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

Geun-Young Kim[1]†

IMER, Bank of Korea

June, 2009

Abstract

The aim of this paper is to examine the monetary policy implications for emerging economies under double drains, that combine an external risk premium shock and a domestic credit crunch. We construct a two sector small open economy model with features such as original sin and dollar pricing, which are relevant to emerging markets. The results imply that the monetary authority should consider in deciding its policy stance the extent to which international shocks are transmitted in the domestic credit markets. When international financial shocks hit the economy without being spread by contagion to domestic financial intermediation, the target interest rate increases and the economy reduces its external debts and expands net exports, while the contraction in real economic activities is partly smoothed by reallocating input resources into the traded sector. However, if the international shock is contagious, and domestic financial markets dip into a credit crunch, the target interest rate may be lowered to buffer this common negative impact in both sectors, depending on 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 is desirable.

Keywords: External Drain; Double Drain; Monetary Policy; Small Open Economy;

JEL classification : E5; E3; F4

[1]Economist, Corresponding address : Instutute for Monetary & Economic Research, The Bank of Korea, E-mail : kgy3104@hanmail.net.

† The author thanks the committee (Seungje Hong, Junhan Kim, Byoung-Ki Kim) and Young-Kyung Suh for their helpful comments. The author also thanks seminar participants at the Bank of Korea.

1 Introduction

The recent financial turmoil originating from the U.S. sub-prime mortgage crisis has been affecting many emerging economies especially those with a heavy dependence on external borrowing. Financing from international capital markets gives these emerging countries opportunities to achieve higher economic growth. However, 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 lead to instability of the financial and real sectors in these emerging economies[2]. During a period of sudden reversal in capital flows, emerging economies experience a rapid deterioration in the conditions for obtaining new foreign loans or rolling over existing borrowings, and usually need to reduce the outstanding stock of foreign debt by running current account surpluses, generally accompanied by a sharp reduction in output and employment.

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 inflows, has been an important issue, particularly after global financial instability swept across the world economy. 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 sudden stop shocks in order to buffer a severe economic downturn[3].

There are several theoretical papers on optimal monetary policy during a period of financial turmoils. Braggion, Christiano and Roldos (2007) construct a model where an initial tightening followed by a later loosening is optimal. The 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.

[2] Cavlo (1998) use the term 'sudden stop' for this phenomena of capital reversal. Some people differentiate 'sudden flights' which means investment abroad by domestic residents from 'sudden stops' in capital inflows by foreign investors. Deterioration in the capital account in a country can be caused by these two effects toghther.

[3] Stanley Fischer has been one of the main exponents of the first view in the context of the Asian 1997 crisis, while Joseph Stiglitz has been one of the most vocal critics of it arguing that this set of policy recommendations worsened the downturns in the countries hit by external shocks.

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 is a decline 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 rise 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$\sim$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 occurred since 1990. They find evidence that those countries that tightened monetary and fiscal policy during these crises, experienced larger output contractions than countries that followed a looser policy stance.

In this paper, we argue that it might be important to distinguish two possible situations in exploring a desirable monetary policy stance in response to external shocks with substantial deteriorations in the cost of foreign borrowing; an *external drain case* in which the cost of borrowing from abroad is surging, and a *double drain case* in which an international financial shock is contagious, so causing an internal drain with a domestic credit crunch. Though there is no ex-ante reason to expect occurrence of such a domestic credit crunch following an external risk premium shock, financing conditions in domestic markets tend to tighten under this external shock in many emerging economies[4]. This double drain - combined the external drain caused by deteriorated conditions of foreign borrowing and the internal drain by way of a credit crunch - is an interesting feature in emerging markets during periods of financial turmoil[5]. 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 the feature of emerging economies - original sin, dollar pricing in external trade as well as working capital constraint. We depart from the standard real business cycle model with a perfectly competitive credit market between households/lenders and firms/borrowers by introduc-

[4] In appendix 1, we provide empirical evidence of double drains in Korea.

[5] 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 with a weak banking system.

ing a banking sector. We 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 the interest rate on deposits (lending rate) may differ from the interest rate on loans (borrowing rate) which generates an interest rate spread.

The main findings are as follows: If there is no contagion effect from international financial shocks on domestic financial intermediation, the target interest rate must rise under an external premium shock with decrease of 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 case of a double drain with a domestic credit crunch, it might be desirable for the monetary policy authority to respond by lowering the target interest rate, depending on the size of the contagion effects. In order to mitigate the cost of contraction in output, 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, and the equilibrium conditions are derived in Section 3. In Section 4, the main results of monetary policy implications and dynamics of real variables under two cases together with some discussions are presented. Section 5 concludes the paper.

2 The Model

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

$$Max\ E_0 \sum_{j=0}^{\infty} \beta^j U(C_{t+j}, N_{t+j}) \tag{1}$$

$$U_t(C_t, N_t) = \frac{(C_t - N_t^{\varphi})^{1-\sigma} - 1}{1-\sigma} \tag{2}$$

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

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

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 composite consumption index.

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

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

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

where $\varepsilon > 1$ is price elasticity of demand, $j \in [0,1]$ denotes the good variety 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

$$P_t \equiv [(1-\alpha)(P_{N,t})^{1-\eta} + \alpha(P_{T,t})^{1-\eta}]^{\frac{1}{1-\eta}} \tag{4}$$

where $P_{T,t} \equiv (\int_0^1 P_{T,t}(j)^{1-\varepsilon} dj)^{\frac{1}{1-\varepsilon}}$, $P_{N,t} \equiv (\int_0^1 P_{N,t}(j)^{1-\varepsilon} dj)^{\frac{1}{1-\varepsilon}}$ are the traded goods price index and the non-traded goods price index in the domestic currency, respectively.

Households' optimal allocations within each category of goods is the following demand functions :

$$
\begin{aligned}
C_{T,t}(j) &= \left(\frac{P_{T,t}(j)}{P_{T,t}}\right)^{-\varepsilon} C_{T,t} \\
C_{N,t}(j) &= \left(\frac{P_{N,t}(j)}{P_{N,t}}\right)^{-\varepsilon} C_{N,t}
\end{aligned}
$$

Using the definition of total consumption in (3), we can derive the optimal allocation of expenditures between traded and non-traded goods :

$$
C_{T,t} = \alpha \left(\frac{P_{T,t}}{P_t}\right)^{-\eta} C_t \tag{5}
$$

$$
C_{N,t} = (1-\alpha) \left(\frac{P_{N,t}}{P_t}\right)^{-\eta} C_t \tag{6}
$$

Then total consumption is reduced as follows:

$$
P_{T,t}C_{T,t} + P_{N,t}C_{N,t} = P_t C_t \tag{7}
$$

The household owns domestic final goods producers and accumulates physical capital. The law of motion of the capital stock in both sectors is given by :

$$
K_{T,t+1} = K_{T,t}(1-\delta) + I_{T,t} \tag{8}
$$

$$
K_{N,t+1} = K_{N,t}(1-\delta) + I_{N,t} \tag{9}
$$

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

Representative agents' intertemporal budget constraint in nominal terms is the following:

$$
\begin{aligned}
& P_t(C_t + I_{T,t} + I_{N,t}) + D_t + F_{t-1}S_t(1 + i^*_{t-1} + \Psi_{t-1}) \qquad (10) \\
\leq \; & S_t F_t + (1 + i^d_{t-1})D_{t-1} + W_t N_t + Q_{T,t}K_{T,t} + Q_{N,t}K_{N,t} + \Pi^F_t + \Pi^B_t
\end{aligned}
$$

The right hand side of this equation 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 labour services to the firm, rental earning $Q_t K_t$ on capital in both sectors, share of profits Π_t from firms and banks, interest earnings on deposit, and the amount of foreign currency denominated debt F_t. i^d_t denotes the nominal interest rate earned on the deposit and S_t is the nominal exchange rate defined as units of home currency per unit of foreign currency. The left hand side corresponds to the uses of these resources. The household can use these to consume goods, accumulate capital, and pay back the external debt borrowed and deposit D_t with the financial intermediary.

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

$$\Psi_t = k\exp(S_tF_t - \overline{SF}) + \nu_t \tag{11}$$
$$\nu_t = (1-\rho_\nu)(\nu) + \rho_\nu(\nu_{t-1}) + \varepsilon_t^\nu \tag{12}$$

Consumption, investment are defined as a nested CES combination of domestically produced non-traded goods, A_N, and domestically produced traded goods, A_T. Traded and non-traded goods are combined into a quantity of goods absorbed, A_t.

$$C_t + I_{T,t} + I_{N,t} = A_t = [(1-\alpha)^{\frac{1}{\eta}}(A_{N,t})^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}}(A_{T,t})^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \tag{13}$$
$$A_{T,t} = \alpha\left(\frac{P_{T,t}}{P_t}\right)^{-\eta} A_t \tag{14}$$
$$A_{N,t} = (1-\alpha)\left(\frac{P_{N,t}}{P_t}\right)^{-\eta} A_t \tag{15}$$

The household chooses the paths of $\{C_t, N_t, K_{T,t+1}, K_{N,t+1}, D_t, F_t\}$ to maximize its expected lifetime utility subject to the constraint (10) with equality and initial values for $K_{T,0}, K_{N,0}, F_0, D_0$. The first-order conditions with respect to $\{C_t, N_t, K_{T,t+1}, K_{N,t+1}, D_t, F_t\}$ can be summarized by :

$$1 = \frac{W_t}{P_t}N_t^{1-\varphi} \tag{16}$$
$$1 = \beta E_t[(\frac{P_t(1+i_t^d)}{P_{t+1}})\left(\frac{(C_{t+1}-N_{t+1}^\varphi)}{(C_t-N_t^\varphi)}\right)^{-\sigma}] \tag{17}$$
$$1 = E_t\frac{S_{t+1}}{S_t}\frac{(1+i_t^*+\Psi_t)}{(1+i_t^d)} \tag{18}$$
$$1 = E_t\frac{1}{P_t(1+i_t^d)}[Q_{T,t+1} + P_{t+1}(1-\delta)] \tag{19}$$
$$1 = E_t\frac{1}{P_t(1+i_t^d)}[Q_{N,t+1} + P_{t+1}(1-\delta)] \tag{20}$$

Additionally, transversality conditions should be satisfied.

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 produces lending service L_t to each intermediate goods-producing firm, subject to the linear production function:

$$L_t \leq \phi_t D_t \tag{21}$$

where ϕ_t represents efficiency in banking technology.

Following the literature on the liquidity effect (e.g., Christiano(1991), Auray and Feve(2005)), the bank collects $(1+i_t^l)L_t^s$ of principal and interest from each intermediate goods-producing firm and repay the interests for the money deposits by the household at the end of period t. Then the bank's problem is :

$$\begin{aligned} & \underset{D_t,\, L_t}{Max}\ E_t \sum_{j=0}^{\infty} \Lambda_{t,t+j} \Pi_{t+j}^B \\ s.t \qquad & L_t \leq \phi_t D_t \end{aligned}$$

where

$$\Pi_t^B = D_t - (1+i_t^d)D_t - L_t + (1+i_t)L_t \tag{22}$$

Optimality conditions for the bank's deposits and loans are as follows:

$$i_t^d = \phi_t i_t^l \tag{23}$$

$$L_t = \phi_t D_t \tag{24}$$

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

So long as the net nominal interest rate i_t^l is positive, the bank will lend all of its funds and eq.(21) will hold with equality, but face 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 would decrease and the lending rate would 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[6], it is assumed that firm j transforms domestic and imported intermediate goods bundles into a differentiated traded goods j using a CES technology:

$$Y_{T,t}(j) = [(1-\gamma)^{\frac{1}{\tau}} IMD_t(j)^{\frac{\tau-1}{\tau}} + \gamma^{\frac{1}{\tau}} IMR_t(j)^{\frac{\tau-1}{\tau}}]^{\frac{\tau}{\tau-1}}, \quad 0 < \tau, \quad 0 < \gamma < 1 \tag{25}$$

where $IMD_t(j)$ and $IMR_t(j)$ represents the domestic and imported intermediate goods, respectively.

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

$$IMD_t(j) = K_{T,t}(j)^{\alpha_T} N_{T,t}(j)^{1-\alpha_T}, \quad 0 < \alpha_T < 1 \tag{26}$$

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

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

$$W_t N_{T,t}(j) + Q_{T,t} K_{T,t}(j) \leq L_{T,t}(j) \tag{27}$$

$$P^*_{F,t} IMR_t(j) \leq F_t(j) \tag{28}$$

It is assumed that the firm must borrow funds $L_t(j)$ from banks to pay its wages and rental on capital. Then the marginal cost of employing an additional unit of the labor & capital is $(1+i^l_t)W_t$,and $(1+i^l_t)Q_t$. When the net nominal interest rate i^l_t is positive, this above financial constraint holds with equality. In this case, if the firm choose the optimal amount of labor and capital inputs, the amount of borrowing demand from bank $L_{i,t}$ is determined, given wage and rental rate.

Furthermore, this economy can not borrow in its own currency, so it must borrow foreign currency debt to purchase the imported intermediate goods, which is commonly

[6] 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.

known as 'original sin' in emerging economies[7]. The manufacturers purchase the imported materials with foreign currency borrowed at rate of $(1+i_t^*+\Psi_t)$, hence the marginal cost of employing an additional unit of the imported intermediate goods is $(1+i_t^*+\Psi_t)S_tP_{F,t}^*$ in which the higher external risk premium will adversely affect the purchases of imported materials.

The first-order conditions of the firm's problem are :

$$\frac{(1-\alpha_T)K_{T,t}(j)}{\alpha_T N_{T,t}(j)} = \frac{W_t}{Q_{T,t}} \tag{29}$$

$$\gamma^{\frac{1}{\tau}}[PPI_{T,t}\left(\frac{IMD_t(j)}{Y_{T,t}(j)}\right)^{\frac{1}{\tau}}] = (1+i_t^*+\Psi_t)P_t^*S_t \tag{30}$$

$$PPI_{D,t} = (1+i_t^l)Q_{T,t}[W_t(1+i_t^l)]^{1-\alpha_T}\alpha_T^{-\alpha_T}\ (1-\alpha_T)^{\alpha_T-1} \tag{31}$$

$$PPI_{T,t} = \{(1-\gamma)PPI_{D,t}^{1-\tau}+\gamma[(1+i_t^*+\Psi_t)P_t^*S_t]^{1-\tau}\}^{\frac{1}{1-\tau}} \tag{32}$$

where $PPI_{T,t}$ is the producer price of traded goods, $P_{F,t}^*$ is the foreign currency price of imported materials.

2.3.2 Non-traded goods sector

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

$$Y_{N,t}(j) = K_{N,t}(j)^{\alpha_N}N_{N,t}(j)^{1-\alpha_N} \tag{33}$$

with same working capital constraint :

$$W_tN_{N,t}(j)+Q_{N,t}K_{N,t}(j) \leq L_{N,t}(j) \tag{34}$$

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

$$\frac{(1-\alpha_N)K_{N,t}(j)}{\alpha_N N_{N,t}(j)} = \frac{W_t}{Q_{T,t}} \tag{35}$$

$$PPI_{N,t} = (1+i_t^l)Q_{T,t}[W_t(1+i_t^l)]^{1-\alpha N}\alpha_T^{-\alpha_N}(1-\alpha_n)^{\alpha_N-1} \tag{36}$$

[7] The term 'original sin' was used firstly in Eichengren and Hausmann(1999), which refers to two types of original sin ; International original sin - the instability of borrowing in terms of domestic currency - and domestic original sin - instability to borrow domestically long term. Recently original sin in most of the literature usually implies the first meaning.

2.3.3 Nominal Rigidity

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

In this model, there are three types of sticky price : the retail prices of non-traded goods, domestic retail prices of traded goods, and 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 price setters who purchase an undifferentiated input goods 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 to reset their price $\bar{P}_{T,t}(j), \bar{P}_{N,t}(j), \bar{P}_{X,t}(j)$ in the domestic and foreign markets. Retailers are not allowed to change their prices unless they receive a random price change signal. Under this price setting structure, $P_{i,t+k}(j)$ equal $\bar{P}_{i,t}(j)$ with probability $\theta_i^k, i = T, N, X,\ k = 0, 1, 2, ...$ 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 :

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

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

where $\Lambda_{t,t+k}$ is the ratio of marginal utility between period t and $t + k$.

By the first order condition and symmetry imposing, the optimal price for domestic markets $\bar{P}_{T,t}$ must satisfy the following condition:

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

Rewriting this in terms of optimal price, we obtain

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

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

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:

$$\bar{P}_{T,t} = \frac{\varepsilon}{(\varepsilon-1)}\frac{E_t\sum_{k=0}^{\infty}(\theta_T\beta)^kY_{T,t+k}MC_{T,t+k}}{E_t\sum_{k=0}^{\infty}(\theta_T\beta)^kY_{T,t+k}} \quad (37)$$

which implies that the new price set by firm j, at time 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 $\frac{\varepsilon}{\varepsilon-1}$. 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

$$P_{T,t} = [(1-\theta_T)(\bar{P}_{T,t})^{1-\varepsilon} + \theta_T(P_{T,t-1})^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \quad (38)$$

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

$$\bar{P}_{N,t} = \frac{\varepsilon}{(\varepsilon-1)}\frac{E_t\sum_{k=0}^{\infty}(\theta_N\beta)^kY_{N,t+k}MC_{N,t+k}}{E_t\sum_{k=0}^{\infty}(\theta_N\beta)^kY_{N,t+k}} \quad (39)$$

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

$$P_{N,t} = [(1-\theta_N)(\bar{P}_{N,t})^{1-\varepsilon} + \theta_N(P_{N,t-1})^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \quad (40)$$

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

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

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

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

$$\bar{P}_{X,t} = \frac{\varepsilon}{(\varepsilon-1)} \frac{E_t \sum_{k=0}^{\infty} (\theta_x \beta)^k Y^*_{T,t+k} MC_{T,t+k}}{E_t \sum_{k=0}^{\infty} (\theta_x \beta)^k Y^*_{T,t+k} S_{t+k}} \tag{41}$$

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

The price index of export goods is :

$$P_{X,t} = [(1-\theta_x)(\bar{P}_{X,t})^{1-\varepsilon} + \theta_x (P_{X,t-1})^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{42}$$

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 domestic price of imported intermediate goods is foreign currency price, which is determined exogenously to this economy, times nominal exchange rate.

2.4 *Central Bank's Monetary Policy*

The formulation of monetary policy 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 target have a feed-back on short-run movements of the nominal interest rate. The following equation describes the target for the nominal deposit interest rate[8]:

$$\log \frac{(1+i_t^d)}{(1+\bar{\imath})} = \mu \log \frac{(1+i_{t-1}^d)}{(1+\bar{\imath})} + (1-\mu)[\Phi_\pi \log(\frac{\pi_t}{\bar{\pi}}) + \Phi_y \log(\frac{GDP}{\overline{GDP}})] \tag{43}$$

where $\mu, \bar{\pi}, \overline{GDP}$ 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:

$$\begin{aligned} K_t &= \textstyle\int_0^1 K_t(j)dj \\ N_t &= \textstyle\int_0^1 N_t(j)dj \\ IMD_t &= \textstyle\int_0^1 IMD_t(j)dj \\ IMR_t &= \textstyle\int_0^1 IMR_t(j)dj \end{aligned}$$

$$Y_{T,t} = [(1-\gamma)^{\frac{1}{\tau}} IMD_t^{\frac{\tau-1}{\tau}} + \gamma^{\frac{1}{\tau}} IMR_t^{\frac{\tau-1}{\tau}}]^{\frac{\tau}{\tau-1}}, \quad 0 < \tau, \quad 0 < \gamma < 1 \tag{44}$$

$$IMD_t = K_{T,t}^{\alpha_T} N_{T,t}^{1-\alpha_T}, \quad 0 < \alpha_T < 1 \tag{45}$$

$$Y_{N,t} = K_{N,t}^{\alpha_N} N_{N,t}^{1-\alpha_N}, \quad 0 < \alpha_N < 1 \tag{46}$$

[8] If we introduce 'money' explicitly in the form of CIA constraint, we may consider alternative monetary targeting rule as follows :

$$\dot{m}_t = \Phi_\pi \log(\frac{\pi_t}{\bar{\pi}}) + \Phi_y \log(\frac{GDP}{\overline{GDP}})$$

where $\dot{m}_t$is money growth rate($\frac{m_t}{m_{t-1}}$).Here we consider interest rates as an menetary policy instrument and money supply just meets money demand given the level of interest rate.

In a symmetric equilibrium, we have

$$\frac{(1-\alpha_T)K_{T,t}}{\alpha_T N_{T,t}} = \frac{W_t}{Q_{T,t}} \tag{47}$$

$$\frac{(1-\alpha_N)K_{N,t}}{\alpha_N N_{N,t}} = \frac{W_t}{Q_{N,t}} \tag{48}$$

$$\gamma^{\frac{1}{\tau}}[PPI_{T,t}\left(\frac{IMD_t}{Y_{T,t}}\right)^{\frac{1}{\tau}}] = (1+i_t^* + \Psi_t)P_t^* S_t \tag{49}$$

$$PPI_{D,t} = (1+i_t^l)Q_{T,t}[W_t(1+i_t^l)]^{1-\alpha_T}\alpha_T^{-\alpha_T}\ (1-\alpha_T)^{\alpha_T - 1} \tag{50}$$

$$PPI_{T,t} = \{(1-\gamma)PPI_{D,t}^{1-\tau} + \gamma[(1+i_t^*+\Psi_t)P_t^* S_t]^{1-\tau}\}^{\frac{1}{1-\tau}} \tag{51}$$

$$PPI_{N,t} = (1+i_t^l)Q_{T,t}[W_t(1+i_t^l)]^{1-\alpha N}\alpha_T^{-\alpha_N}(1-\alpha_n)^{\alpha_{N-1}} \tag{52}$$

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

$$Y_{T,t}(j) = C_{T,t}(j) + I_{T,t}(j) + X_t(j) = \left(\frac{P_{T,t}(j)}{P_{T,t}}\right)^{-\varepsilon}[A_{T,t}] + \left(\frac{P_{X,t}(j)}{P_{X,t}}\right)^{-\varepsilon} X_t \tag{53}$$

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

$$Y_{T,t} = \Delta_{T,t}(A_{T,t}) + \Delta_{X,t}X_t \tag{54}$$

$$Y_{N,t} = \Delta_{N,t}(A_{N,t}) \tag{55}$$

$$Y_t = Y_{T,t} + Y_{N,t} \tag{56}$$

$where\ \Delta_{i,t} = \int_0^1 (\frac{P_{i,t}(j)}{P_{i,t}})^{-\varepsilon}dj, i = T, N, X$ is a measure of relative price dispersion in the domestic and export goods sector indicating 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[9] in terms of Calvo relative prices, as the following law of motion.:

$$\Delta_{i,t} = (1-\theta_i)\frac{\bar{P}_{i,t}}{P_{i,t}} + \theta_i(\frac{P_{i,t}}{P_{i,t-1}})^{\varepsilon}\Delta_{i,t-1},\ i = T, N, X \tag{57}$$

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

[9] Woodford defined a measure of price dispersion in the calvo model as a cross-section variance of logarithms of individual prices, i.e, $\triangle_t \equiv var_i \log p_t(i)$. For a detailed discussion, see Woodford(2003), ch.6, p399.

we have

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

which implies

$$(\frac{\bar{P}_{i,t}}{P_{i,t}}) = \left(\frac{1-\theta_i(\frac{P_{i,t-1}}{P_{i,t}})^{1-\varepsilon}}{(1-\theta_i)}\right)^{\frac{1}{1-\varepsilon}} \tag{58}$$

By plugging (58) into (57), we obtain

$$\Delta_{i,t} = (1-\theta_i)\left(\frac{1-\theta_i(\pi_{i,t})^{\varepsilon-1}}{(1-\theta_i)}\right)^{\frac{1}{1-\varepsilon}} + \theta_i(\pi_{i,t})^{\varepsilon}\Delta_{i,t-1}, where\ \pi_{i,t} = \frac{P_{i,t}}{P_{i,t-1}} \tag{59}$$

which implies that the current level of the measure of relative price distortion depends on the current rate of inflation and the previous level of the measure of relative price distortion.

By substituting profits $\Pi_t^F = P_{T,t}(A_{T,t}) + S_t P_{X,t} X_t - Q_{T,t} K_{T,t} - (1+i_t^l) W_t N_{T,t} - S_t P_t^*(1+i_t^*) IMR_t + P_{N,t}(A_{N,t}) - Q_{N,t} K_{N,t} - (1+i_t^l) W_t N_{N,t}$ and $\Pi_t^B = D_t - (1+i_t^d) D_t - L_t + (1+i_t) L_t$ into household budget constraint (10) and rearranging it, we obtain the country's resources constraint as follows:

$$\begin{aligned} & P_t(C_t + I_t) + F_{t-1} S_t (1 + i_{t-1}^*) \qquad (60) \\ = \quad & F_t S_t + P_{T,t}(A_{T,t}) + S_t P_{X,t} X_t + P_{N,t}(A_{N,t}) - S_t P_{F,t}^*(1+i_t^*) IMR_t \end{aligned}$$

3.2 *External Sector*

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

$$X_t = \bar{X}(\frac{P_{X,t}}{P_{X,t}^*})^{\theta_1}(Y_t^*)^{\theta_2} \tag{61}$$

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

Net exports in real terms NX_t can be expressed as

$$NX_t \equiv \{P_{T,t}A_{T,t} + P_{N,t}A_{N,t} + S_t P_{X,t} X_t - P_t(C_t + I_t) - S_t P_t^*(1 + i_t^* + \Psi_t) IMR_t\}/P_{T,t} \tag{62}$$

Substituting (62) into the country's resources constraint (60), 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 :

$$-F_t = -F_{t-1}(1 + i^*_{t-1} + \Psi_{t-1}) + \frac{P_{T,t}NX_t}{S_t} \tag{63}$$

3.3 *Credit Markets*

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

$$L_t = W_t N_{T,t} + W_t N_{N,t} + Q_{T,t}K_{T,t} + Q_{N,t}K_{N,t} \tag{64}$$

3.4 *Exogenous Shocks*

The data on bond yields show that the premium on bonds issued by emerging market countries rose dramatically during the period associated with reversal in capital inflows to these economies. So we model sudden financial turmoils originating from global markets as unexpected exogenous shocks to country risk premium on borrowing from abroad.

$$\nu_t = (1 - \rho_\nu)\nu + \rho_\nu \nu_{t-1} + \varepsilon^\nu_t, \quad \varepsilon^\nu_t \sim iid(0, \sigma^2_v) \tag{65}$$

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 to maintain a given level of loans and deposits (such as evaluating creditors, managing deposits, renting buildings, maintaining ATM's, and so on) and the cost of this activities tends to be higher (efficiency tends to be lower) in a period of financial turmoil[10].

$$\phi_t = (1 - \rho_\phi)\phi + \rho_\phi \phi_{t-1} - \omega(\varepsilon^v_t), \quad \omega'(\cdot) \geq 0, \ \omega''(\cdot) = 0 \tag{66}$$

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

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

[10] Refer to S. Edwards & C.A. Vizgh(1997): "*During financial crisis, banks are required to spend more efforts to monitor their customor firms, so productivity tends to be lower than in normal economic condition.*"

where $\varepsilon_t^{Y^*}$, $\varepsilon_t^{p^*}$ are independent white noises with a finite standard deviation.

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 $\{P_t, \bar{P}_{T,t}, P_{X,t}, \bar{P}_{X,t}, P_{N,t}, \bar{P}_{N,t}, \pi_t, \pi_{T,t}, \pi_{N,t}, \Psi_t, W_t, i_t^d, i_t^l, MC_{T,t}, MC_{N,t}, \Delta_{i,t}, S_t, Q_T, Q_N,$ $C_t, C_{T,t}, C_{N,t}, N_{Tt}, N_{Nt}Y_t, Y_{T,t}, Y_{N,t}, F_t, L_t, K_{T,t+1}, K_{N,t+1}, I_{T,t}, I_{N,t}, IMR_t, X_t\}_{t=0}^{\infty}$ such that for each time period, the optimality conditions of the representative household, the bank and firms hold and all markets clear.

4 Results : Implications for Monetary Policy

4.1 *Transmission channel*

We will work with a log-linearized model around a zero inflation steady-state. Following Cook & Devereux (2006), sudden reversal in capital flows is represented by unexpected exogenous shocks to country risk premium(Ψ_t) on borrowing from abroad. When a shock to risk premium on external borrowing hits the economy, domestic financial markets may or may not lead to credit crunches, in accordance with the overall soundness of banking industry, macroeconomic conditions and expectations of severity of the shocks, etc. We distinguish a double drain case with a domestic credit crunch from the case without contagion (sudden stop only) : that is, productivity in bank's credit technology is assumed to be affected by the shock from international capital markets under a double drain as follows[11].

[11] Here, we don't include any endogenous ampilfication mechanism of external shocks into domestic credit markets explicitly, because there could be several competitive stories relavant to the reality, and it is also sufficient for us to examine the difference in monetary policy implications between the two cases - external drain and double drain. However, discussing which story is more relevant empirically and modeling the story as an endogenuous amplification mechanism in a model is definitely worth doing by itself. As well summarized in Adrian and Shin(2008), the literature has identified two distinct channels. 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), Kiyotaki and Moore (1998, 2001)). The second is the channel that operates through the banks' balance sheets, either through the liquidity structure of the banks' balance sheets (Bernanke and Blinder (1988), Kashyap and Stein (2000)), or the cushioning effect of the banks' capital (Van den Heuvel (2002)).

$$\begin{aligned} \omega(\varepsilon_t^v) &= z \cdot (\lambda \varepsilon_{t-i}^v),\ i \geq 0 \\ if\ z &= 0 : external\ drain\ case \\ z &> 0 : double\ drain\ case \end{aligned} \tag{67}$$

where z is the degree of contagion parameter, and λ is the parameter to adjust the size (unit) of shocks[12].

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 rate may rise or drop depending on the effects of the shock on inflation and output gap. 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[13]. 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 increase in the unit cost for the additional foreign input. In traded goods sector, decrease in imported intermediate input causes drop in production of traded goods, even though there might be some substitution effects of reallocating capital and labor inputs into the traded sector from non-traded sector. This case of no contagion is similar to the situations described in Selim & Tchakrov (2007) and Gertler, Gilchrist and Natalucci (2007).

Double Drain Case with Contagion What if the domestic financial condition is tightened according to a sudden capital reversal shock? When productivity in the financial intermediation functions, the loan interest rate is higher than the deposit rate, i.e., there is a spread between loan and deposit interest rate as well as the effects under the above contagion case. Hence, the cost of hiring labor and capital input in both sectors increases

[12] The shock to risk premim ε^v a addictive type shock to interest rates, i.e., $i_t + \varepsilon^v\ while\ \varepsilon^\phi$ is a shock to liquidity (loan and deposit) which means it's a multiplicative type shock to interest rate $i_t\varepsilon^\phi$. We adjust the size of domestic credit crunch shock when we examine the double drain case, so the size of absolute decline of output to a 1 s.d. shock at the trough is equal to that under the external drain case.

[13] We can express the risk premium augmented UIP condition by log-linearization equation (19) as follows : $\frac{\bar{i}^d}{(1+\bar{i}^d)}\widehat{i}_t^d + \widehat{S}_t = \frac{\bar{i}^*}{(1+\bar{i}^*+\Psi)}\widehat{i}_t^* + \frac{\Psi}{(1+\bar{i}^*+\Psi)}\widehat{\Psi}_t + E_t\widehat{S}_{t+1}$

and then traded and non-traded sector outputs decrease. This credit crunch shocks under double drain are common in both traded and non-traded sectors.

[Figure 1] Comparing the Shock Transmission under Two Cases

(i) External Drain Case

$$\varepsilon_t^v \uparrow \Rightarrow \begin{array}{l} \nearrow \qquad \Delta i_t \uparrow \lessgtr \Delta\Psi_t \uparrow \Longrightarrow \; S_t \uparrow\downarrow \\ \searrow \; P_t^*(1+i_t^*+\Psi_t)S_t \uparrow \Rightarrow IMR \downarrow \rightarrow L_T \uparrow, L_N \downarrow, Y_T \downharpoonleft, Y_N \Downarrow \end{array}$$

(ii) Double Drain Case

$$\begin{array}{l} \text{(i)} + \text{Internal drain channel} \\ \varepsilon_t^v \uparrow \Rightarrow \phi_t \downarrow \Rightarrow i_t^l \uparrow \Rightarrow L_T, L_N \downarrow \Rightarrow Y_T, Y_N \downarrow \end{array}$$

4.2 *Parameterization*

We assign a value of 0.99 to the subjective discount factor β, 2.0 to intertemporal elasticity of substitution of consumption σ, 1.5 to elasticity of labor supply parameter φ. It is assumed that the annual depreciation rate is 10%, which makes $\delta = 0.025$. We have chosen 10 to the price elasticity of demand ε which implies the price mark-up of 11%.

<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
θ_1	-0.88	θ_2	1.5
μ	0.69	λ	600
ρ_ϕ, ρ_v	0.9	σ_v	0.002

The elasticity of substitution between home and foreign goods η is set to 6 and the coefficient of risk premium k is set to 0.04. For the parameters ϑ_1, ϑ_2 in the rest of world demand for home goods, the share of imported consumption goods α, capital share in traded and non-traded sector α_T, α_N, the degree of interest rate smoothing μ are set to match Korean macroeconomic data. We set 0.75 to the degree of price stickiness parameter in the domestic and export market $\theta_T, \theta_N, \theta_X$. We choose the parameter λ so that one standard deviation shock to risk premium and domestic credit crunch can induce the same depth in response of output at the trough in both cases.

4.3 *Monetary Policy Stances*

In this paper, we compare a few cases with different set of policy parameters being able to represent key monetary policy stances, rather than searching particular welfare-maximizing policy parameters. We consider a baseline stance in which policy parameters($\phi_\pi = 1.5, \phi_y = 0.5$) are taken from the values in previous literature[14], as well as four different policy stances : Anti-inflation stance(1.75, 0.25), Anti-output gap stance(1.25, 0.75), Active response stance(3.0, 1.0), Passive response stance(1.25, 0.25). By comparing these policy stances, we figure out what stance in monetary policy is desirable under two different cases - an external drain and a double drain - in terms of output loss[15].

<Table 2> Various Monetary Policy Stances

MP stance	(BASE)	(ACTIVE)	(PASSIVE)	(Anti-Infla)	(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

4.4 *Output Cost with various Monetary Policy Stances upon an External Shock*

External drains in emerging markets appears 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,

14 For example, Cook & Devereux(2007) and Elekdag & Tchakarov(2007).

15 Our approach is different from most previous literature on optimal monetary policy in which the goal of monetary authority is to search for a welfare maximizing policy rule under uncertainty on exogenous shocks. In this paper, we focus on output loss, because the risk of recession is the main concern for policy maker in most countries after global financial turmoil erupted once. If we adopt the welfare criteria, the optimal policy stance may be different, but the main implications with different interest rate responses depending on the possibility of contagion still hold.

Hutchison and Noy (2006) investigate whether sudden-stop crises are unique phenomena and whether they entail an especially large and abrupt pattern of output collapse using panel data set over 1975∼1997 and 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 further contraction in output. Hence, when international capital inflows stop suddenly and the cost of foreign borrowing rise sharply, one of the main concern of policymaker is how to prevent or mitigate the severity of contraction (or recession) in real economic activities. If the main objective of monetary authority is aims to mitigate the negative impact of external risk premium shocks on output, more effective policy stance might be different in accordance with the possibility of contagion. In this chapter, we examine the output cost of different monetary policy stances under two scenarios - external drain without contagion and double drain with contagion.

4.4.1 External Drain Case

In <Table 3>, we compare the output cost of different monetary policy stances in the case of external drain case without contagion. Output cost of a specific case under external risk premium shocks is calculated as the mean level of real output for 3 years after 1 standard deviation size of external risk premium shock hits this economy[16]. 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 more active policy stance in terms of output cost (-0.07%). Actually, the active policy stance leads to the largest output losses with big drops in imported intermediate goods and domestic loans. Between 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 target interest rate is higher and real exchange rate is slightly lower, which implies the financing cost of imported intermediate goods increase less. As a result, the average level of domestic loan and imported input decrease less and the impact of external risk premium shocks on real output is mitigated.

[16] We choose three years for calculation of output cost because in most cases, it takes 3 years for the economy can recover from contractions upon the impact of a shock.

<Table 3> Output cost 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	0.0139	0.0083	0.0086	0.0125
INF	0.0013	0.0014	0.0013	0.0013	0.0014
Y	**-0.0775**	**-0.1010**	**-0.0675**	**-0.0748**	**-0.0851**
C	-0.0027	-0.0162	0.0030	-0.0021	-0.0059
INV	-0.1132	-0.1132	-0.1001	-0.0937	-0.1198
Loans	-0.0836	-0.1126	-0.0766	-0.0879	-0.0905
N	0.2222	0.0157	0.6385	0.7032	0.0222
NX/Y	0.0418	0.0454	0.0379	0.0378	0.0442
F/Y	-0.8105	-0.8073	-0.8038	-0.7970	-0.8177
RER	-0.0006	-0.0030	-0.0010	-0.0024	-0.0007
EXPORT	-0.0061	-0.0039	-0.0124	-0.0138	-0.0031
IMPORT	-0.3030	-0.3501	-0.2948	-0.3127	-0.3152
S.D.(%)					
R	0.0358	0.0441	0.0246	0.0230	0.0436
INF	0.0219	0.0207	0.0193	0.0181	0.0217
Y	0.1356	0.2321	0.0193	0.0176	0.2201
C	0.1113	0.1874	0.0633	0.0694	0.1741
INV	0.1381	0.1292	0.2245	0.2353	0.1215
Loans	0.1751	0.2933	0.1126	0.1245	0.2730
N	0.8849	0.2978	2.4948	2.7668	0.2832
NX/Y	0.2093	0.1708	0.2811	0.2900	0.1784
F/Y	0.1377	0.1611	0.1544	0.1553	0.1673
RER	0.0133	0.0260	0.0039	0.0051	0.0241
EXPORT	0.0060	0.0059	0.0077	0.0080	0.0057
IMPORT	0.6980	0.7396	0.9156	0.9561	0.7434

4.4.2 Double Drain Case

If the domestic credit markets are affected directly by international risk premium shocks, a policy stance may result in different implications from those under the external drain case. <Table 4> shows that an active policy stance, in which monetary authority responds to inflation and output gap more aggressively, leads to the best outcome (-0.23% of output loss), though 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 (-0.37%) while an anti-output gap stance is relatively desirable. Under both active and anti-output gap stances, the average level of interest rate is lower and domestic loan and imported intermediate goods decrease less.

<Table 4> Output cost 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	**-0.2830**	**-0.2282**	**-0.3691**	**-0.3773**	**-0.2409**
C	-0.1062	-0.0362	-0.2019	-0.2070	-0.0573
INV	-0.1904	-0.2895	-0.0557	-0.0471	-0.2604
Loans	-0.4378	-0.3529	-0.5714	-0.5852	-0.3715
N	-3.8573	-3.8739	-3.6090	-3.4653	-4.0094
NX/Y	0.0665	0.0749	0.0568	0.0565	0.0720
F/Y	-1.1909	-1.2711	-1.0819	-1.0734	-1.2532
RER	0.0615	0.0717	0.0454	0.0435	0.0696
EXPORT	0.0093	0.0141	-0.0011	-0.0038	0.0151
IMPORT	-0.5488	-0.4667	-0.7035	-0.7272	-0.4755
S.D.(%)					
R	0.0420	0.0526	0.0263	0.0231	0.0536
INF	0.0422	0.0409	0.0389	0.0368	0.0423
Y	0.3459	0.4564	0.2001	0.1758	0.4598
C	0.2450	0.3282	0.1538	0.1447	0.3291
INV	0.1545	0.1764	0.2128	0.2349	0.1723
Loans	0.4649	0.6092	0.2981	0.2792	0.6081
N	1.6113	1.8517	1.9505	2.3502	2.0617
NX/Y	0.2757	0.2585	0.3236	0.3423	0.2565
F/Y	0.2078	0.2564	0.1742	0.1713	0.2735
RER	0.0141	0.0266	0.0134	0.0156	0.0269
EXPORT	0.0119	0.0139	0.0112	0.0120	0.0126
IMPORT	1.0528	1.2392	0.9826	1.0437	1.2485

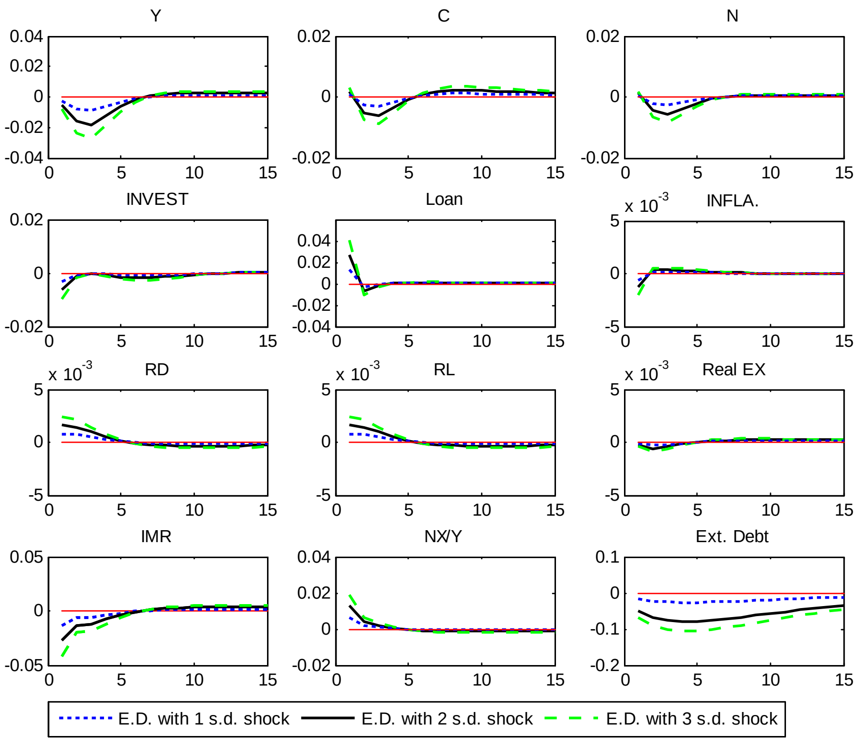
4.4.3 Impulse Responses under the Policy Stance Minimizing Output Loss

In this section, we compare the impulse responses of macro variables under two cases with the optimal policy stance which can minimize output loss in each case. The overall patterns of impulse responses in the model are coincide with those in empirical analysis[17].

[17] See Appendix 2 for the empirical impulse response analysis.

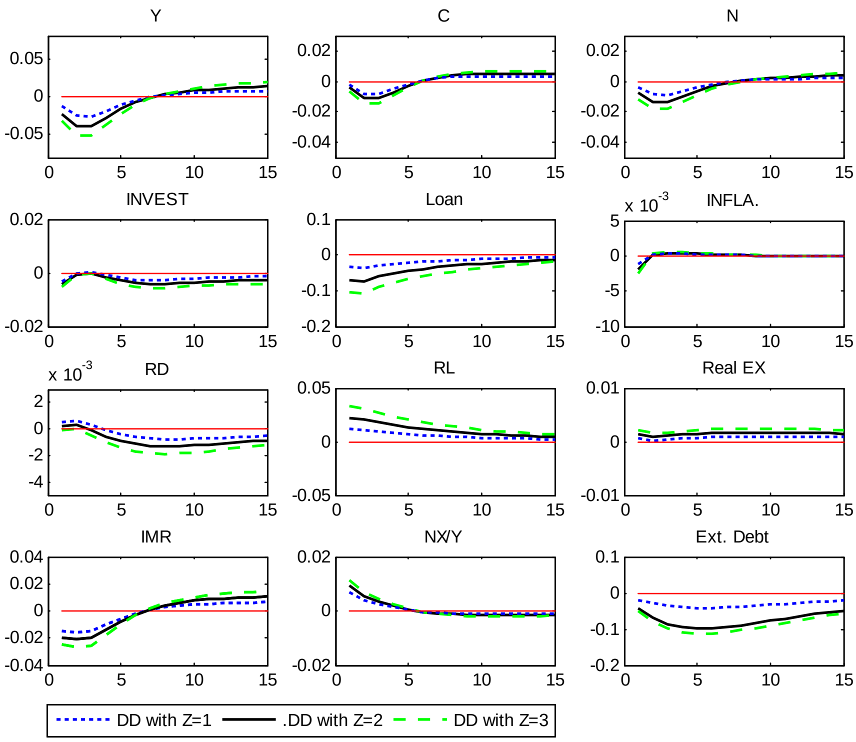
External Drain Case without Contagion When the economy is hit by an external risk premium shock, the target interest rate increases and real economy contracts, while the net exports improve and foreign debt decreases. The reasoning behind the policy responses is as follows. The external risk premium shock is a negative shock in that it increases the cost of acquiring imported intermediate goods necessary to produce, 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., mainly affect the traded good sector. Higher interest rates play a role in giving the economy a buffer to the shock by reallocating input resources from non-traded good sector to 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 a risk premium shock is, the higher interest rate responds as shown in Figure 2. In contrast to Curdia (2007), the real exchange rate appreciates slightly in the present model, hence the adverse effect caused by bigger burden of imports can be suppressed, while exports are not so much affected with the assumption of local currency pricing in exporting behavior.

[Figure 2] Impulse Responses under External Drain Case



Double Drain Case with Contagion What if the international shock is contagious to domestic credit markets? In Figure 3, we compare impulse responses of the cases with three different degrees of contagion from international risk premium shocks into domestic credit crunch shocks. The more the efficiency of financial intermediation is affected by exogenous risk premium shocks, the more likely it is that real economic variables contract, net exports improve and external debt is repaid. However, the target interest rate moves lower with stronger contagion effects, which is contrary to the case of no contagion.

[Figure 3] Impulse Responses under Double Drain Case



4.5 Discussion : Why Different Policy Responses are Required?

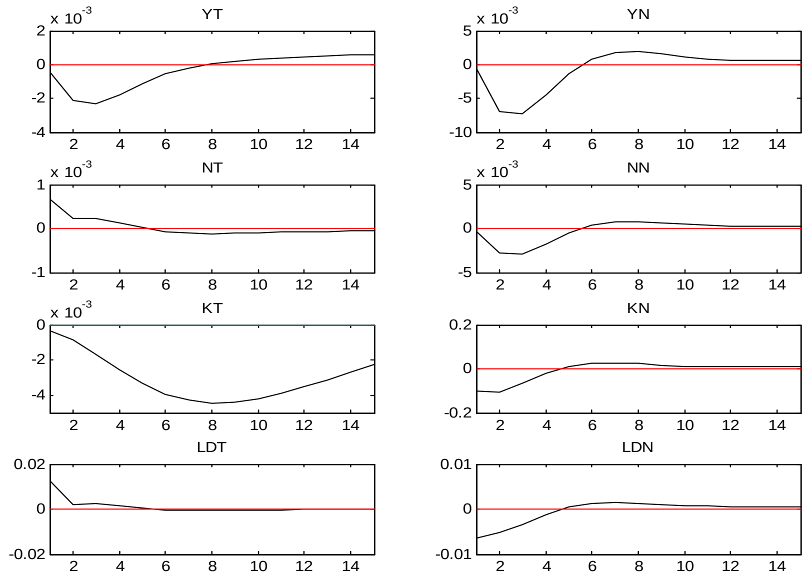
In the previous section, we find that whether financial intermediation of domestic banks is affected or not by international financial shocks could be important in deciding the stance of monetary policy. Under an external drain without contagion, the target interest rate rises responding to a country risk premium shock. The bigger the international financial shock is, the higher the target interest rate must rise. However, under a double drain with contagion into domestic financial intermediation, the target interest rate may rise or drop under an international risk premium shock, depending on the severity of contagion. The more severe the contagion from international financial shocks to domestic credit crunches, the lower the target interest rate should be.

The reason for this difference comes from the nature of the two shocks - external risk premium shocks and domestic credit crunch shocks. A higher domestic interest rate is helpful to mitigate the pressure of exchange rate depreciation and negative effects on the cost of importing intermediate goods under original sin assumption. Furthermore, an increase in loan interest rates plays a role in reallocating natural resources from the non-traded sector into the traded sector which is desirable under an external drain, because traded goods are more valuable for this economy to repay foreign debt and expand net exports upon international financial shocks.

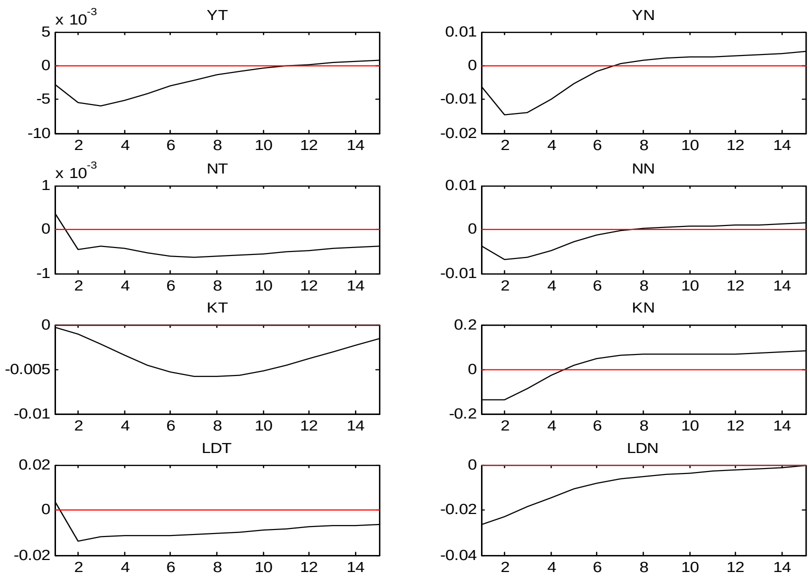
Unlike the risk premium shock, domestic credit crunch shocks affect directly both the traded and non-traded sectors. Hence the negative impacts on the traded and non-traded sector are stronger, the need to reallocate input resource into the traded sector hit by sector specific external risk premium shocks become weaken, and policy response to deterioration of output gap dominates the movement of the target interest rate.

In Figure 4 and Figure 5, the bank loans as well as labor inputs to traded goods sector increase with higher domestic interest rate after a risk premium shock hits the economy, so the sharp contraction in traded goods sector can be mitigated. However, in the double drain case, non-traded goods sector is also facing the (higher) pressure of contraction in output, hence the monetary authority is required to support the production activity in the both sector together, which leads to the validity of lowering the target interest rate. In a double drain case, external risk premium shocks have relatively less impacts on traded good sector because domestic credit crunches also raise the financing cost of common input used in both sectors. As a result, there is less pressure for the economy to move into new contractionary equilibrium under sudden reversal in capital inflows in case of a double drain.

[Figure 4] Impulse Responses in Traded and Non-traded sector : External Drain Case



[Figure 5] Impulse Responses in Traded and Non-traded sector : Double Drain Case



5 *Concluding Remarks*

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

In this paper, we examine the monetary policy implications upon this external shock with focus on its contagion effects on domestic financial intermediation. Our results indicate that monetary authority should consider how much international shocks are transmitted to 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, it would be an appropriate response to increase the target interest rate. However, if the tightening of international credit conditions spreads into domestic credit markets, which means a double drain occurs, monetary easing may be desirable, according to 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.

We do not have an endogenous amplification mechanism of international shocks in the model. Examining which story of the link between external and internal drains is more relevant to a particular economy would be important work to do empirically or theoretically. The inclusion of an amplification mechanism might strengthen the validity of a double drain case.

[References]

Adrian, Tobias and Hyun Shin, 2008, “Liquidity and financial cycles”, BIS Working Papers No 256

Alberto Ortiz, Pablo O. Ceres, F. Sturzenegger and Ernesto T. Ceres, 2007, “Monetary and Fiscal Policies in a Sudden Stop: Is Tighter Brighter?”, Mimeo.

Aurey S. and Feve P., 2005, “Modeling the Liquidity Effect with the Limited Participation Model : A Skeptical View”, Economic Letter 87, 259-265.

Bernanke, B. and M. Gertler, 1989, “Agency Costs, Net Worth, and Business Fluctuations,” American Economic Review, 79, 14–31.

Bernanke, B and A Blinder, 1988, “Credit, Money and Aggregate Demand”, American Economic Review, vol 78, pp 435-9.

Braggion, F., Christiano, L.J. and J. Roldos, 2007, "Optimal Monetary Policy in a Sudden Stop", NBER WP. 13254.

Calvo, G. A. Izquierdo, 1998, "Capital Flows and Capital-Market Crises: The Simple Economics of Sudden Stops", Journal of Applied Economics, November 1(1) pp. 35-54.

Calvo G., A. Izquierdo, and E. Talvi, 2006, “Phoenix Mirales in Emerging Markets: Recovering without Credit from Systemic Financial Crises,” NBER Working Paper No. 12101.

Cepedes, L. F., R. Chang and A. Velasco, 2004, “Balance Sheets and Eschange Rate Policy,” American Economic Review, 94, 1183–1193.

Christiano L.J., 1991, "Modeling the Liquidity Effect of a Money Shock", F.R.B. of Minneapolis, Quarterly Review 15, 3-34.

Christiano, L.J., Gust, C. and J. Roldos, 2004, "Monetary Policy in a Financial Crisis?", Journal of Economic Theory, Vol 119, 64–103.

Cook, David, and Michael B. Devereux, 2006, "Accounting for the East Asian Crisis: A Quantitative Model of Capital Outflows in Small Open Economies", Journal of Money, Credit, and Banking, Vol. 38, No. 3.

Curdia, V., 2007, "Monetary Policy Under Sudden Stops", Federal Reserve Bank of New York Staff Report No. 278.

Edward, Sebastian and Carlos A. Vizgh,1997, "Banks and Macroeconomic Disturbances under Predetermined Exchange Rates", Journal of Monetary Economics 40, 239-278.

Eichengreen, Barryand Ricardo Haussmann, 1999, “Exchange Rates and Financial Fragility” Federal Reserve Bank of Kansas City. New Challenges for Monetary Policy, pp. 329-368.

Elekdag, Selim and Ivan Tchakarov, 2007, "Balance Sheets, Exchange rate Policy and Welfare", Journal of economic dynamics and control 31, 3986-4015.

Gertler, M., S. Gilchrist and F. M. Natalucci, 2007, "External Constraints on Monetart Policy and the Financial Accelerator," Journal of Money, Credit, and Banking.

Hevia, Constantino, 2007, "Optimal Policy with Sudden Stops", mimeo.

Hutchison, Michael M. and Ilan Noy, 2005, "How Bad Are Twins? Output Costs of Currency and Banking Crises", Journal of Money, Credit and Banking 37, 725-752.

________________ , 2006, "Sudden Stops and the Mexican Wave: Currency Crises, Capital Flow Reversals and Output Loss in Emerging Markets", Journal of Development Economics 79, 225-248

Hutchison, Michael M. Ilan Noy and Lidan Wang, 2007, "Fiscal and Monetary Policy and the Cost of Sudden Stops", Working Paper 07-24.

Kashyap, A and J Stein, 2000, "What do a Million Observations on Banks Say about the Transmission of Monetary Policy?", American Economic Review, vol 90, pp 407-428.

Kehoe, T.J. and K.J. Ruhl, 2005, "Sudden Stops, Sectoral Reallocations, and the Real Exchange Rate", Working paper.

Kollmann, R., 2002, "Monetary Policy Rules in the Open Economy:Effects on Welfare and Business Cycles", Journal of Monetary Economics 49, 989-1015

McCallum, B.T., Nelson, E., 2001. "Monetary Policy for an Open Economy:an Alternative Framework with Optimizing Agents and Sticky Prices", Oxford Review of Economic Policy 16,74-91

Mendoza, Enrique G. and Katherine A. Smith, 2006, "Quantitative Implications of a Debt-deflation Theory of Sudden Stops and Asset Prices", Journal of International Economics 70, 82– 114

Miller, Victoria, 1996, "Speculative Currency Attacks with Endogenuously Induced Commercial Bank Crises", Journal of international Money and Finance vol. 15, No.3 383-403

____________ , 1998, "The Double Drain with a Cross-Border Twist: More on the Relationship between Banking and Currency Crises", The American Economic Review, Vol. 88, No. 2.

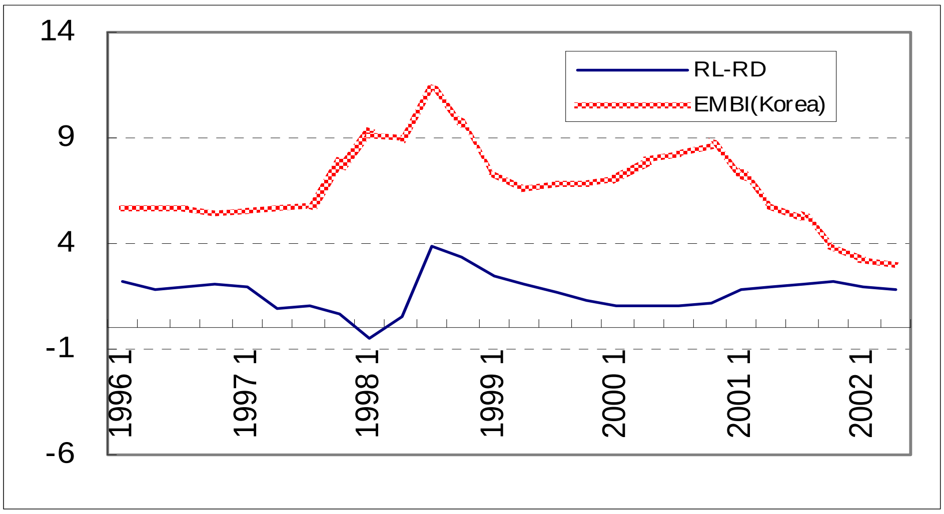
Ortiz, Alberto, Pablo Ottonello, F. Sturzenegger and E. Talvi, 2007, "Monetary and Fiscal Policies in a Sudden Stop : Is Tighter Brighter?".

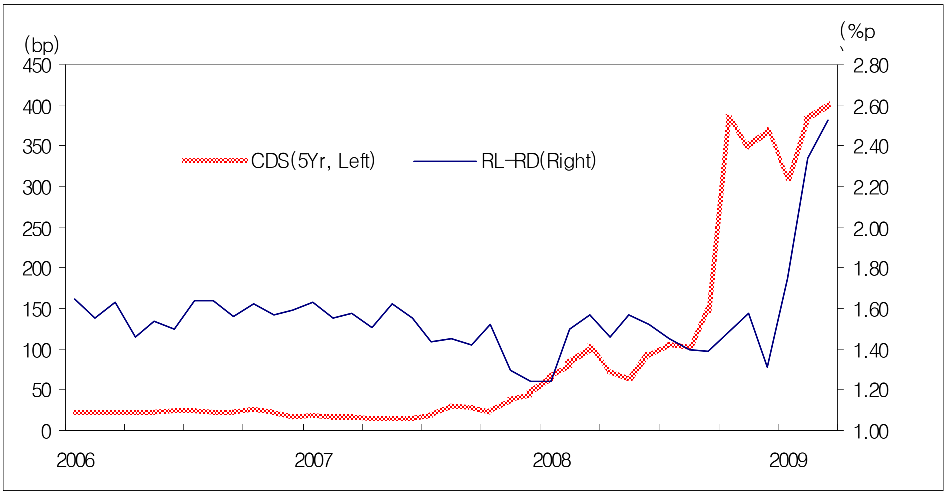
Van den Heuvel, S, 2002, "The Bank Capital Channel of Monetary Policy", Wharton School, University of Pennsylvania, working paper

Woodford, Michael, 2003, Interest and Prices: Foundations of a Theory of Monetary

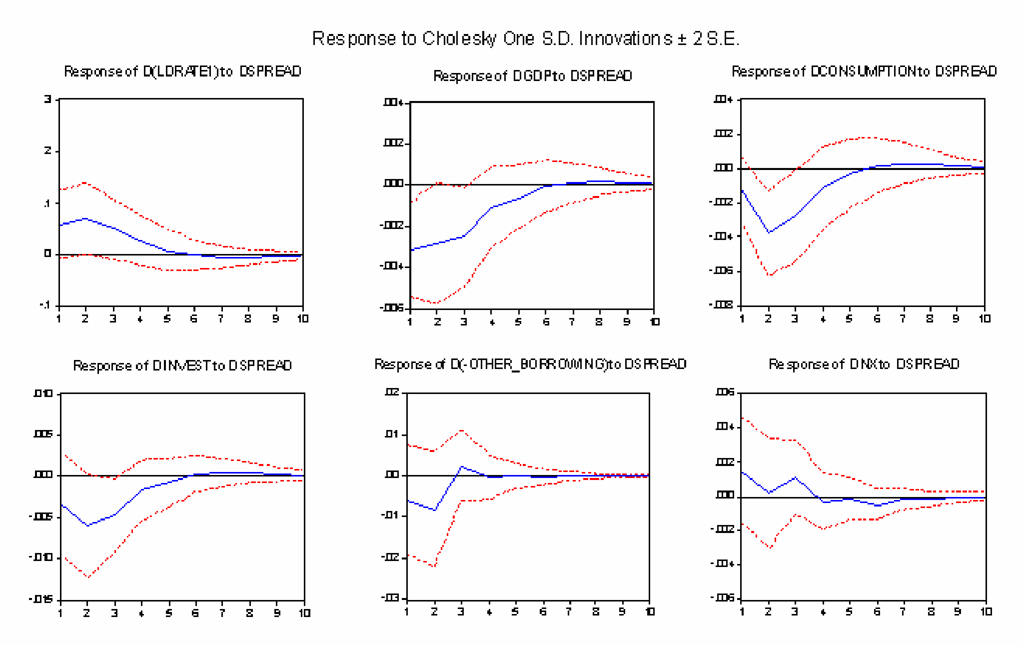
Policy, Princeton University Press.

Appendix 1 : Empirical Evidence of a Double Drain in Korea





Appendix 2 : Empirical Impulse Responses Results from a VAR in Korea



○ Period : 1999.1/4 ~ 2008.3/4

○ Ordering : Risk premium, Loan-deposit rate spread, External debt, Net exports, Consumption, Investment, GDP

○ Lag = 1