism might strengthen the likelihood of a double drain case.

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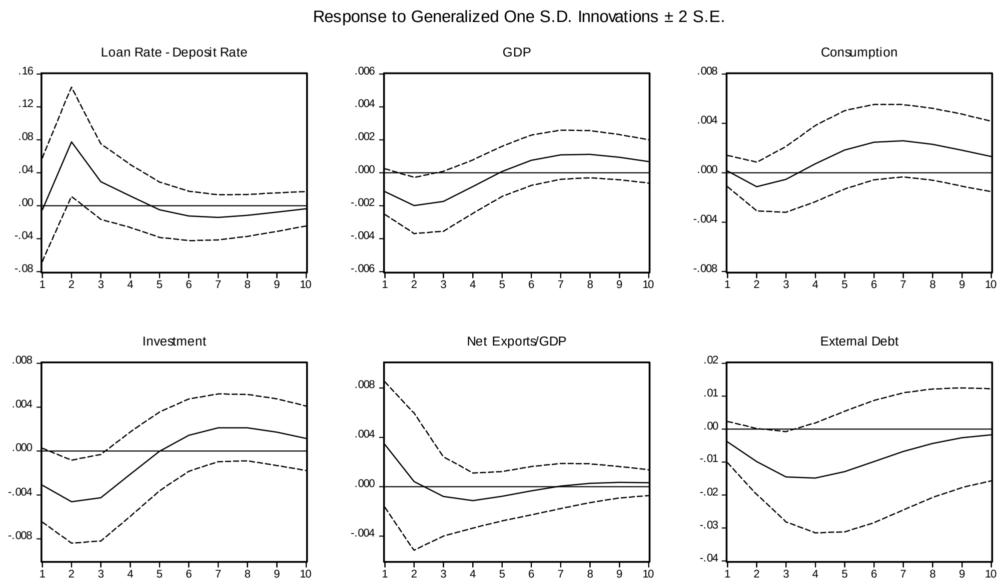
Appendix : Empirical Impulse Responses from a VAR Model in Korea



- Sample Period : 2000.1/4~2008.3/4
- Variables : Risk premium, Spread between Loan rate and Deposit rate,
  External debt, Net exports, Consumption, Investment, GDP
- Lag = 1