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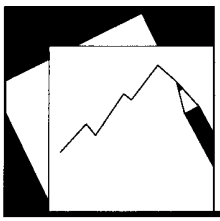

IMF Working Paper

Capital Flows and Economic Fluctuations: The Role of Commercial Banks in Transmitting Shocks

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Capital Flows and Economic Fluctuations: The Role of Commercial Banks in Transmitting Shocks

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Abstract

This paper uses a general equilibrium model to examine the central role played by commercial banks in intermediating and amplifying the capital flow shocks to the local economy in the 1997 Asia financial crisis. It finds that a sudden stop of capital inflows affects the equilibrium credit supply through two channels: first, the plunge of foreign financing decreases the loanable funds directly; and second the sudden stop drives up the cost of providing banking services, thereby additionally reducing the available bank credit to firms through a "deposit run". Empirical results from a VAR model broadly support the theoretical implications.

JEL Classification Numbers: E44; E51; F41

Keywords: Capital Flows; Financial Intermediation; Bank Credit

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Contents

1 Introduction

In July 1997 Thailand devalued its currency and plunged into a deep financial crisis. Even worse, the Baht crisis was just a prelude to the 1997 financial crisis. The devaluation virus spread like a vicious contagion in the area: Indonesia, Malaysia and Korea all soon followed suit, devaluing their currencies and falling into deep recession. This turn of events took the whole world by surprise. Overnight, the once highly applauded Asian miracle turned into a mirage.

In the mid to late 1990s, the Asian economies experienced large fluctuations in foreign capital flows. This boom and bust in capital flows to Asia in the 1990s was intermediated predominately by domestic commercial banks. Leading up to the crisis, the commercial banks channeled capital flows to the domestic economy through expanded bank lending, fueling the credit boom. The onset of the crisis was associated with a massive reversal of the foreign bank flows. This reversal triggered recessions in the affected economics through the sudden stop of bank credit to firms that relied predominately on domestic banks for their financing needs.

Given that, understanding how banks respond to crisis is an important link in explaining the transmission mechanism of the financial crisis. While there has been considerable research developed to explain banks' critical role in inititating and exacerbating financial crisis in developing countries, less attention has been paid particularly to their role in transmitting external financial shock to local economic activities. Furthermore, the existing literature on banks' transmission of capital flow shocks mainly focuses on their effect on the supply side. By contrast, banks' role on the demand side and the interaction between the financial system and the real economy has been largely ignored.

This paper focuses on the central role played by domestic commercial banks in spreading the shock of capital flows to both the demand and supply side of the economy and amplifying the sudden drop in credit(in the form of bank lending) in the 1997 Asia crisis. Playing a pivotal role in the model, the banking sector connects the supply and demand sides by financing its credit through taking deposits from households as well as borrowing abroad. Households need to have demand deposits in banks before carrying out any consumption transactions and firms must borrow from banks to pay labor costs prior to production and the sale of output. In this model, banks operate with a costly technology; the banking cost depends on the size of deposits, credits and foreign bonds as well as an exogenous cost multiplier which captures all other non-operational costs of the banks. The model considers a capital flow shock, in the form of an unexpected plunge of foreign loans to domestic banks, as a negative shock to the cost multiplier of the banking sector. This shock, in our model, drives up the lending spread and the deposit spread via the increased cost of providing banking services. On the demand side, the increase in the deposit spread increases the effective price of carrying out consumption, so that households are forced to reduce their spending, therefore driving down demand deposit. On the supply side, the increase in the lending spread reduces the equilibrium credit, therefore cutting employment and limiting

firms' production.

The model implies that a sudden stop in capital inflows will affect the equilibrium credit supply through two channels. Directly, the abrupt drop of foreign financing is itself a contractionary shock. The resulting collapse of domestic bank funds obtained abroad severely restricts bank lending. Moreover, the drop in demand deposits resulting from the increased deposit spread reinforces the slump in bank credit available to the firms. Banks cut back their lending both because of the fall of foreign funds and a domestic deposit run. Hence,the plunge in credit originating from the capital outflow is amplified by banks' pivotal role in the economy. Figure 1 illustrates the shock transmission mechanism in this model.

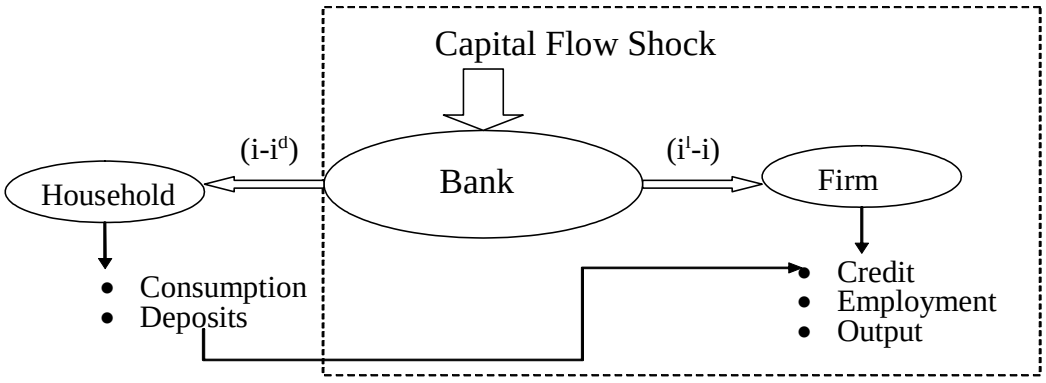

Figure 1: The Pivotal Role of Commercial Banks in Transmitting Capial Flow Shocks

To test the plausibility of these theoretical implications, we apply a VAR model including commercial banks' net foreign liabilities, credit to the private sector, interest rate spread, lending rate, demand depostis, cyclical component of industrial output and the unemployment rate. Findings from Granger causality tests reveal that changes in commercial banks' net foreign liabilities Granger-cause the domestic financial and real activities; while the reverse causality is not supported. Results from the impulse response functions show that, on the impact of shocks to banks' net foreign liabilities (as a proxy for capital flow shocks), interest spreads and lending rates respond negatively; bank credit and demand deposits respond positively. On the other hand, on the impact of interest rate spread shocks, bank credit, deposits, output and employment all respond negatively. In general, the empirical results are consistent with the implications of the analytical framework that banks intermediated and amplified the external financial shock to the local economy in the 1997 Asian financial crisis.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 presents the empirical evidence for the model. Section 4 develops the theoretical model. Section 5 contains the empirical analysis. Secion 6 provides some policy implications. Section 7 concludes.

2 Related Literature

There is a burgeoning number of papers that study financial crises by focusing on the relationship between capital flows and banks' interemediation. Goldfajn and Valdes (1995) shows how changes in international interest rates and capital inflows are amplified by the intermediating role of banks and how such swings may also produce an exaggerated business cycle that ends in bank runs and financial and currency crashes. Chan-Lau and Chen (1998) argues that banking crises occur when banks find it profitable not to monitor their borrowers. In this model, large capital inflows into the banking system can be followed by large outflows even when the "fundamentals " change very little. Agénor and Aizenman (1999) claims that commercial banks transmit the volatility of private capital flows to the domestic economy. The effect of changes in external interest rates can be magnified through credit market inefficiencies which lead to fluctuations in domestic output. Dekle and Kletzer (2001) develops a model of the domestic financial intermediation of foreign capital inflows based on agency costs in order to study financial crises in emerging markets. However, most of those models focus only on the supply side of the economy and fail to take account of some of the interactions between the financial sector and demand side of the economy in a period of capital flow shocks.

This paper is also related to a growing body of literature focusing on the credit channel of the monetary transmission mechanism (Bernanke and Gertler (1995); Kashyap and Stein (1997)). The relationship between bank lending spreads and productive activity has been widely studied in the tradition of the credit channel. Kashyap, Stein, and Wilcox (1993) shows that, in general, tight monetary conditions bring about a widening in the spread between commercial paper and T-bill rates; Gertler, Hubbard, and Kashyap (1991), as well as Friedman and Kuttner (1998) document that an increase in the spread is a good predictor of a subsequent decline in investment and real output. Tornell and Westermann(2002) finds that shocks to the spread between domestic and international interest rates have a strong effect on GDP and a stronger effect on domestic credit. However, there are some aspects not yet explored in the existing credit channel literature, such as, the credit channel in an open economy, the role of foreign liabilities in domestic credit cycles, and the relationship between capital flows and credit channels. As to the recent crises experienced by emerging market economies, commercial banks' role has not been studied widely in most formal theoretical and empirical analysis of shock transmission.

It is important, however, to emphasize that the goal of this paper is not to explain the role of banks in initiating crises[1], but rather to offer a largely ignored but important insight into a different aspect of banks during the crises: the central role of commercial banks' in the shock transmission mechanism from external financial markets to real economic activities; in particular, how the shock of capital flows to the economic activities are intermediated and magnified via the banking sector.

[1] The literature on debt crises(Calvo (1988); Cole and Kehoe (1998)) and bank-runs (Diamond and Dybvig (1983); Chang and Velasco (1998a)) offer important insights on banks' role in causing crises.

3 Empirical Evidence for The Model

3.1 Boom and bust in banking flows

Associated with the enormous loss of economic activity in East Asian crisis economomies were the sudden reversal of foreign capital inflows that were attracted into the region during the 1990s. According to Fig.2, private capital flows to the five crisis economies (Thailand, Malaysia, Indonesia, Korea and Philippines) started to rise sharply in 1994 and reached a record high US$ 76.64 billions in 1996. In 1997, however, net private inflows changed to a net outflow of $11.39 billion, a turnaround of $88 billion or a swing of 10.7% GDP on an average pre-shock GDP of those economies combined from 1990 to 1996 (about $822.37 Billion).

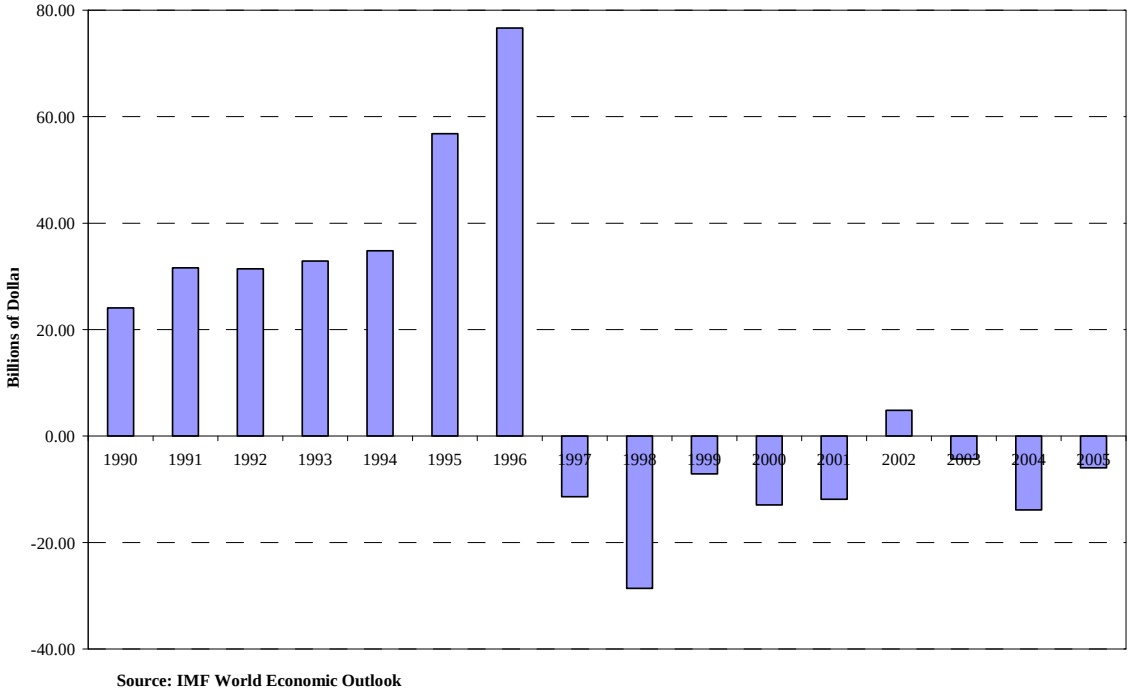

Figure 2: Net Private Capital Flows to Five Asian Crisis Economies (Korea, Malaysia, Indonesia, Thailand and Philippines)

Fig.3 illustrates the breakdown of the reversal of flows for the five Asian crisis countries: the largest swing in capital flows to the affected countries in Asia was bank lending and other investment flows; bank lending flows dominate in this category. The figure shows that banks were not only the largest group of creditors before the Asian crisis (except in year 1993), bank lending was also the most volatile category of capital flows during the crisis. In 1996, net flows from banks into Korea, Malaysia, Philippines and Indonesia accounted for about US$38 billion, or almost half of the total private inflows. In 1997 net inflows from banks had

turned into net outflows of about $30 billion. FDI and portfolio flows, by comparision, have been much more stable. The precipitous decline of almost $88 billion in net private capital flows to Asia in 1997 reflected a $68 billion turn around in bank lending flows and $20 billion in portfolio flows, while FDI flows to the region remained relatively stable.

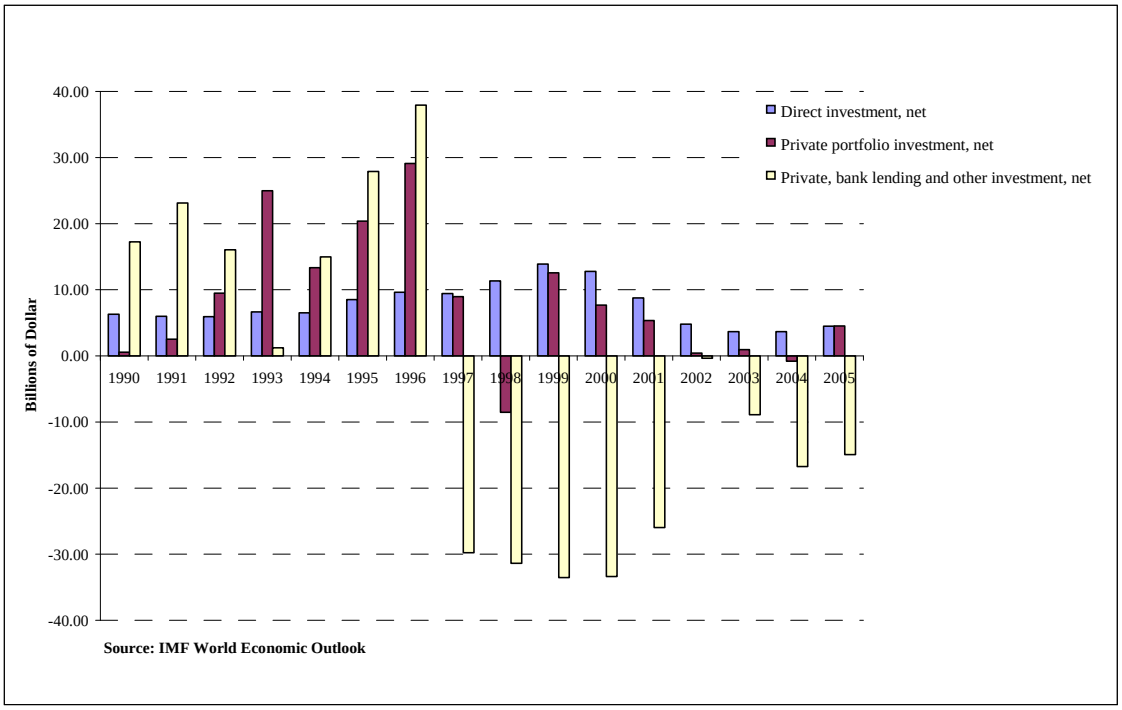

Figure 3: Net Private Capital Flows to Five Asian Crisis Countries by Categories

3.2 Domestic banking system intermediated the capital inflows

At the same time that private capital flows surged into the crisis countries, credit to the private sector expanded very rapidly. As shown by Table 1, deposit money banks' lending to the private sector grew with sustained upwarding trend before the crisis, with average lending growth being more than 20% since 1993 in the five crisis countries. In 1998, the growth rate of credit to the private sector contracted abruptly in four of the five crisis countries[2].

The lending boom is also evident from Table 2 which indicates that: in Korea, the ratio between deposit monetary banks' claims on the private sector and GDP started to rise in 1995, jumping from around 53% of GDP in 1995 to about 60% of GDP in 1996. In Malaysia, the lending to GDP ratio increased moderately from 1990 to 1992, and more strongly from 1993. In Thailand, the lending to GDP ratio kept growing strongly, with a growth rate of 78.84% between 1991 and 1996. In the Philippines, the stock of credit was much smaller(reaching just 29% of GDP in 1993), but credit grew by an average of over 40%

[2]The exception was Indonesia where bank lending was maintained at a high rate until 1998 and start declining in 1999

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Indonesia	17.82	12.29	25.48	22.97	22.57	21.45	29.32	33.22	-55.71	20.01	10.58	17.89	21.09
Korea	20.78	12.55	12.94	20.08	15.45	20.01	21.95	8.46	20.47	19.11	13.88	20.64	8.91
Malaysia	20.58	10.79	10.80	16.04	30.65	26.43	23.61	2.87	1.84	6.11	4.54	6.82	5.84
Philippines	7.30	24.66	40.74	26.52	45.40	48.72	28.79	-6.63	-2.31	5.36	-1.77	0.78	1.10
Thailand	20.44	20.52	24.03	30.26	23.76	14.65	22.21	-7.50	-5.38	-16.01	-10.37	16.69	6.82

Table 1: Annual Growth Rate of Bank Lending to Private Sector

per year from 1993 to 1996, and the ratio of lending to GDP in 1996 was about 218% higher than in 1991. Only in Indonesia did credit growth remain relatively modest.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Malaysia	73.76	73.28	71.05	72.63	83.37	92.41	102.86	105.27	100.96	93.88	100.72	99.50	96.60
Indonesia	45.79	45.51	48.90	51.88	53.48	55.43	60.82	53.21	20.48	21.37	20.62	21.88	23.88
Philippines	17.76	20.44	26.37	29.06	37.53	48.98	56.46	48.00	41.98	39.25	35.61	32.92	30.64
Korea	52.62	52.19	49.82	51.12	50.34	53.71	59.82	65.83	72.50	79.02	83.70	91.81	94.41
Thailand	67.70	72.24	80.14	91.04	97.68	101.68	121.07	114.55	108.14	85.55	73.53	80.88	79.34

Table 2: Bank Lending to Private Sector as a Share of GDP

These data indicate a strong link between capital inflows and lending, especially in Korea, Malaysia and Thailand since 1994, suggesting that domestic banks intermediated the booming capital inflows to domestic economies through expanded bank credit.

3.3 Heavy corporate dependance on domestic bank financing

Asian financial systems are largely bank-dominated, with bank lending playing a crucial role in allocating resources and funding investment.

Table 3 compares the relative importance of equity markets, bank loans and bonds in the financing of corporations in Asian crisis economies and some developed countries. In terms of composition of external financing, Asian crisis countries generally rely more on bank loans than on bond and equity markets. However, there is also considerable variation among countries. The banking sector is particularly important for corporations' external financing in Indonesia, Korea and Thailand. Korea also enjoys the most developed bond markets among the crisis group, as corporations can issue sizable amounts of bonds and commercial paper. The stock market dominates Malaysian firms' external financing because the authorities have aggressively promoted it. Despite these variations, bank credit is the most important of these three sources of financing in 3 of the 5 countries. In sum, this table

confirms that Asian crisis countries relies more on banks and less on bonds and equities than did developed countries. Data in year 2003 suggest that these distinctive characteristics of Asian financial systems have not changed much to this day.

	91-97 Average			2003		
Country	Stock	Bank Credit	Bond	Stock	Bank Credit	Bond
Indonesia	21.14	51.39	0.50	26.24	55.7	1.2
Korea	30.93	64.42	17.68	54.45	105.59	27.11
Malaysia	217.59	123.14	14.54	162.31	152.08	12.92
Philippines	61.68	54.36	0.00	29.25	59.55	0.12
Thailand	62.75	124.30	0.78	83.04	112.99	4.76
Australia	62.33	77.51	10.29	112.08	104.55	24.62
United Kindom	119.74	119.50	11.49	134.41	150.35	15.9

Source: World Development Indicators and Bank for International Settlements
Indicator Descriptions:
Stock: Market capitalization of listed companies (% of GDP)
Bank Credit: Domestic credit provided by banking sector (% of GDP)
Bond: Domesticn Corporate debt securities outstatnding(% GDP)

Table 3: The Financing of Corporations

4 The Model

The model is closely related to the framework used in Edwards and Végh (1997) which seeks to explain the role of the banking sector in amplifying the economic cycles in Mexico and Chile brought about by exchange rate stabilization. In this light, my model stresses the banks' role in transmitting and amplifying external financial shocks to the local economy in the Asian financial crisis. The model assumes an infinite horizon, small open economy with money. In each period, there is an endowment of one unit of a non-tradable good as well as the production of a tradable good that uses labor as its own input. This tradable good is used as the numeraire and all real variables are measured in terms of this good. There is free movement of the tradable good across countries and purchasing power parity holds: $P_t = E_t P_t^*$. Perfect capital mobility implies that $i_t = i_t^* + \varepsilon_t$ where $i_t^* = r + \pi_t^*$(r denotes the real interest rate and π_t^* denotes the foreign inflation rate), and $\varepsilon_t = \frac{\dot{E}}{E}$ denotes the rate of depreciation of the domestic currency. By assuming zero foreign inflation, we obtain $i_t = r_t + \varepsilon_t$.

4.1 The Structure of the Model

The economy is inhabited by four types of agents: households, firms, banks and a government. The households need to use demand deposits to carry out consumption (deposit-in-advance). The firms must borrow from the banks to pay their wage bill prior to production and the sale of output (credit-in-advance). The risk neutral banks provide intermediate

services by receiving deposits from households, issuing bonds abroad and granting credit to firms, as well as holding an amount of reserves in the central bank. Banking is costly in this economy and the operating cost depends on factors both in and outside the economy. We assume there is homogeneity among each type of agent so that we can use a representative agent to stand for each type. The government's role is to set the rate of exchange rate devaluation and the reserve requirement ratio.

The Representative Household (RH) The representative agent has preference over tradable goods, non-tradable goods and leisure. The lifetime utility of the representative household is given by

$$\int_0^\infty U(c_t^T, c_{t,}^N x_t) \exp(-\beta t) dt \tag{1}$$

where $U(.)$ is assumed to be increasing, twice continously differentiable and strictly concave in c_t^T, c_t^N and x_t. c_t^T denotes consumption of tradable goods, c_t^N denotes consumption of non-tradable goods, x_t denotes leisure, and β is the subjective discount rate[3]. The household is endowed with one unit of time in each period, labor supply is thus $1-\ x_t$.The RH can borrow and lend in international capital markets at a constant real interst rate r.

The RH holds two assets: domestic demand deposits d_t and an internationally-traded bond b_t^h. Let $a_t^h = d_t + b_t^h$ denotes the RH's real financial wealth, then the RH's flow budget constraint is given by

$$\dot{a}_t^h = r b_t^h + w_t(1 - x_t) + (i_t^d - \varepsilon_t) d_t + \Pi_t^f + \Pi_t^b + \tau_t - c_t^T - p_t c_t^N \tag{2}$$

where w_t is the real wage rate , i_t^d is the nominal deposit rate. Π_t^f and Π_t^b are dividends from firms and banks respectively, τ_t denotes real lump sum transfers from the government and p_t denotes the relative price of non-tradable goods in terms of tradable goods[4]. Because the demand deposit is held in domestic currency, its real return is $i_t^d - \varepsilon_t$.Throughout the paper, $\dot{x}_t$ denotes $\frac{dx}{dt}$.

Adding and substracting $r d_t$ on the right hand side of Eq.2 and rearrange terms, we get

$$\dot{a}_t^h = r a_t^h + w_t(1 - x_t) + \Pi_t^f + \Pi_t^b + \tau_t - c_t - p_t c_t^N - (i_t - i_t^d) d_t \tag{3}$$

Eq.3 states that at each point of time the RH's income consists of the real return on its financial assets, $r a_t^h$, labor income, $w_t(1-x_t)$, dividends from firms Π_t^f, dividends from banks, Π_t^b, and transfers from the government, τ_t. The RH's expenditure consists of consumption of tradable good, c_t, consumption of non-tradable goods, $p_t c_t^N$, and the oppotunity cost of holding demand deposits, $(i_t - i_t^d) d_t$.

[3]To eliminate trends in the current account we assume that $\beta = r$

[4]Since we assume the price of tradable good is unity, p_t denotes the price of non-tradable goods.

The household faces a deposit-in-advance constraint on consumption purchases. We can think of this as an economy where the RH does not hold any cash and the only way purchases can be made is by using a debit card. The deposit-in-advance constraint requires that the total expenditure on consumption of tradable and non-tradable goods should not exceed the liquidity service provided by demand deposits, i.e.,

$$d_t \geqslant \alpha(c_t^T + p_t c_t^N)^5 \tag{4}$$

Integrating Eq.3 after pre-multiplication by e^{-rt}, imposing transversality condition $\lim_{t\to\infty} a_t^h e^{-rt} = 0$, and taking into account Eq.4, the RH's intertemporal budget constraint is

$$a_o^h + \int_0^\infty \left\{ w_t(1-x_t) + \Pi_t^f + \Pi_t^b + \tau_t - (c_t^T + p_t c_t^N)\left[1 + \alpha I_t^d\right] \right\} \exp(-rt)dt = 0 \tag{5}$$

Here $I_t^d = i_t - i_t^d$ is referred to as the deposit spread. The optimization problem of the RH is to choose equilibrium paths for $\left\{c_{t,}^T c_t^N, x_t\right\}$, to maximize Eq.1 subject to Eq.5 given its initial financial wealth, a_o^h, and a known time paths for $w_t, I_t^d, \Pi_t^f, \Pi_t^b$ and τ_t.

The RH's first order conditions are:

$$U_{c_t^T} = \lambda\left[1 + \alpha I_t^d\right] \tag{6}$$

$$U_{c_t^N} = \lambda p_t\left[1 + \alpha I_t^d\right] \tag{7}$$

$$U_{xt} = \lambda w_t \tag{8}$$

where λ is the time invariant multiplier associated with constraint Eq.5. Eq. 6 and Eq. 7 imply that, at an optimum the RH equates the marginal utility of consumption to the marginal utility of wealth times the effective price of the tradable goods and non-tradable goods respectively. The effective price of one unit tradable good is the sum of its market price (equal to unity plus the oppotunity cost of holding the demand deposits which are needed to purchase one unit of tradable consumption, αI_t^d. The effective price of one unit non-tradable good is the sum of its market price (equal to p_t) plus the oppotunity cost of holding the demand deposits which are needed to purchase one unit of non-tradable consumption, $\alpha p_t I_t^d$. Eq.8 states that, at an optimum, the marginal utility of leisure is equal to the marginal utility of wealth times the real wage. Given the optimal choice of consumption on tradable and non-tradable goods, Eq.4 determines the optimal path of demand deposits.

[5] This is a first order approximation of the actual deposit-in-advance constraint for continuous time. Since the deposit spread is always positive throughout this paper, Eq.4 always holds with strict equality in equilibrium.

The Representative Firm (RF) The RF is assumed to use only labor l_t in the production of tradable goods.The production function is

$$y_t = \eta_t f(l_t) \tag{9}$$

where $f(l_t)$ is assumed to be increasing and concave in l_t. y is tradable output and η is a productivity shock.

The RF is assumed to face a "credit-in-advance" constraint in the sense that the RF must use bank credit to pay the wage bill before production and the sale of output. Formally,

$$z_t \geq \gamma w_t l_t, \gamma > 0 \tag{10}$$

Here z_t denotes the real stock of bank credits[6].

The RF may also hold foreign bonds, b^f, at an interest rate of r. Thus the real net financial assets of the RF at time t is given as follows:

$$a_t^f = b_t^f - z_t \tag{11}$$

Using i^l to denote the lending rate charged by banks we can write the firm's flow constraint as follows:

$$\dot{a}_t^f = rb_t^f + y_t - w_t l_t - (i_t^l - \varepsilon_t)z_t - \Pi_t^f \tag{12}$$

where w_t is the real wage rate , i_t^l is the nominal lending rate and Π_t^f are dividends paid to the RH. Because the credit is held in domestic currency, the real cost of it is $i_t^l - \varepsilon_t$.

Letting $I^l \equiv i^i - i$ denotes the lending spread , using Eq.11 and the identity $i_t = r_t + \varepsilon_t$, we can rewrite the RF's flow budget constraint as

$$\dot{a}_t^f = ra_t^f + y_t - w_t l_t - I_t^l z_t - \Pi_t^f \tag{13}$$

Eq.13 states that, at each point of time, the RF's income consists of the real return on its financial assets, ra_t^f, and revenue from the sale of output, y_t. The RF's payment consists of the wage bill, $w_t l_t$, dividends to the RF, Π_t^f, and the financial cost, $I_t^l z_t$, incurred by the firm for using bank credit to pay the wage bill. Integrating forward Eq.13, imposing the no-Ponzi game condition, $\lim_{t\to\infty} a_t^f e^{-rt} = 0$, and taking into account Eq.9 and Eq.10, the present discounted value of the RF's dividends can be written as

$$\underset{l_t}{Max} \int_0^\infty \Pi_t^f \exp(-rt)dt = a_0^f + \int_0^\infty [\eta_t f(l_t) - w_t l_t(1 + \gamma I_t^l z_t)] \exp(-rt)dt \tag{14}$$

The RF chooses a path of l_t to maximize the present discounted value of dividends, which is given by the right hand side of Eq.14 taking as given the paths for w_t, I_t^l and the initial stock of financial assets a_0^f. The first-order condition for this problem is given by:

[6]As will be seen later, since the lending spread $(i^l - i)$ is non-negative, the credit-in-advance constraint will always hold as an equality.

$$\eta_t f'(l_t) = w_t \left[1 + \gamma I_t^l\right] \tag{15}$$

Eq.15 shows that, at the optimum, the RF equates the marginal productivity of labor to the marginal cost of an additional unit of labor, which is the sum of the real wage, w_t, plus the associated financial cost, $w_t \gamma I_t^l$, which is incurred due to the fact that firms have to borrow from banks to finance the wage bill.

The Representative Bank (RB) Playing a crucial role in this economy, the RB finances itself both domestically (through taking deposits from the RH) and externally (by issuing bonds in international capital markets), lends to the RF and holds reserves in the central bank. The RB charges an interest rate of i^l to the RF and pays households an interest rate i^d on demand deposits. The net wealth of the RB are:

$$a_t^b = -b_t^* + h_t + z_t - d_t \tag{16}$$

where b_t^* denotes the RB's net foreign liabilities and h_t denotes the RB's required cash reserves in the central bank. Banking is costly[7] in this economy and the cost of providing banking services consists two parts: the operational costs[8] and the non-operational costs. The operational costs depend on the size of deposits, loans, and foreign bonds. And the non-operational costs are captured by an exogenous multiplier ξ_t, called the cost multiplier in this paper. ξ_t is affected by many factors such as credit market efficiency, banks' perception of risk (default risk and macroeconomic risk), financial liberalization and contagion. The lower the banking cost, the higher the productivity of providing banking services. The RB's cost function is:

$$\Psi_t = \xi_t \phi(b_t^*, z_t, d_t) \tag{17}$$

where $\phi(.) > 0, \phi_z > 0, \phi_d > 0, \phi_{b^*} > 0, \phi_{zz} > 0, \phi_{dd} > 0, \phi_{b^*b^*} > 0, \phi_{zd} < 0, \phi_{zb^*} < 0, \phi_{db^*} > 0$. For $b^* > 0, z > 0$ and $d > 0$, it also satisfies, $\phi(0, 0, b^*) = 0, \phi_z(0, d, b^*) = 0$, and $\phi_d(z, 0, b^*) = 0$.

Thus, the marginal costs of providing credit, accepting deposits and issuing foreign debt are positive and rise with an increase in the stock of loans, deposits and foreign liabilities respectively. The negative cross partial derivative between loans and deposits indicates that there is complementarity in the production of credits and deposits. As a result the marginal cost of granting credit increases for the bank if the amount of deposits decreases[9]. The negative cross partial derivative between foreign loans and bank credit indicates that the marginal cost of extending loans to firms decreases when banks can get more funds abroad.

[7] Variations of "costly banking" can be found in Fischer (1983), Lucas (1993), Diaz-Gimenez et al (1992) and Edwards and Végh (1997.)

[8] Operational costs include banks' costs in evaluating creditors, managing deposits, monitoring loans, renting buildings, maintaining ATM's and etc.

[9] This may reflect the fact that the amount of deposits provide useful information on borrowers which makes it less costly for banks to monitor loans.

The positive cross partial derivative between deposits and foreign bonds indicate that they are substitutes with each other and therefore the cost of taking deposits increases if the RB can borrow more abroad.

Contagion, Capital flows and the cost multiplier ξ_t In this paper, sudden capital outflows caused by international financial contagion[10] negatively affect ξ_t due to the increase of banks' perceved risk of macroeconomic instability. We conjectured the the cost multiplier ξ_t increased abruptly at the onset of the crisis through the following scenes of events: the sudden capital outflow in 1997 reflected a sudden reversal of market sentiment regarding a country's economic outlook which is assumed to drive up commercial banks' intermediation costs, reduce banking productivity, thus induce a higher cost multiplier ξ_t. This view is consistent with a more general interpretation of external shocks, which is reflected in the sharp increase in interest spreads on liabilities issued by banks in the immediate aftermath of the Asian financial crisis[11].

The central bank imposes a reserve requirement ratio $\delta > 0$ on the RB's demand deposits. Since required reserves do not earn interest, at an optimum the RB will not hold any excess reserves. Hence, the RB's required cash reserves is given by :

$$h_t = \delta_t d_t \tag{18}$$

The flow constraint faced by the bank is then given by:

$$\dot{a}_t^b = -rb_t^* + (i_t^l - \varepsilon_t)z_t - (i_t^d - \varepsilon_t)d_t - \varepsilon_t h_t - \Psi_t - \Pi_t^b \tag{19}$$

where rb_t^* is the interest payments on bonds issued to foreigners, $(i_t^l - \varepsilon_t)z_t$ is the real return on lending to the firm, $(i_t^d - \varepsilon_t)d_t$ is the real interest payment on demand deposits and $\varepsilon_t h_t$ is the oppotunity cost for holding cash reserves in domestic currency.

Using Eq.16 and rearranging terms by using the identities $(i_t^l - \varepsilon_t) = r + (i_t^l - i_t)$ and $(i_t^d - \varepsilon_t) = r - (i_t - i_t^d)$, we can rewrite Eq.19 as

$$\dot{a}_t^b = ra_t^b + I_t^l z_t + I_t^d d_t - i_t h_t - \Psi_t - \Pi_t^b \tag{20}$$

Eq.20 shows that at each point of time, the RB's revenue consists of the real return on its financial assets, ra_t^b, the net gains on lending to the firms, $I_t^l z_t$ [12] and the net gains on

[10] Furman and Stiglitz (1998) and Radelet and Sachs (1998) argue that although some fundamentals may have worsened in the mid 1990s, the extent and depth of the crisis can be attributed not to a deterioration of fundamentals but rather to the panicky reaction of anxious domestic and foreign investors.

[11] There are similar assumptions in the literature: Agenor (1999) assumes contagion exogenously affects the external lending premium negatively; Gertler, Gilchrist and Natalucci (2003) represent a sudden capital outflow as a positive jump in the country's borrowing premium.

[12] The real return on a unit of credit is $i_t^l - \varepsilon_t = r + (i_t^l - i_t)$, so the term $I_t^l \equiv i_t^l - i_t$ denotes the real return on bank credit in excess of the world real interest rate. In other words, since banks can always lend to the rest of the world (by buying bonds) at the rate $i_t, i_t^l - i_t$ is the spread earned by banks from lending domestically.

borrowing from the households, $I_t^d d_t$[13]. The RB's payment also consists of three parts: the opportunity cost for holding cash $i_t h_t$, the operating cost of providing banking services Ψ_t, and its dividends to the RH, Π_t^b.

Integrating forward Eq.20 and imposing the no-Ponzi games condition $\lim_{t\to\infty} a_t^b e^{-rt} = 0$:

$$\underset{l_t}{Max} \int_0^\infty \Pi_t^b \exp(-rt)dt = a_0^b + \int_0^\infty [I_t^l z_t + I_t^d d_t - i_t h_t - \xi_t \phi(b_t^*, z_t, d_t)] \exp(-rt)dt \tag{21}$$

The RB maximizes its profit function Eq. 21 by choosing sequences of $\{z_{t,} h_t, d_t\}$ subject to Eq.18 and taking as given the paths of I_t^d, I_t^l, δ_t and i_t. Assuming interior solutions, the first order conditions for the bank's optimization problem are as follows:

$$I_t^l = \xi_t \phi_{z_t}(b_t^*, z_t, d_t) \tag{22}$$

$$I_t^d = \delta_t i_t + \xi_t \phi_{d_t}(b_t^*, z_t, d_t) \tag{23}$$

From the previous two equations several features are evident. First, as follows from Eq.22, the marginal cost of extending bank credit is positive, therefore, the lending spread $(i_t^l - i_t)$ is positive and the lending rate, i_t^l will always be above i_t. Second, because the marginal cost of taking more deposits is positive (follows from Eq.23), the deposit spread is positive $(i_t - i_t^d)$ and the deposit rate, i_t^d, will always be below the cost of funds (adjusted by the required reserves ratio), $i_t(1-\delta)$). Third, both the lending spread $(i_t^l - i_t)$ and the deposit spread $\left(i_t - i_t^d\right)$ increase with the cost multiplier ξ_t, so that, the interest rate spread, $(i_t^l - i_t^d)$=I_t^l+ I_t^d, will also increase when banking costs increase[14].

To simplify the analysis, the RB is assumed to finance its operations only through retained earnings and that its initial net assets are zero (which implies that $a_t^b = 0$ for all t). It then follows from Equations 16 and 18 that

$$z_t = b_t^* + (1-\delta)d_t \tag{24}$$

The above equation states that the RB is financing its lending activities both domestically through taking demand deposits and by issuing bonds in international capital markets. At an optimum, both sources of financing are equally costly.

[13]The interest rate paid on deposits (in real terms) is $(i_t^d - \varepsilon_t) = r - (i_t - i_t^d)$. In equilibrium, $i_t^d < i_t$.Therefore, the term $i_t - i_t^d$ indicates the gain to the bank (in real terms) from paying depositors less than the world real interest rate. In other words, since banks can always borrow from the rest of the world (by selling bonds) at the rate $i_t, i_t - i_t^d$ is the spread earned by banks from borrowing domestically at a lower cost.

[14]Hence, the wedge $(i_t^l - i_t^d)$ can be used as a proxy for ξ_t in the empirical analysis.

The Government The government comprises the monetary and the fiscal authority. The monetary authority (the central bank) issues high powered money, h, which is held by banks in the form of cash reserves and holds interest bearing foreign reserves. It also sets the path of the devaluation rate, ϵ_t ,and the reserve-requirement ratio, δ_t. On the fiscal side, the government receives interest on its net foreign assets, collects revenues from money creation, and gives lump-sum transfers to households. The consolidated government's flow budget constraint is given by:

$$\dot{b}_t^g = rb_t^g + \dot{h}_t + \epsilon_t h_t - \tau_t + \xi_t \phi(b_t^*, z_t, d_t)^{15} \tag{25}$$

The government's lifetime constraint is got by integrating Eq.25 forward and taking into no-Ponzi games condition $\lim_{t\to\infty} b_t^g e^{-rt} = 0$:

$$\dot{b}_0^g + \int_0^\infty [\dot{h}_t + \epsilon_t h_t - \tau_t + \xi_t \phi(b_t^*, z_t, d_t)] \exp(-rt)dt = 0 \tag{26}$$

4.2 Equilibrium Conditions

Labor market equilibrium implies that:

$$1 - x_t = l_t \tag{27}$$

The clearing of the non-tradable goods market means:

$$c_t^N = y_t^N \tag{28}$$

Perfect capital mobility requires that the interest parity condition holds:

$$i_t = i_t^* + \varepsilon_t = r_t + \varepsilon_t \tag{29}$$

By combining the flow constraints of the four agents, given by Equations 2, 13, 20 and 25 respectively, and taking into account Equations 9, 27 and 28, the economy's lifetime resource constraint follows

$$k_0 + \int_0^\infty \eta_t f(l_t) \exp(-rt)dt = \int_0^\infty c_t^T \exp(-rt)dt \tag{30}$$

where $k_0 = b_0^h + b_0^f + b_0^g - b_0^*$ denotes the economy's initial net stock of foreign bonds.

[15] Here we assume that banking cost is a private cost, not a social cost. Making banking cost a social cost will produce welfare effects that complicate the model without important implications in this paper.

4.3 Perfect foresight equilibrium

Assuming log utility funtion $U(c_{t,}^T c_t^N, x_t) = \log(c_t^T) + \log(c_t^N) + \log(x_t)$, linear production function $y_t = \eta_t f(l_t) = \eta_t l_t$ and banking cost function of the form: $\Psi_t = \xi_t \phi(z_t, d_{t,} b_t^*) = \xi_t \sqrt{z_t^2 + (d_t + b_t^*)^2}$. If for all $t \in [0, \infty)$, we have that $\varepsilon_{t,}$ i_t^*, δ_t and ξ_t are perfectly known by all agents in this economy, the following equations characterize the equilibrium of the economy:

$$\frac{1}{c_t^T} = \lambda \left[1 + \alpha I_t^d\right] \tag{31}$$

$$\frac{1}{p_t c_t^N} = \lambda \left[1 + \alpha I_t^d\right] \tag{32}$$

$$\frac{1}{1 - l_t} = \lambda w_t \tag{33}$$

$$\eta_t = w_t[1 + \gamma I_t^l] \tag{34}$$

$$I_t^l = \xi_t \phi_{z_t}(\frac{z_t}{d_t + b_t^*})^{16} \tag{35}$$

$$I_t^d = \delta_t i_t + \xi_t \phi_{d_t}(\frac{d_t + b_t^*}{z_t})^{17} \tag{36}$$

$$k_0 + \int_0^\infty \eta_t f(l_t) \exp(-rt) dt = \int_0^\infty c_t^T \exp(-rt) dt \tag{37}$$

$$c_t^N = y_t^N \tag{38}$$

$$z_t = \lambda w_t l_t \tag{39}$$

$$d_t = \alpha(c_t^T + p_t c_t^N) \tag{40}$$

Given the intial condition of k_0, and the path of $\varepsilon_{t,} \delta_t$, ξ_t, η_t, y_t^N, all of the endogenous variables $(\mathrm{c}_{t,}^T c_t^N, p_t, w_{t,} I_t^d, I_t^l, l_{t,} z_{t,} d_t, \lambda)$ can be derived from the above equations.

---

[16] $\phi_{z_t}(z_{t,} d_t, b_t^*) = \frac{\partial \sqrt{z_t^2 + (d_t + b_t^*)^2}}{\partial z_t} = \frac{1}{\sqrt{(\frac{d_t + b_t^*}{z_t})^2 + 1}} = \phi_{z_t}(\frac{z_t}{d_t + b_t^*})$

[17] $\phi_{d_t}(z_t, d_t, b_t^*) = \frac{\partial \sqrt{z_t^2 + (d_t + b_t^*)^2}}{\partial d_t} = \frac{1}{\sqrt{(\frac{z_t}{d_t + b_t^*})^2 + 1}} = \phi_d(\frac{d_t + b_t^*}{z_t})$

Equilibrium equations for the supply side of the economy In this section, we derive some main endogenous variables of the supply side of the economy to examine the relationship between the lending rate and the supply side of this economy.

Rearrange Eq.34 as

$$w_t = \frac{\eta_t}{1+\gamma I_t^l} \tag{41}$$

Using Eq.33 and Eq.34 to get

$$l_t = 1 - \frac{1+\gamma I_t^l}{\lambda \eta_t} \tag{42}$$

The expression of z_t then follows

$$z_t = \gamma w_t l_t = \gamma(\frac{\eta_t}{1+\gamma I_t^l} - \frac{1}{\lambda}) \tag{43}$$

Output can also be written as a function of the lending spread

$$y_t = \eta_t l_t = \eta_t - \frac{1}{\lambda}(1+\gamma I_t^l) \tag{44}$$

The above four equations show that an increase in the lending spread will lead to a decline in the wage rate, employment, bank credit and output.

Partial equilibriums in credit and deposit markets Since in the model, the credit and deposit markets play a key role in the shock transmission mechanism, it is useful to study them in some detail here.

The demand function of bank credit can be derived from the RF's credit-in-advance constraint (Eq.10) and the RF's first order condition (Eq. 15),

$$I_t^l = \frac{\eta_t}{\frac{1}{\lambda\gamma} + \frac{z_t}{\gamma^2}} - \frac{1}{\gamma} \tag{45}$$

The RF's demand for bank credit is an inverse function of the lending spread (the downward-sloping curve in panel A of Fig.4). Because a higher lending spread leads to a lower real wage (Eq.41) and a lower labor supply (Eq.42) which in turn leads to a lower wage bill being financed by bank credits (Eq.43).

The supply function of bank credit can be viewed as implicitly determined by the RB's first order condition Eq.22

$$I_t^l = \xi_t \phi_{z_t}(\frac{z_t}{d_t + b_t^*}) \tag{46}$$

It is an upward-sloping curve as in Panel A of Fig.4. Because for a given level of deposits and foreign bonds, banks will extend more credit only when the lending spread increases.

For a given level of deposits, Equations 45 and 46 together determine the equilibrium lending rate and credit (point E_1 in the Panel A of Fig.4).

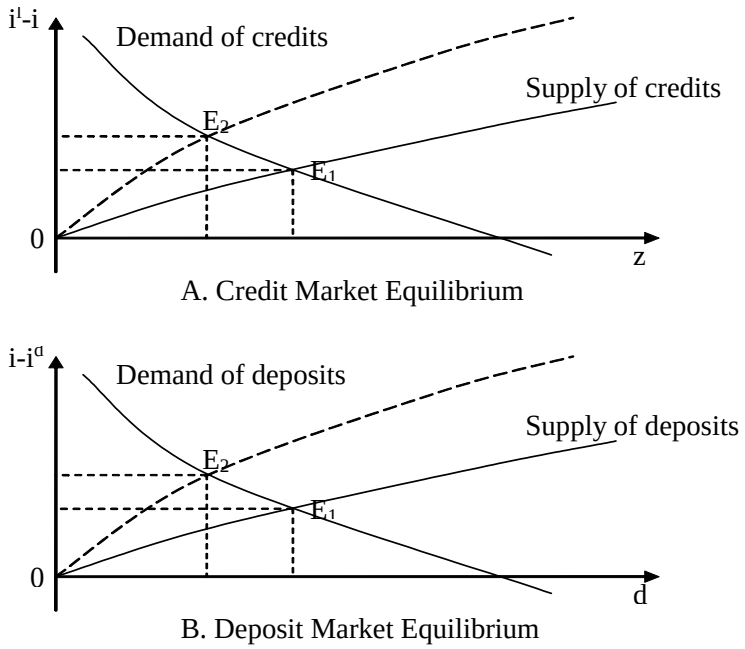

Figure 4: Equilibrium in Credit and Deposit Markets

Similarly, the RH's demand function of demand deposits can be derived from Equations 31, 32 and 40 as follows

$$I_t^d = \frac{1}{\lambda d_t} - \frac{1}{\alpha} \tag{47}$$

The RH's demand for deposits is an inverse function of I_t^d. Because the higher the deposit spread, the higher the oppotunity cost of consumption, therefore the RH will reduce its consumption and demand deposits.

The supply function of demand deposits can be viewed as implicitly determined by the RB's first order conditon Eq.23

$$I_t^d = \delta_t i_t + \xi_t \phi_{d_t}(\frac{d_t + b_t^*}{z_t}) \tag{48}$$

Eq.48 is an upward sloping curve because for a given level of credits and foreign bonds, the higher the deposit spread, the higher the gain to banks borrowing from households, therefore banks would like to take more deposits from households. For a given level of credits, Eq.47 and Eq.48 together determine the equilibrium demand deposits and deposit spread (point E_1 in the Panel B of Fig.4).

4.4 Sudden stop and banks' amplification

Suppose now there is a sudden stop in capital inflows (in other words, foreign creditors suddenly refuse to lend to domestic banks or a decrease of b^*) triggered by an international

financial contagion. This sudden stop is assumed to signal increased macroeconomic risk of this economy, which leads to an increase in ξ_t. The following proposition shows how this shock will affect economic activities.

Proposition 1 *Consider a perfect foresight equilibrium path along which* $i_t^* = i^*, \varepsilon_t = \varepsilon, \delta_t = \delta, \eta_t = \eta, y_t^N = y^N$ *for all* $t \in [0, \infty)$, *if for some* $t \in [T,\ 2T]$, b^* *decreases, then,* I^l *and* I^d *increase.*

Proof. See appendix. ■

This proposition says that during a "sudden stop", both lending and deposit spreads will be high. It is then easy to characterize the response of all other relevant variables (illustrated in Fig.5).

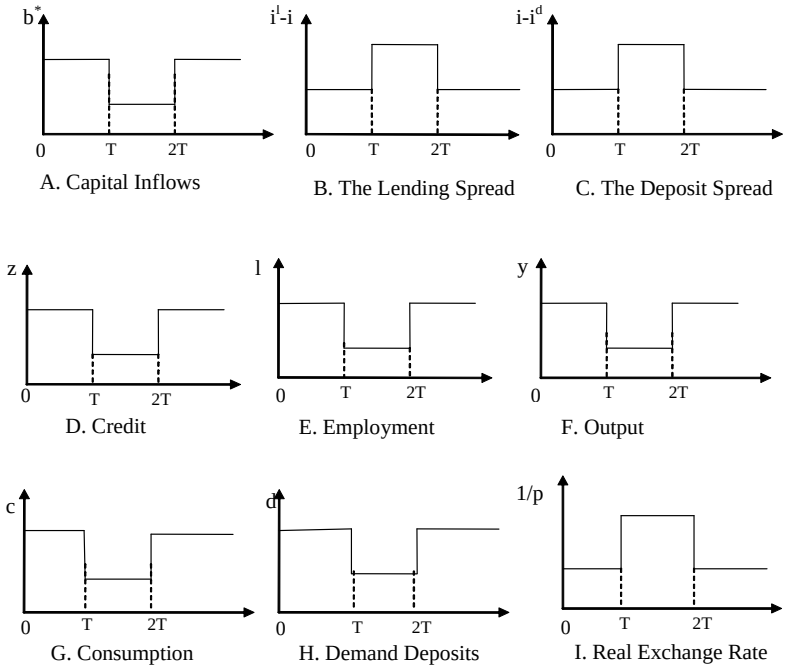

Figure 5: Shocks to Capital Flows

A higher lending spread ($i_t^l - i_t$) results in a lower real wage (Eq.41), lower employment (Eq.42) and a lower level of real credit in the economy (Eq.43). On the other hand, a higher deposit spread ($i_t - i_t^d$) implies a higher opportunity cost of consumption, and thus a decrease in equilbrium purchases of both tradable goods and non-tradable goods (Eq.31). The reduction of consumption, through the deposit-in-advance constraint (Eq.4), reduces the demand for deposits. Households thus withdraw deposits from the banking sector[18].

[18]It is worth to note that without resorting to asymmetric information, incomplete market and moral hazard which are traditionally used to generate a "deposit run" during crisis, this general equilibrium model of a small open economy is able to derive the same result in the period of a sudden stop of capital inflows.

Because non-tradable consumption c_t^N is assumed to be equal to the constant exogenous non-tradable output y^N, the price of non-tradable p_t must fall (Eq.32) which implies that the real exchange rate ($1/p_t$) depreciates. The intuition is that when the effective price of consumption increases, the relative price of non-traded goods must decrease (i.e. the real exchange rate must depreciate) to equilibrate supply and demand.

Intutitively, a lower b^* increases banking costs directly. In terms of Fig.4, it shifts both the credit supply and deposit supply curves upward. To clear the credit market, the lending spread must increase which reduces the credit to firms and leads to lower employment and output; on the deposit market, similarly, the supply of deposit shifts upward which results in an increase of the deposit spread and a decrease of deposits in equilibrium.

In conclusion, a sudden drop of b^* not only imposes a direct negative effect on z_t, it also affects z_t indirectly through the reduction of demand deposits (or a deposit run), thus reinforcing the decline of the available bank credits to the firm[19]. Therefore, the fluctuations of capital flows are further amplified by the banking system through transmitting shocks to both sides of domestic economic activities.

4.5 Reserve requirement as a countercyclical policy tool

The use of reserve requirement during episodes of capital inflows or outflows is a popular policy topic of discussion. It has been argued in Calvo et al. (1993) that raising reserve requirements during episodes of capital inflows might help in preventing the resulting credit boom and the real exchange rate appreciation. Almost all Asian crisis countries use reserve requirements as a countercyclical policy tool. The following proposition shows the use of lower reserve requirements in injecting liquidity into the banking system and mitigating the credit crunch, thereby cousioning the economy from the sudden capital outflow.

Proposition 2 *Consider a perfect foresight equilibrium path along which* $i_t^* = i^*, \varepsilon_t = \varepsilon, \delta_t = \delta, \eta_t = \eta$ *for all* $t \in [0, \infty)$. *If for some* $t \in [T, 2T]$, b^* *decreases(capital outflows), if* δ_t *is reduced,* I_t^l *can be kept constant, but* I_t^d *will decrease.*

Proof. See appendix. ■

At the time of a sudden stop, if reserve requirement δ_t can be lowered to boost d_t and hence make up the drop of b_t^*, thus lowering $\frac{z_t}{d_t + b_t^*}$ to the point where the fall of marginal cost of extending credit exactly offsets the rise in ξ_t, the lending spread can be kept constant and the negative effect on credits may be alleviated to some extent, if not completely.

If we can find a policy tool to insulate both z and d during shocks, it will be the optimal choice. However, since the shock hit the banking system directly, it is impossible to insulate both sides of the economy. By this proposition, while lending spreads can be kept constant during the periods of capital flight, consumption and deposits will increase due to the lower deposit spreads.

[19] This argument is clear from the RB's balance sheet identity (Eq.24): $z_t = b_t^* + (1 - \delta_t) d_t$.

5 Empirical Analysis

In this section, we apply Granger causality tests and VAR analysis to see whether the empirical results support the implications derived from our theoretical model.

5.1 Granger causality

The aim of the Granger causality test is to examine the causal relationship across capital flows, domestic financial variables and real activities. This investigation will reveal whether prior movements of capital flows influence the development of domestic financial variables, such as lending rates, interest rate spreads, real claims, and demand deposits. An important implication of the analytical model is that capital flows manifeste themselves in lending by banks; therefore it is important to test if the lending rate Granger causes domestic credit, output, and employment. This involves a series of bivariate Granger causality tests, where the estimated equations are of the form:

$$Y_t = \eta + \Sigma_{i=1}^{m} \delta_i Y_{t-i} + \Sigma_{i=1}^{m} \mu_i X_i + \nu_t \tag{49}$$

Variables tested are net foreign liabilities, lending rates, interest spreads, credit, deposits, the cyclical component of industrial production and the unemployment rate. We compute F-tests for the null hypothesis of the non-Granger causality of the X and Y and calculate the marginal significance levels (p-values) for the bi-variate Granger causality tests for lag length 3[20]. The smaller the p-value, the stronger the predictive content of the X for Y. The results obtained are summarized in Table 4.

As can be seen, the null hypothesis that net foreign liabilities Granger cause real credit, deposit rates, and lending rates cannot be rejected at significant levels; reverse Granger-causality, on the other hand, is rejected. Further as predicted by the analytical model, lending rates precedes real credit, employment and real output(proxied by industrial production). The Granger causation between lending rate and wage earning, however, cannot be decided from the tests.

5.2 VAR analysis

A vector autoregression (VAR) model captures time-series data on multiple variables in the form of a system in which they mutually affect one another, either simultaneously or with a time lag. In this section, using VAR analysis, we examine the dynamic responses of some key variables to capital flows. The model is estimated with monthly data of Korea from January 1994 through December 1999. According to the model, the interest rate spread is considered to be a proxy of banking costs, and it is the increase in the lending spread which affects credit, output, employment and wage earnings. The analysis, therefore, was carried out in two stages. First, we investigate the way in which capital flow shocks affect lending rates, lending spreads, deposits and bank credit. Next, we analyzed how shocks to

[20] The results remain robust even we change the length of lags to 2, 4 or 5.

Null Hypothesis	F-Statistic	Probability
Foreign liability does not cause real credit	4.17888	0.00764
Real credit does not cause foreign liability	0.97155	0.40894
Foreign liability does not cause deposit rate	22.743	1.60E-11
Deposit rate does not cause foreign liability	0.79021	0.50187
Lending rate does not cause foreign liability	1.50744	0.21663
Foreign liability does not cause lending rate	10.4901	4.00E-06
Lending rate does not cause real credit	3.67347	0.01443
Real credit does not cause lending rate	0.0784	0.97158
Lending rate does not cause industrial production	6.23338	0.0006
Industrial production does not cause lending rate	1.28526	0.28309
Wage earning does not cause real credit	1.26763	0.2891
Real credit does not cause wage earning	5.96552	0.00083
Unemployment does not cause lending rate*	3.00877	0.03553
Lending rate does not cause unemployment	8.28985	8.00E-05
Wage earning does not cause lending rate	1.39313	0.24875
Lending rate does not cause wage earning	1.36684	0.25674
Demand deposit does not cause deposit rate	1.03554	0.37985
Deposit rate does not cause demand deposit	1.86781	0.13924

* The Granger causality test between unemployment and lending rate has only 81 obs

Table 4: Pairwise Granger Causality Tests: Korea

the lending spread influence lending rates, real credit, real deposits, industrial output, and the unemployment rate. Both VARs include three lags[21] and one time trend. The first VAR contains net foreign liabilities, the lending rate, the interest spread, real claims and real demand deposits as endogenous variables. The second VAR contains the lending spread, the lending rate, real credit, industrial production and the unemployment rate as endogenous variables. The industrial production index is detrended by applying the Hodrick-Prescott filter. The variables were included in first differences (i.e.monthly changes) because the Augmented Dickey-Fuller (ADF) tests found that all variables but the domestic interest rate spread contained a unit root as shown by Table 5, and are therefore stationary in first differences.

The effects of a positive shock on net foreign liabilities, were analyzed using generalized impulse response functions. Fig.6 indicates that such a shock leads to a decrease in the domestic interest spread and the domestic lending rate, an increase in real claims and demand deposits, which are consistent with the results from the analytical framework. Lending rate

[21] The results are robust even to the number of lags and the order of the variables.

Null Hypothesis: D(variable) has a unit root
Exogenous: Constant

	Levels		1st Difference	
	t-statistic	Prob*	t-statistic	Prob*
Real Net Foreign Asset	-1.6524	0.4528	0.4528	0.0000
Real Private Claim	-0.2527	0.9272	-5.1793	0.0000
Real Demand Deposit	-1.5326	0.5138	-15.2028	0.0000
Industrial Production	1.0620	0.9970	-3.6819	0.0057
Lending Interest Rate	-1.9672	0.3009	-6.7521	0.0000
Interest Rate Spread	-3.1092	0.0285	-8.0872	0.0000
Unemployment Rate	-1.5975	0.4793	-4.7342	0.0002
Monthly Wage Earnings	-0.3181	0.9175	-3.0619	0.0326

*MacKinnon (1996) one-sided p-values.

Table 5: Augmented Dickey-Fuller Unit Root Test

and interest spread decline sharply as the result of a positive capital flow shock and the decrease lasts for 3 and 2 periods respectively. The increase in net foreign liabilities results in increase in real credit and demand deposits; however, the positive responses are volatile, with real credit having a stronger reaction than demand deposits.

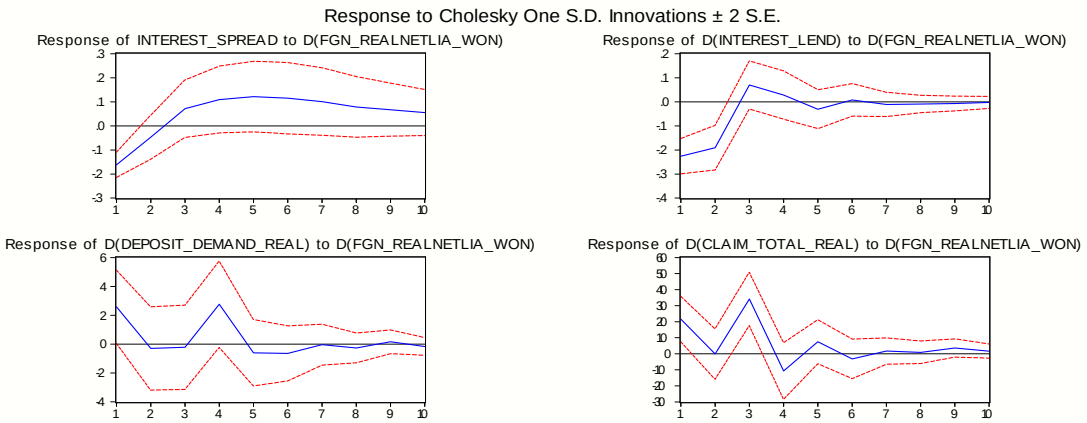

Figure 6: Impulse Responses to a Shock in the Net Foreign Liabilities

The responses indicated in Fig.7 are also consistent with our model. On the impact of an increase in the interest rate spread, which is caused by capital outflows and can be taken as a proxy for rising banking costs, the lending rate increases immediately and stays positive for about two periods before decreasing. Output and employment react significantly on impact, with output cut for three perionds then increasing and the negative effect on employment leveling off only after 8 periods. Both credit and deposits drop as expected, but with a volative reaction.

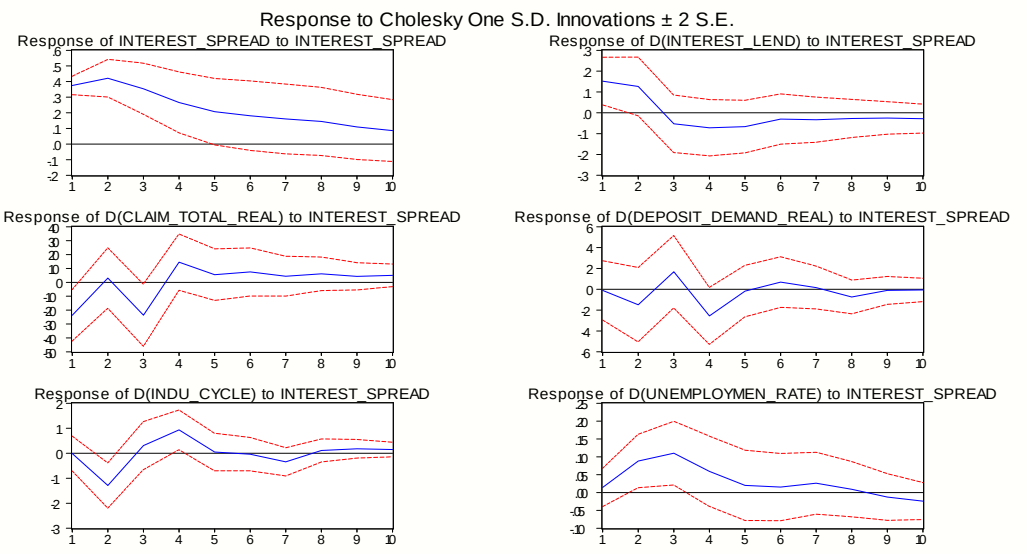

Figure 7: Impulse Responses to a Shock in the Interest Rate Spread

In sum, all results from the empirical analysis are consistent witht the predictions of our analytical framework, although the relative magnitude and the time pattern of the response are different across variables.

6 Policy Implications

Domestic commercial banks play a crucial role in the economy since they intermediate large capital flows to domestic economy, channel credit to firms, and take deposits from households; they are therefore at the center of the crisis transmission mechanism.When designing policies aimed at mitigating the foreign shock impact on the domestic economy, we have to take into account banks' central role in the shock intermediation mechanism. An immediate policy suggestion implied by this paper is to discourage banks' tendency to over-lend during inflow booms and alleviate the effect of credit crunch in times of sudden stop of capital inflows. Prudential banking regulation and supervision is therefore a principal element in creating and maintaining financial system stability so that capital inflows are less likely to produce a lending boom and excessive risk taking by banking institutions. For example, banks might be restricted in how fast their borrowing could grow and this might have the impact of limiting capital inflows. This policy can be easily captured in the model by imposing a pro-cyclical reserve requirement ratio on both the domestic demand deposits and foreign funds. Specifically, raise reserve ratio during capital inflows and cut it in capital outflows. Chile is widely cited as a model. It has various restrictions on inflows, including a requirement that a portion of any money borrowed abroad be deposited for a year at the central bank, without interest[22].

[22] However, economists disagree about the effectiveness of Chile's short term capital controls.

Another finding from the paper is that policies that attempt to decrease the banking cost multiplier after a crisis will contribute to a prompt recovery of the overall economy. This is precisely why the IMF's emergency lending to the crisis countries was essential for them to achieve a rapid recovery: IMF loans help lower both the lending and deposit spreads by decreasing the cost multiplier of providing banking services.

7 Conclusions

The task to explore the critical role of the banking system in transmitting external financial shocks to domestic economic activities is extremely important for emerging market economies. Because in those countries whose bond and equity markets are underdeveloped, banks play a particularly important role in financial intermediation and the banking channel therefore is of particular significance as a conduit for domestic and foreign shocks.

This paper develops a general equilibrium model of a small open economy that explains the banking sector's significant role in channeling and amplifying capital flow shocks to the local economy in the Asian financial crisis. The analysis considers the sudden capital outflow which occurred in 1997 just prior to the crisis, as a negative shock to the productivity of the banking sector. In our model, this shock drives up the cost of providing banking services. The shock is transmitted, via the channel of lending spreads that banks charge to the firms and deposit spreads that banks offer to the households. The increased lending spread hits firms which rely on bank credit to hire labor to produce output, thus decreasing output and employment. On the demand side, the increased deposit spread raises the effective price of consumption; therefore, equilibrium consumption and demand deposits decrease. Moreover, the decrease in deposits further reduces the available bank funds to firms. In short, the costly banking system helps to propagate and amplify the capital flow shocks to domestic economies. Econometric evidence from Korea and other crisis countries broadly supports the transmission channels and the main implications of the model.

This framework can be used as a springboard for further research. In particular, given that banks' foreign borrowing is denominated in foreign currency but their assets are often fixed in domestic currency terms, it is important to examine how banks' balance sheets are affected by currency mismatch following an exchange rate plunge caused by the sudden stop. Further, it is important to investigate how and to what extent liability dollarization on banks' balance sheets affects the local economy. However, with a perfect flexible price system as in our model now stands, an unanticipated increase in the level of exchange rate would simply generate an equal-proportional rise in prices. Hence, some nominal rigidity is needed to make banks' balance sheet effect a non-trivial experiment. Finally, while in the model the rise in the loan-deposit interest rate spread is due to the sudden capital outflows that increases banking cost, it should also capture other phenomenon such as: a sudden deterioration in loan quality; an increase in banking risk due to an increase in macroeconomic instability (i.e. frequent and high swings in the real exchange rate); and the maturity mismatch between deposits and loans. These are areas for future work.

8 Appendix

Proof of proposition 1 **Proof.** Part I: $\mathbf{b}_T^*$ **decreases,** $\mathbf{I}_T^l$ **increases**.The proof proceeds by contradiction

(i) Suppose that I_t^l remains unchanged at T. This implies, by Eq.43, that z_T doen't change. Because ξ_T increases on the impact of the decrease of $\mathbf{b}_T^*$, by Eq.35, that $\frac{z_T}{d_T+b_T^*}$falls.The fall in $\frac{z_T}{d_T+b_T^*}$implies that, by Eq.36 that I_T^d rises. Hence, by Eq.31, c_T falls. This implies that , by the deposit in advance constraint, d_T falls. The unchanged z_T, decreased d_T and b_T^*imply that $\frac{z_T}{d_T+b_T^*}$rises, which is a contradiction. (ii) Suppose that I^l falls at T. This implies, by Eq.43 that z_T increases and, by Eq.35 that $\frac{z_T}{d_T+b_T^*}$falls. The fall in $\frac{z_T}{d_T+b_T^*}$implies that, by Eq.36 that I_T^d rises. Hence, by Eq.31, c_T falls. This implies that, by the deposit in advance constraint,

d_T falls. The increased z_T, decreased d_T and b*imply that $\frac{z_t}{d_t+b_t^*}$rises, which is a contradiction.

Part II: $\mathbf{b}_T^*$ **decreases,** $\mathbf{I}_T^d$ **increases**. The proof proceeds by contradiction.

Now rewrite $\mathrm{z}_t = (1-\delta)d_t + b_t^*$,hence Eq.36 changes to $I_t^d = i_t\delta + \xi_t\phi_d(\frac{1}{1-\frac{\delta_t}{1+\frac{bt^*}{d_t}}})$

(i) Suppose I_T^d remains unchanged at time T, by Eq.31, c_T doesn't change. This implies that, by Eq.32 and Eq.40, d_T doesn't change. Since $I_T^d = i_T\delta + \xi_T\phi_d(\frac{1}{1-\frac{\delta}{1+\frac{b_T^*}{d_T}}})$, if I_T^d doesn't change and ξ_T increases, ϕ_d has to fall. This implies that d_T has to fall. Which is a contradiction.(ii) Suppose I_T^d decreases at T, by Eq.31, c_T increases. This implies that, by Eq.32 and Eq.40, d_T increases. Since $I_T^d = i_T\delta + \xi_T\phi_d(\frac{1}{1-\frac{\delta}{1+\frac{b_T^*}{d_T}}})$, if I_T^d decrease and ξ_T increases, ϕ_d has to fall. This implies that d_T has to fall. Which is a contradiction. ■

Proof of proposition 2 **Proof.** Because ξ_T increases on the impact of the decrease of $\mathbf{b}_T^*$, by Eq.35, if d_T increases to an extent so that $\frac{z_T}{d_T+b_T^*}$ drops and $\xi_T\phi_z(\frac{z_T}{d_T+b_T^*})$ doesn't change, then $\mathbf{I}_T^l$ can be kept constant. By Eq.36, it implies that if δ_T can be lowered to compensate the increase of $\xi_T\phi_d(\frac{d_T+b_T^*}{z_T})$ then $\mathbf{I}_T^d$ falls. So that c^T and pc^{NT} can go up(Eq.31 and Eq.32) to bring up a higher deposits (Eq.4). ■

Data Sources All data sources except indicated are from IMF's IFS.

Variables included in the VARs. Source: International Financial Statistics (IFS)

Real claims: deposit money banks, claims on Private Sector:Line 54222d..ZF, divided by CPI: Line 54264..ZF; Real Demand deposits: deposit money banks, demand doposits 54224...ZF; Industrial Production: HP filtered line 54266...ZF; Net foreign liabilities: Deposit Monetary Banks' foreign assets line 54221...ZF minus deposit monetary banks' foreign liabilities line 54226C..ZF then divided by CPI; Lending rate: line 54260P..ZF; Deposit rate: line 54260L..ZF; Unemployment rate: line 54267R..ZF..

A. The Households' Balance Sheet

Liabilities	Assets
	b^h (households' foreign bonds)
	d (demand deposits)
	a^h (net worth)

B. The Firms' Balance Sheet

Liabilities	Assets
z (bank credit)	b^f (firms' foreign bonds)
	a^f (net worth)

C. The Banks' Balance Sheet

Liabilities	Assets
b^* (net foreign liabilities)	z (bank credit to firms)
d (demand deposits)	h (reserves)
	a^b (net worth)

D. The Government's Balance Sheet

Liabilities	Assets
h (commercial banks' reserves)	b^g (foreign bonds)

Figure 8: The Balance Sheets of The Agents

References

[1] Agenor, P.R., Aizenman, J., and Hoffmaister A. 1999. " Congtagion, Bank Lending Spreads, and Output Fluctuations," World Bank Working Papers 2186

[2] Agenor, Pierre-Richard and Aizenman, Joshua, "Financial Sector Inefficiencies and Coordination Failures," World Bank Working Papers 2185

[3] Aghion, Philippe, & Bacchetta, Philippe and Banerjee, Abhijit, 2004. "Financial Development and the Instability of Open Economies," NBER Working Papers 10246

[4] Aghion, Philippe & Bacchetta, Philippe & Banerjee, Abhijit, 2000. "A simple model of monetary policy and currency crises," European Economic Review, Elsevier, vol. 44(4-6), pages 728-738.

[5] Aghion, Philippe & Bacchetta, Philippe & Banerjee, Abhijit, 2004. "A corporate balance-sheet approach to currency crises," Journal of Economic Theory, Elsevier, vol. 119(1), pages 6-30.

[6] Aghion, Philippe & Bacchetta, Philippe & Banerjee, Abhijit, 2001. "Currency crises and monetary policy in an economy with credit constraints," European Economic Review,

Elsevier, vol. 45(7), pages 1121-1150. Kaminsky, Reinhart and Végh.2003 *"The Unholy Trinity of Financial Contagion". Mimeo*

[7] Arias, Andres F.,"Banking Productivity and Economic Fluctuations: Columbia 1998-2000," UCLA mimo

[8] Bernanke, Ben S & Gertler, Mark, 1995. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," Journal of Economic Perspectives, American Economic Association, vol. 9(4), pages 27-48.

[9] Chang, Roberto and Velasco, Andres, 1998. "Financial crises in emerging markets: a canonical model," Federal Reserve Bank of Atalanta, Working Paper 98-10.

[10] Chinn, Menzie D. and Kletzer, Kenneth M.,2000, "International Capital Inflows, Domestic Financial Intermediation and Financial Crises under Imperfect Information," NBER Working Paper 7902

[11] Christensen, Jakob 2004. "Capital Inflows, Sterilization, and Commercial Bank Speculation: the Case of the Czech Republic in the Mid-1990s," IMF Working Paper WP/04/218

[12] Dekle, Robert and Kletzer, Kenneth, 2001, "Domestic Bank Regulation and Financial Crises: Theory and Empirical Evidence from East Asia," NBER Working Paper 8322

[13] Domac, Ilker and Ferri, Giovanni 1998. " The Real Impact of Financial Shocks: Evidence from Korea," World Bank Working Papers 2010.

[14] Eichengreen, Barry and Arteta, Carlos, 2000. "Banking Crises in Emerging Markets: Presumptions and Evidence," Center for International and Development Economics Research (CIDER) Working Papers C00-115, University of California at Berkeley.

[15] Edwards and Végh ,1997, "Banks and Macroeconomic Disturbances under Predetermined Exchange Rate," Journal of Monetary Economics 40 239-278

[16] Gertler, Mark, Gilchrist, Simon and Natalucci, Fabio M., 2003, "External Constraints on Monetary Policy and the Financial Accelerator," NBER Working Paper 10128

[17] Goldfajn, Ilan and Rodrigo Valdes (1995), "Balance of Payments Crises and Capital Flows: The Role of Liquidity," unpublished manuscript, MIT.

Gupta, Poonam, 2000. "Aftermath of Banking Crisis: Effects on Real and Monetary Variables," IMF Working Paper WP/00/96

[18] Kaminsky, Graciela L. and Reinhar Carmen M.,"Bank Lending and Contagion: Evidence From the Asian Crisis," mimo 1999

[19] Kaminsky, Graciela L. & Reinhart, Carmen M., 1999. "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems," American Economic Review, American Economic Association, vol. 89(3), pages 473-500

[20] Kiyotaki, N. and J. Moore, 1997,"Credit Cycles," JPE, vol.105, no.2, pp.211-248.

[21] Mishkin, Frederic S., 1999, "Lessons From The Asian Crisis," NBER Working Paper 7102

[22] Morsink, James and Bayoumi, Tamim, "A Peek Inside the Black Box: The Monetary Transmission Mechanism in Japan," IMF Working Paper WP/99/137

[23] Oviedo, P. Marcelo, "Intermediation of Capital Inflows: The Macroeconomic Implications of Neoclassical Banks and Working Capital," Iowa State University 2004

[24] Radelet, Steven and Sachs, Jeffrey 1998. " The Onset of the East Asian Financial Crisis," NBER Working Paper 6680

[25] Richard J. Herring and Nathporn Chatusripitak, 2000. "The Case of the Missing Market: the Bond Market and Why It Matters for Financial Development", The Wharton Financial Institutionss Center, Working Paper Series #01-09

[26] Singh, Rajesh, 2002, "Why do Banks Fail before BOP Crises? An East Asian Perspective," Iowa State University Manuscript

[27] Sachs, Jeffrey, Tornell, Aaron, and Velasco, Andres, 1996, "Financial Crises in Emerging Markets: the Lessons From 1995," NBER Working Paper 5576

[28] Tornell, Aaron and Westermann, Frank,2002, "The Credit Channel in Middle Income Countries," NBER Working Paper 9355