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Over-investment, Collateral Lending, and Economic Crisis

Yong Jin Kim
Dongduk Women's University
and

Jong -Wha Lee
Korea University

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Abstract

The paper describes an economy in which firms, because of government subsidy, are motivated to over-invest. The firms are assumed to bear the burden of the inefficiency caused by the government and compensate for their losses by obtaining bank loans. We also assume that domestic banks will continuously lend money to the firms as long as the total amount of accumulated loans remain within the limit of the collateral value of real estate. Domestic banks borrow from foreign investors to provide loans for the firms. With these assumptions, we obtain the following results that may well be consistent with the experience of the East Asian countries. First, a higher growth economy with a higher government subsidy shows higher investment and GDP growth rates, a higher level and growth rate of real estate price, and a higher level of current account deficit. Second, the rapid growth caused by higher government subsidy exposes the economy to adverse shocks. This model also has the feature of the self-fulfilling prophecy of a bank run. When adverse shocks hit the economy, domestic banks become too risky for foreign investors. Subsequently, financial panic and economic crisis occur all of a sudden. Third, capital market liberalization amplifies the scale of crisis due to the huge foreign capital inflow and outflow.

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* The authors thank seminar participants at the Summer 1998 Korea Economic Association Meeting and the 57th Japan Society of International Economics Conference for helpful comments. E-mail addresses: yongkim@www.dongduk.ac.kr; jongwha@kuccnx.korea.ac.kr

I. Introduction

Last year financial crisis erupted in the rapidly growing East Asia as large-scale foreign capital flowed out of the economies followed by a huge depreciation of domestic currencies. The causes of this crisis have been the topic of a hot debate not only because East Asia had been growing rapidly, serving as a growth model that many developing countries tried to emulate, but also because its sudden collapse was the least anticipated. Krugman (1998) argues that Asian crisis is a moral hazard crisis as a consequence of poorly regulated and over guaranteed banks that have recklessly extended credits to risky projects. Radelet and Sachs (1998) regard the crisis in essence as a financial panic triggered by a sudden withdrawal of foreign capital. IMF(1997) attributes the crisis to a combination of factors, including a boom of international lending caused by high growth performance, adverse external shocks, mismanagement of macroeconomic and exchange rate policies, and weak financial sector.

East Asian crises show a complex mixture of currency crisis, banking crisis, and foreign debt crisis, any of which can not be singled out as being the sole cause of the crises. Recent empirical studies that have examined through a large sample of countries for the determinants of the crises could not come up with a clear answer.[1] Theoretical models are still very much sought for.

In this paper, we present a model that explains some salient features of the East Asian economies. The growth process of the East Asian economies is typically characterized by high investment rate and economic growth, high real estate price, a current account deficit, and sudden financial crisis. Until recently, the East Asian economies displayed high saving and investment rates, and rapid GNP growth. Along with these positive signs were a few negative signs such as decline in productivity, growth of current account deficit, and accumulation of corporate debts. Then suddenly, financial crises swept through these countries. Thus, this paper presents a model in which higher growth can make a country more vulnerable to financial crises.

[1] See Kaminsky and Reinhart (1996), Demirguc-Kunt and Detragiache (1997), and Eichengreen and Rose (1997).

The model presented in the paper describes an economy in which firms, because of government subsidy, are motivated to over-invest. We assume that firms pay tax and thereby bear the burden of the inefficiency caused by the government distortion. They, in turn, obtain bank loans to compensate for the losses. We also assume that domestic banks borrow from foreign investors to provide funds for the firms. The foreign borrowing will continue to accumulate, as long as domestic banks and foreign investors continue to provide funds for them. One of the critical assumptions of the model is that domestic banks will continue lending money to firms as long as the value of the firms' real estate collateral covers the accumulated loans.

The model shows that the higher growth economy caused by a higher government subsidy shows a higher price of real estate, higher investment and GDP growth rates, a higher current account deficit, and a higher ratio of debt-to-collateral value. Thus, this model shows that a higher growth economy is more likely to be subject to a crisis. It also shows that the financial fragility makes the whole economy extremely vulnerable to adverse shocks. When the adverse shocks hit the economy and foreign investors decide domestic banks too risky, financial panic and economic crises can occur all of a sudden. In another words, as soon as foreign investors start to doubt the safety of domestic banks, real estate price falls to such a level that the market value of real estate can no longer cover the loans which were based on their pre-fall value. As a result, firms and banks go bankrupt. Banking and foreign debt crises break out. This model also shows that the liberalization of the capital market amplifies the scale of crisis due to the huge foreign capital inflow and outflow.

The paper is organized as follows. Section 2 describes the basic setup of the model and characterizes its equilibrium. Section 3 derives several implications related to the question previously posed, and Section 4 analyzes the effect of financial market opening on the economy. Section 5 relates the model to other models, and shows that it can be interpreted as the moral hazard model. Section 6 concludes.

II. The Model

The economy consists of identical households, firms and banks. The representative agent (household) owns a representative firm through holding shares in the competitive financial markets. The agent consumes one type of commodity and housing service.

The representative firm produces a commodity with an AK type production technology. The firm owns a real estate of a house and uses it as a collateral to borrow money from banks. The banks lend money to the firm as long as the accumulated loss of the firm remains within the market value of real estate.

2.1. Firm's Maximization

The firm produces an output Y_t by employing capital K_t. We assume that the firm receives a government subsidy sY_t proportional to the firm's output.[2] The firm bears the burden of a lump-sum tax of T_t. More generally, this tax represents inefficiencies, proportional to the size of the government subsidy, incurred by the over-investment in the economy. These inefficiencies can be caused by the firm's briberies to politicians, and owner-manager's moral hazard behavior.[3] Each representative firm owns the fixed $\bar{h}$ units of real estate[4]. Further we assume that the firm knows the current period's productivity of A_t in the beginning of each period but cannot observe the next period's productivity (A_{t+1}). A change in A_t can represent a productivity shock, a term of trade shock, or other shocks affecting the firm's revenue. Then, the representative firm owned

[2] The government subsidy *s* is a key parameter in this model. It captures the government policy that induces firms to expand size and thereby distorting resource allocation. The government may impose this subsidy cum tax scheme on producers in order to maximize growth rate of income (see section 3.1). This subsidy includes various export promoting schemes, such as export financing with lower interest rates, lower tariffs on import of materials and intermediate goods, providing factory sites at cheaper prices, and so on. Lee (1996) shows that, based on the manufacturing industries of Korea, tax incentives increase output growth rates by stimulating capital accumulation, and do not affect TFP, while nontariff barriers decrease both the output growth rates and TFP. He also shows that financial incentives have no significant effect on either the output growth rates or TFP. From this, we can conclude that Korean government policies led to over-investment and inefficiency. Also note that the model can be completely reinterpreted as a standard moral hazard model. Section 5 treats this issue.

[3] One of the logical linkages between over-investment and inefficiencies can be attributed to 'crony capitalism'.

[4] We assume that only firms can hold real estate in order to focus on the problem of bank lendings to firms. We further assume, as it is the case in Japan and Korea, that firms are virtually prohibited from getting capital gains by real estate sales due to high tax rates on capital gains. Hence, the fixed patch of land is not considered as a variable controlled by the firms.

by a representative household maximizes its expected discounted profit[5] with respect to the capital stock (k_t) as

$$\max \; E_t\left[\sum_{k=0}^{\infty}\left(\prod_{i=1}^{k}\frac{1}{r_{t+i}}\right)\{(1+s)A_{t+k}k_{t+k}+q_{t+k}\bar{h}-r_{t+k}k_{t+k}-T_{t+k}\}\right] \tag{1}$$

where r_t represents a gross interest rate at time t greater than one, $q_t\bar{h}$ a rental revenue from a household, and s the government subsidy. Here, we assume that capital depreciates by 100 per cent at the end of the period for simplicity. The first order condition with respect to k_t yields an equilibrium interest rate as[6]

$$r_t = A_t(1+s) \tag{2}$$

The government balanced budget constraint produces the relationship of

$$sA_tk_t = T_t \tag{3}$$

We assume that the firm pays d_t a dividend to stockholders and the dividend equals the rental revenue, because the firm's capital that stockholders own is the real estate.[7]

$$d_t = q_t\bar{h} \tag{4}$$

From equations (1), (2), (3) and (4), the firm's profit after dividends will be

$$\begin{aligned}\pi_t &= -T_t \\ &= -sA_tk_t\end{aligned} \tag{5}$$

[5] This profit is the operating profit, which does not include capital gains from holding real estate.
[6] The firm's investment is financed through domestic saving at the domestic equilibrium rate.
[7] In other words, stockholders are being paid the market equilibrium yield for owning the real estate.

We assume that the firm will compensate for the loss by borrowing foreign capital from banks. The loss will be accumulated as long as the firm continues to borrow.[8]

2.2. Household's Maximization

A representative household lives in the house that she rents from the representative firm. The representative agent living an infinity life maximizes the preference of [9]

$$\max \quad U = E_t[\sum_{j=0}^{\infty} \beta^{t+j} \{\log(c_{t+j}) + \theta \cdot \log(h_{t+j})\}], \tag{6}$$

where $E_t[\cdot]$ represents an expectation operator conditional on the information set of time t, c_t consumption of the commodity at time t, h_t consumption of housing service[10] and β a time discount rate.

The agent maximizes her discounted utility with the budget constraint of

$$c_t + q_t h_t + k_{t+1} = r_t k_t + d_t, \tag{7}$$

[8] To simplify the problem, we assume that all economic agents are myopic in the sense that they do not consider the possibility of a financial and economic crisis. This assumption is not strong, not only because many studies showed that the East Asian financial crises were least anticipated, but also because the main results will not change by incorporating the possibility of crisis. It is easy to know that the firm's maximization problem will not change even in the model when we consider the possibility. However, the dividend should increase to compensate for the risk of a crisis. Then, the firm's losses also increase. Notice also that as long as the foreign investors are willing to lend money with the collateral value covering the debt, all of the agents ignore the firm's losses. It is because shareholders are well compensated for their investment at the market (risk-adjusted) rate and because the investment by domestic banks and foreign investors is safely secured by the collateral (with foreign interest rate raised to cover the risk of a crisis). Owner-managers as well as shareholders may even prefer higher subsidy causing more losses to the firms since such subsidy, although increasing the firm's losses, raises the economic growth rate.

[9] The households do not consider the possibility of a crisis, as stated in the above footnote. One of the easiest ways to incorporate the crisis possibility is stated in Footnote 17.

[10] In equilibrium, $h_t = \bar{h}$.

where q_t denotes the price of one unit of housing service, k_{t+1} the saving, r_t an one period gross interest rate on the saving of k_t observable at time t in the competitive financial market, and d_t the dividend from the holding shares at time t[11]. The budget constraint shows that the household does not bear the burden of the tax at all.[12]

Using equations (2) and (4), equation (7) can be transformed as

$$\begin{aligned} c_t + k_{t+1} &= I_t \\ &= (1+s)A_t k_t \end{aligned} \tag{8}$$

where I_t represents the household's disposable income after paying rents at time t.

The representative consumer's maximization problem of (6) subject to (7) can be solved by setting up the value function as follows, neglecting the utility from housing service consumption. Here, time subscripts are omitted and the prime on variables represents 'the next period'.

$$\begin{aligned} &V((1+s)Ak) = \\ &\max_{k'} \ \log((1+s)Ak - k') + \beta \int V((1+s)A'k')dP(A' \mid A) \end{aligned} \tag{9}$$

where $P(A' \mid A)$ the cumulative distribution function of A' conditional on the realized value of A.

After positing the value function as

$$V(I) = a + b\log(I), \tag{10}$$

[11] The household owns the firm through holding shares. The profit she obtains through dividends can not be negative due to her limited liability. To simplify the problem, we assume that the dividend equals the rent $q_t h_t$.

[12] If the household bears the full burden of the tax, firms will not suffer losses since the tax is completely internalized by the household. However, even in this case, firms will incur losses due to

we can solve (9) using an envelop theorem and the FOC.

First, we obtain the following relationship by applying an envelop theorem on equation (9) and combining it with equation (10) as

$$\frac{b}{(1+s)Ak} = \frac{1}{(1+s)Ak - k'} \Rightarrow k' = \frac{b-1}{b}((1+s)Ak) \tag{11}$$

Additionally, equation (11) and the FOC with respect to k' yield

$$\begin{aligned} \frac{1}{(1+s)Ak - k'} &= \beta \int \frac{b(1+s)A'}{(1+s)A'k'} dP(A' \mid A) \\ &= \beta \int \frac{b^2}{(b-1)(1+s)Ak} dP(A' \mid A) \end{aligned} \tag{12}$$

Equation (12) yields a solution for b as

$$b = \frac{1}{1-\beta} \tag{13}$$

Thus, equation (11) produces a solution for k' as

$$k' = \beta(1+s)Ak \tag{14}$$

Also, from equations (8) and (14), we can solve for an optimal consumption decision as

$$\begin{aligned} c &= \frac{I}{b} \\ &= (1-\beta)(1+s)Ak \end{aligned} \tag{15}$$

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inefficiencies, which is proportional to the size of the subsidy, caused by the over-investment, as stated

Notice that consumption and investment decisions do not depend on the probability distribution of A'.

Equations (14) and (15) produce optimal growth rates of consumption and capital stock as

$$\frac{k'}{k} = \beta(1+s)A \qquad (16)$$
$$\frac{c'}{c} = \beta(1+s)A$$

Equations (15) and (16) show that the household in this economy with a positive government subsidy, s>0, enjoys higher consumption-income ratio and higher consumption growth rates over the period.

Utilizing the properties of a logarithmic utility function, we can solve for the price of one unit of the housing service with a general equilibrium condition $h_t = \bar{h}$ as

$$q_t = \frac{\theta c_t}{\bar{h}} \qquad (17)$$

2.3. The Equilibrium

Equation (16) shows that consumption and capital grow at the rate $\beta(1+s)A_t$. Consumption and investment ratios to income stay constant over time, as we can see from equations (11) and (15).

Equation (8) implies that excess demand for goods over GNP leads to current account deficit. It is because the tax burden imposed on firms is not internalized in the household's budget constraint. As indicated in equation (8), the household budget exceeds the general equilibrium condition for a commodity market by $sA_t k_t$, because the economy produces only $A_t k_t$. However, in an open economy, which we assume here, the excess demand of $sA_t k_t$ will be financed by current account deficit. Notice that an economy with s=0 satisfies the general equilibrium condition with zero current account deficit (see Table 1 in Appendix Table).

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before.

2.4. Bank's Behavior

Assume that domestic banks borrow money from foreign investors and lend it to firms to pay for their loss. Further we assume that the banks will continue lending to the firms as long as the collateral value of real estate covers the accumulated bank loan (the firm's accumulated loss).[13]

We also assume that domestic banks and foreign investors are risk neutral. In other words, they are concerned solely about an expected return. Thus, if the expected return of loans falls below a certain threshold level, they will stop providing funds for the firms. Therefore, if the expected ratio of the collateral value to loan falls below a certain threshold level, then foreign investors will not lend money to domestic banks. Domestic banks are also assumed to behave as foreign investors do by lending money to the firms until the expected ratio of collateral value to loan falls below the threshold level.[14]

Using equations (2), (16) and (17), the price of one unit of real estate will be calculated as

$$
\begin{aligned}
P_{ht} &= E_t[\sum_{j=0}^{\infty}(\prod_{k=1}^{j}\frac{1}{r_{t+k}})q_{t+j}] \\
&= E_t[\sum_{j=0}^{\infty}(\prod_{k=1}^{j}\frac{1}{r_{t+k}})\frac{\theta}{\bar{h}}c_{t+j}] \\
&= E_t[\sum_{j=0}^{\infty}(\prod_{k=1}^{j}\frac{g_{t+k}}{r_{t+k}})\frac{\theta}{\bar{h}}c_t] \\
&= \frac{\theta}{\bar{h}}c_t(1-\beta)^{-1} \\
&= A_t k_t \frac{\theta(1+s)}{\bar{h}}
\end{aligned}
\tag{18}
$$

[13] This assumption implies that banks are doing business mainly by collateral lending, rather than credit lending based on credit evaluation. This is a well-known business practice by banks in underdeveloped countries.

[14] Even though the foreign investor's threshold level can be much lower than the domestic bank's, we simply assume that these threshold levels are identical. This assumption does not influence the main implication. It is because as long as the foreigner's threshold level is lower than or equal to the domestic bank's, the crisis depends only on the foreign investor's, not on the domestic bank's. The optimal threshold level can be derived from the bank's profit maximization problem.

where g_t represents the gross growth rate of income at time t. Equation (18) says that real estate price in an over-investment economy with positive government subsidy $s>0$ is higher and grows faster than in an economy with $s=0$.

Then, the ratio of real estate value to GNP will be

$$\frac{P_{ht}\bar{h}}{A_t k_t} = \theta(1+s) \tag{19}$$

Equation (19) implies that an increase in s raises this ratio.[15]

Now, recall that domestic banks borrow money from foreign investors to lend to firms and the money covers the losses firms have incurred as long as the total amount of loan to firms does not exceed the collateral value of the real estate. To simplify the analysis, we further assume that the lending rate to firms to compensate for their losses is the foreign gross interest rate r^f.[16]

From equation (4), the firm's accumulated bank loan to bear its losses at time t can be calculated to be

$$\begin{aligned} L_t &= s(A_t k_t + r^f A_{t-1} k_{t-1} + r^{f\,2} A_{t-2} k_{t-2} + \ldots + r^{f\,t} A_0 k_0) \\ &= sA_t k_t \left(1 + \frac{r^f}{\beta r_t} + \frac{r^f}{\beta r_t}\frac{r^f}{\beta r_{t-1}} + \frac{r^f}{\beta r_t}\frac{r^f}{\beta r_{t-1}}\frac{r^f}{\beta r_{t-2}} + \ldots + \frac{r^f}{\beta r_t}\frac{r^f}{\beta r_{t-1}}\ldots\frac{r^f}{\beta r_1}\right) \end{aligned} \tag{20}$$

Equation (20) implies that the total amount of bank loans can remain within the collateral value at any point in time, if $\frac{r^f}{\beta r_i} \le \varepsilon < 1$ for each period, where ε is a constant less than one. Henceforth, we assume that this holds true. When the domestic interest rate is higher than the

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[15] This partly explains why Korea and Japan show very high values of this ratio. One study shows that Korea has a ratio of 4-5, Japan of 2-3, compared to U.S. of 0.6.

[16] The result will not change qualitatively when banks are allowed to charge firms a lending rate higher than the foreign rate. We can assume that the domestic lending rate will fall to the foreign rate level through competition among banks. In the model considering the crisis possibility, the foreign rate can be slightly raised to reflect the risk of crisis.

foreign interest rate, the more probable this relationship holds. A more detailed analysis will be performed in the following subsection.

2.5. Collateral Lending Condition

Equations (18) and (20) yield the expected ratio of bank loan to collateral value to be

$$(21) \qquad E_t[\frac{L_{t+1}}{P_{ht+1}\bar{h}}] = E_t[\frac{s(A_{t+1}k_{t+1} + r^f A_t k_t + r^{f\,2} A_{t-1}k_{t-1} + ... + r^{f\,t} A_0 k_0)}{A_{t+1}k_{t+1}\theta(1+s)}]$$

One thing to note is that a decrease in the expected A_{t+1} increases this ratio, as we can see from (18) and (20), by lowering the land price more than the accumulated amount of the loan. Thus, for example, a negative shock to terms of trade, which lowers A_{t+1}, raises this ratio. With the assumption that foreign debt starts from minus infinity time, for simplicity, equations (20) and (21) give the collateral lending condition that makes this ratio less than one at any time as:

$$(22) \qquad E_t[\frac{L_{t+1}}{P_{ht+1}\bar{h}}] \le \frac{s}{\theta(1-\varepsilon)(1+s)} \le 1,$$

where ε is the smallest value that satisfy $\frac{r^f}{\beta r_i} \le \varepsilon < 1$ for all *i*. The last inequality in equation (22) implies that the lower the foreign interest rate or the government subsidy is, the more probable the condition of (22) holds. Also, the higher θ is, the more probable (22) holds. We also assume that foreign investors will lend money to domestic banks as long as equation (22) is satisfied, just as domestic banks will lend to domestic firms.

III. Implications

3.1. Welfare Maximizing Government Policy

In this subsection, we will explore the welfare implications of government subsidy (s).

Equations (15) and (16) imply that an increase in s raises the household consumption in any period $t \geq t_0$ given a fixed capital stock of k_{t_0}. However, government subsidy can not increase indefinitely because higher s can violate the domestic bank's collateral lending condition of equation (22). Thus, we can guess that the welfare maximizing government subsidy plan will be to set s to the maximum value of s subject to (22).

Using equations (13) and (15), the expected welfare function (the discounted utility) at time t of a representative agent given the capital stock k_t can be described by

$$\begin{aligned}\sum_{i=0}^{\infty}\beta^{t+i}E_t[\log c_{t+i}] &= \sum_{i=0}^{\infty}\beta^{t+i}E_t[\log(c_t\prod_{j=1}^{i}g_{t+i})] \\ &= \frac{1}{1-\beta}\log c_t + \frac{E_t[\sum_{i=1}^{\infty}\beta^i g_{t+i}]}{1-\beta} \\ &= \frac{1}{1-\beta}\log(1-\beta)(1+s)A_t k_t + \frac{\sum_{i=1}^{\infty}\beta^{i+1}(1+s)E_t[A_{t+i}]}{1-\beta},\end{aligned} \tag{23}$$

where g_t represents a gross growth rate at time t.[17]

Thus, the optimal policy of s will be determined by solving the maximization problem of (23) subject to (22). Equation (23) implies that an increase in *s* increases the welfare. In addition, equation (22) implies that the debt to real estate value ratio also increases with *s*, as the accumulated loan to firms increases faster than the real estate value. Thus, we can easily infer that there exists a maximum value of s, s^*, that satisfies (22) for all values of A_t.

A simple manipulation of (22) yields

[17] This welfare function is calculated under the assumption that foreign investors will continue to lend money to domestic banks, as long as the domestic bank's collateral lending condition is satisfied. However, we can consider the possibility of bankruptcy caused by the foreign investor's behavior by plugging in the parameter of not having bankruptcy P. If we assume that the variable P is exogenously given and that the utility under bankruptcy is nil, then all we have to do is to substitute Pβ for β in (23).

(24) $$s^* = \frac{\theta(1-\varepsilon)}{1-\theta(1-\varepsilon)}, \text{ if } \theta(1-\varepsilon) < 1.$$

If $\theta(1-\varepsilon)$ is equal to or greater than one, equation (22) always holds true. Then, s^* will be a plus infinity. Below, we assume that $\theta(1-\varepsilon)$ is strictly less than one.

If the cost of violating the collateral lending condition (22) is large enough, then s^* is the government's optimal policy. Thus, a lemma follows:

Lemma 1: If $\theta(1-\varepsilon) \leq 1$ and the cost of violating the collateral lending condition is very large, the government's optimal policy will be $s^* = \frac{\theta(1-\varepsilon)}{1-\theta(1-\varepsilon)}$.

This lemma implies that if the government's subsidy to induce firm's over-investment is larger than the optimal value s^*, the economic agent's welfare will decrease.

3.2. Over-investment, High Growth, and Current Account Deficit

Now, we can summarize the results obtained above in the following propositions.

Proposition 1: An increase in the government subsidy (s), which induces over-investment of the economy, raises income growth rate, the ratio of consumption to income, welfare, real estate price, and current account deficit as long as $s \leq \frac{\theta(1-\varepsilon)}{1-\theta(1-\varepsilon)}$ and $\theta(1-\varepsilon) \leq 1$. Additionally, this increase raises the probability of violating the collateral lending condition.

(Proof) Refer to Table 1 in Appendix A in which an over-investment economy is compared to a normal economy under the assumption that $s \leq \frac{\theta(1-\varepsilon)}{1-\theta(1-\varepsilon)}$ and $\theta(1-\varepsilon) \leq 1$. The latter part of the proposition can easily be proved by observing that an increase in s raises the debt-to-collateral value ratio from equation (22).///

3.3. Financial Crisis

The continuous accumulation of high corporate and foreign debts arising from the collateral lending practice of domestic banks make this economy very fragile. The high debt economy is exposed to adverse shocks which then can collapse easily whenever the confidence of foreign investors starts to falter. As soon as the foreign investors think that the collateral lending condition will not be likely to hold, they start to recall their loan, which immediately leads to a financial crisis in the country.

Now, we can illustrate the eruption of financial crisis by the following lemma and propositions.

Lemma 2: In an economy which over investment and debt accumulation exist, adverse shocks that lower productivity (A) or raise foreign interest rate (r^f) can increase the expected debt-to-collateral value ratio so that the collateral lending condition of both domestic and foreign banks is not satisfied. This will be more likely to happen in the higher growth economy with the higher level of a government subsidy.

(Proof) In equation (21), a decrease in the expected A_{t+1} or an increase in r^f can increase the debt-to-collateral value ratio above one by lowering the land price more than the accumulated amount of loan. Also, in equations (20) and (22), it is clear that if a permanent adverse shock forces $\frac{r^f}{\beta r_i} > 1$ for each $i > t$, the total expected value of growing loans will exceed the value of real estate collateral in a finite time. The latter part of the proof is obvious from Proposition 1.///

When adverse shocks hit the economy and foreign investors expect the ratio of debt-to-collateral value to rise above one, the foreign investors become skeptical about the future safety of domestic banks. Foreign investors are justified in their misgivings about the safety of domestic banks for several reasons in addition to the fact that the ratio of loan to land value exceeds one. First, the BIS equity-asset ratio of domestic banks will continuously decrease because firms' debt will increase over time. Second, the negative profit-making by domestic firms leads to the accumulation of non-performing loans in domestic banks. Third, due to

continuous current account deficit, the economy is highly vulnerable to a foreign currency liquidity crisis.

As a result, this country with an over-investment policy will become a hostage to a foreign debt and banking crisis. The following proposition will summarize these results.

Proposition 2: Negative shocks such as negative terms-of-trade shocks can push the higher growth country with a higher government subsidy into a financial crisis by raising the debt-to-collateral value ratio above one.

Additionally, this economic crisis possesses a feature of the self-fulfilling prophecy of the bank run model of Diamond and Dybvig (1983). In other words, if foreign investors start to regard domestic banks risky (even if the ratio of debt-to-collateral value is slightly less than one), then it will surely become risky, because the gloomy prospect among foreign investors raises this ratio above one. The story goes as follows. To do this, we need two more equations (25) and (26) below.

Using (16), equation (21) can be transformed into

$$(25) \qquad E_t\left[\frac{L_{t+1}}{P_{ht+1}\bar{h}}\right] = E_t\left[\frac{s\left(A_{t+1}k_{t+1} + r^f A_t k_t + r^{f2} A_{t-1}k_{t-1} + \ldots + r^{ft} A_0 k_0\right)}{A_{t+1}A_t k_t \beta\theta (1+s)^2}\right].$$

If each foreign investor expects that all other foreign investors will not lend money to domestic banks, the collateral value will fall. The reasoning goes as follows. If economic agents realize that borrowing cannot continue due to the behavior of foreign investors, then they will infer that the economy will shift to an economy with s=0. Then, (19) implies that real estate price will fall with s=0. Since the high growth of the economy can not be sustained without foreign borrowing, economic agents expect that the future expected rents will drop and then the real estate price, the expected summation of future rent flows, will fall. During this period with a given amount of the firm's bank loan, the collateral lending condition (21) with a proper inequality may not be satisfied. When the condition is not satisfied, firms and banks go bankrupt.

Thus, considering that government subsidy is forced to discontinue as foreign investors stop lending, the expected debt-to-collateral value ratio rises as below.

$$(26) \qquad E_t\left[\frac{L_{t+1}}{P_{ht+1}\bar{h}}\right] = E_t\left[\frac{s\left(A_{t+1}k_{t+1} + r^f A_t k_t + r^{f2} A_{t-1}k_{t-1} + \ldots + r^{ft} A_0 k_0\right)}{A_{t+1}A_t k_t \beta\theta}\right].$$

From equations (25) and (26), we can derive an additional proposition related to a self-fulfilling prophecy.

Proposition 3: If $\frac{1}{(1+s)^2} < E_t[\frac{L_{t+1}}{P_{ht+1}\bar{h}}] < 1$ with s positive valued, then a mere bad prospect on the domestic economic condition prevalent among foreign investors can push the economy with a positive s into a lower growth economy with s=0. It can also trigger bankruptcies of banks and firms in the country.

(Proof) Comparing (25) with (26), we can infer that a foreign investor will not invest, as long as the other foreign investors does not invest, because no investment raises the expected ratio to above one. In other words, if a country's debt position is risky enough ($\frac{1}{(1+s)^2} < E_t[\frac{L_{t+1}}{P_{ht+1}\bar{h}}] < 1$), and if some of foreign investors stop lending money to domestic banks because they regard the country to be risky, then other foreign investors stop lending, as well. The mechanism of this investors' animal spirit phenomena is identical to that of the bank run model of Diamond and Dybvig (1983). Specifically, for an individual foreign investor, it is a Nash equilibrium to stop lending money, when other investors stop. If she continues lending money to domestic banks whereas others do not, then she suffers losses. It is because the collateral value cannot cover the total value of debt and thereby domestic firms and banks go bankrupt, as we can see from equations (25) and (26) under the condition that $\frac{1}{(1+s)^2} < E_t[\frac{L_{t+1}}{P_{ht+1}\bar{h}}] < 1$. So, the proof of the second part of the proposition is followed by the

fact that if the debt-to-collateral value ratio exceeds one without further foreign investment, then domestic banks and firms will go bankrupt.///

In a word, if the fear of the domestic country going bankrupt becomes prevalent among foreign investors, then it can turn into a self-fulfilling prophecy[18].

Even when the economy is hit by a temporary adverse shock, in terms of trade for example, the vulnerability of the financial system can bring on a crisis. A small doubt in the economy's capability for future debt service can make a foreign investor run to a domestic bank and recall her loan, which can easily trigger other investors' runs on all other banks. Radelet and Sachs(1998), and Chang and Velasco(1998) explain the recent East Asian crises by this self-fulfilling bank run *a la* Diamond and Dybvig.

A myopic or a more cautious behavior of foreign investors can easily invite a financial crisis. We have assumed that foreign investors will lend money to domestic banks as long as the collateral lending condition is satisfied, just as domestic banks behave toward to the domestic firms. However, in the real world foreign investors are less tolerant and more cautious than domestic banks in evaluating the situation of the debtor economy. It is because they do not hold collaterals directly nor do they have the loan guarantee, explicit or implicit, which domestic financial institutions obtain from the government. Consequently, foreign investors may have threshold levels lower than one, or different expected ratios in the collateral lending condition, which will make the economy further vulnerable to even smaller shocks. In the next section, we will discuss the above implications of banking and economic crises under financial liberalization.

VI. Capital Market Liberalization

[18] This self-fulfilling prophecy is further strengthened with an additional assumption that land price possesses a positive bubble term that will vanish as soon as foreign investors stop lending. It is because if foreign investors stop lending, the land price will drop to such a level that the probability of violating the collateral lending condition becomes much higher.

In previous sections, we assume that foreign capital inflow is allowed only to compensate for the loss of the firm indirectly through bank financing. This section considers the impact of capital market opening on the banking and economic crisis. This consideration is important because capital market liberalization and consequent asset price boom and bust preceded banking and economic crises in most of the countries having experienced recent economic crises(Kaminsky and Reinhart, 1996).

We assume that domestic firms and financial institutions are allowed to borrow foreign capital freely at the world interest rate r^f as long as the collateral lending constraint is satisfied. The other assumptions are identical to those in the previous sections.

4.1. Firm's Maximization

The representative firm maximizes its expected discounted profit under financial liberalization as

$$(27)\ \max\quad E_t[\sum_{k=0}^{\infty}\frac{1}{(r^f)^k}\{(1+s)A_{t+k}(\overset{\circ}{k}_{t+k}+k_{t+k}^f)+q_{t+k}\bar{h}-r^f(\overset{\circ}{k}_{t+k}+k_{t+k}^f)-T_{t+k}\}]$$

subject to satisfying the collateral lending constraint,

where $\overset{\circ}{k}_{t+k}$ indicates the amount of the equilibrium capital stock when the capital market is closed. After the opening, the entrepreneur borrows additional foreign capital (k_t^f) as much as the maximum allowed by the collateral lending constraint.

We assume that $A_t < r^f < (1+s)A_t$. Then, the firm's objective function implies that an additional unit of foreign capital increases the profit (thus, dividend) by $(1+s)A_t - r^f$. However, it decreases the GNP by $r^f - A_t$, because we assume that the marginal productivity of capital is lower than the cost of foreign capital.[19] The above maximization problem with a control variable ($\overset{\circ}{k}_t + k_t^f$), will produce the relationships identical to those in the previous sections with some exceptions. We will show some equations below.

[19] This assumption is necessary to make the 'over-investment' occur in this economy.

Now, the government balanced budget implies

(28) $$sA_t(\overset{\circ}{k}_t + k_t^f) = T_t .$$

This also implies that the current account deficit is $sA_t(\overset{\circ}{k}_t + k_t^f) = T_t$.

Considering that the lower borrowing cost and the additional foreign capital inflow caused by the capital market opening increase the profit by $[(A_t(1+s) - r^f)(\overset{\circ}{k}_t + k_t^f)]$, the dividend will increase as

(29) $$d_t = q_t\bar{h} + [(A_t(1+s) - r^f)(\overset{\circ}{k}_t + k_t^f)]$$

From the above relationships, the firm's profit after dividends will be

(30) $$\begin{aligned} \pi_t &= -T_t \\ &= -sA_t(\overset{\circ}{k}_t + k_t^f) \end{aligned}$$

Recall that the firm will compensate this loss by borrowing foreign capital through the domestic bank. The firm can do business even while accumulating losses as long as the firm can continue to borrow from the bank with the collateral lending constraint satisfied.

4.2. Household's Maximization

All the relationships about the household maximization in the subsection 2.2 also hold true in this subsection, except for the fact that financial liberalization increases the consumer's disposable income from $A_t(1+s)\overset{\circ}{k}_t$ to $A_t(1+s)(\overset{\circ}{k}_t + k_t^f)$. Thus, we will have the following modified relationships.

(31) $$(\overset{\circ}{k} + k^f)' = \beta \cdot A \cdot (1+s)(\overset{\circ}{k} + k^f),$$

(32) $$c = (1-\beta)A(1+s)(\overset{\circ}{k}+k^f).$$

The optimal growth rates of consumption and capital stock are identical to those in the case before capital market liberalization. And equation (17) implies that the housing rental cost will rise because financial market liberalization increases the household's income.

4.3. Bank's Behavior and Implications

Assuming that $E_t[A_{t+k}] = A$ and that A_{t+k} is independent of A_{t+j} for all k and j, the price of one unit of real estate is calculated as

(33)
$$\begin{aligned} P_{ht}^o &= E_t[\sum_{j=0}^{\infty}\frac{q_{t+j}}{(r^f)^j}] \\ &= E_t[\sum_{j=0}^{\infty}\frac{\theta c_{t+j}}{(r^f)^j \bar{h}}] \\ &= \sum_{j=0}^{\infty}\frac{(\beta(1+s)A)^j \theta c_t}{(r^f)^j \bar{h}} \\ &= \frac{r^f}{r^f-\beta(1+s)A}\frac{\theta}{\bar{h}}c_t \end{aligned}$$

where we assume that $A < r^f < (1+s)A$ and that $r^f > \beta(1+s)A$.[20]

Equation (33) implies that the capital market liberalization increases the real estate price through two channels: by lowering the discount rate from the higher domestic interest rate to the lower world interest rate, and by increasing the level of consumption.

Now, let us calculate the collateral lending condition. Using equations (30), and (33), and the fact that the foreign capital inflow to compensate for the current account deficit at time t is $sA_t(\overset{\circ}{k}_t + k_t^f)$, we can explicitly calculate the collateral lending condition. The expected ratio of the bank loan to collateral is less than one, starting from the time of minus infinity, as

$$(34) \qquad E_t[\frac{L_{t+1}}{P_{ht+1}\bar{h}}] = E_t[\frac{F_{t+1} + r^f F_t + r^{f\,2} F_{t-2} + ... + r^{f\,t+i+1} F_{-i} + ...}{P^o_{ht+1}}] \leq 1,$$

where $F_t = sA_t(\overset{\circ}{k}_t + k_t^f)$

To simplify the analysis of the effect of the financial market opening on the economy, we assume $A = A_t$. Right after the financial opening, huge foreign capital flows in until equation (34) is at equilibrium. The real estate price soars as stated above. This also greatly increases consumption, investment, and income level. After this initial adjustment, the equilibrium is restored, as both domestic and foreign capital as well as income and the real estate price increase at the constant growth rate of $\beta A_t (1+s)$. Equations (31) to (34) can easily verify this in that the growth rate of domestic and foreign capital does not violate these conditions.

However, if A_t changes over time, then the magnitude of foreign capital inflow and outflow greatly fluctuates a lot depending on the value of A_t.[21] Thus, the growth rates of income, consumption, and investment changes, as well. It is because the foreign capital flows in continuously to the limit of the credit which depends on the value of A_t, as (34) implies.

Now, we can easily see that the above model has the capacity to explain the observed empirical fact: capital market liberalization leads to huge foreign capital inflow, which in turn increases income, consumption, and asset prices. This asset bubble induces lending boom to risky projects. Sooner or later, the asset bubble bursts at the expense of the banking sector. Then, it drives foreign investors to panic and to withdraw huge foreign capital all at once. Subsequently, banking and economic crises follow. The model provides the causal links as follows: financial opening leads to a huge foreign capital inflow, because firms want to maximize their profit by employing cheaper foreign capital within the collateral lending

[20] Two economies- one with financial liberalization and one without- are compared in Table 2 in Appendix Table.

[21] It is a very interesting fact that due to the credit constraint of collateral lending condition the macroeconomic variables change considerably as productivity changes. See Kiyotaki and Moore(1997) for a model in which a dynamic interaction between credit limits and asset price makes the effects of shocks persist.

constraint. Then, (32) and (33) tell us that a lower world interest rate and an increase in consumption level, caused by a huge inflow of cheaper foreign capital, will hike the real estate price up, encouraging more foreign capital to flow in again by lowering the debt-to-collateral value ratio. This process brings about a lending boom, increasing the real estate price, income, investment and consumption level. This lending boom can accelerate the income growth rate if it allows firms to speculate in more risky projects with a higher s. This will raise the real estate price even further. Then, finally the bubble busts and economic crisis sets in.

If some exogenous shocks, such as bad terms of trade shock which lowers the productivity of capital (A_t), push the debt-to-collateral value ratio into the self-fulfilling prophecy range presented in Proposition 3,[22] then the self-fulfilling prophecy of banking and economic crises will occur. This process is explained well in Proposition 3. However, the crisis with capital market liberalization will be much more severe than the one without capital market liberalization, because the huge outflow of foreign capital plummets income, investment, consumption level and the real estate price.

V. Relations to Other Literature

Recent theoretical models on the Asian Crisis such as Krugman(1998), Schneider and Tornell (1998), Corsetti et al.(1998), and others are based on the 'over-investment' caused by the moral hazard behavior of firms and banks. Even though our model does not possess this feature, our model can be perfectly reinterpreted in the context of moral hazard behavior.

A typical model of moral hazard goes like this. In each period, firms will have a good or a bad productivity shock. Due to the implicit bailout subsidy of government, banks almost freely provide loans to firms with bad productivity shocks to make them liquid and solvent. But firms and banks regard these loans as government subsidy which does not have to be paid. This

[22] Another triggering mechanism can go as follows. As more foreign capital flows in, the current account deficit and foreign debt increase as implied by equation (28). If the increase in foreign debt (particularly, short-term) hits a triggering point of the minimum level of foreign reserve, then foreign investors will panic and make a sudden withdrawal of their capital. In Corsetti et al. (1998), the triggering base is the

mechanism induces an over-investment in risky projects, a fragile financial system, an asset bubble and bust, and finally a banking and economic crisis.

The moral hazard behavior incurs crises in the following process. The over-investment caused by the moral hazard will increase the government burden of the implicit bailout subsidy, that is the bank's bad loans financed continuously by foreign capital over time. Then, when the foreign debt grows too large compared to the size of the total liquid assets of the economy, foreign investors start to doubt the government's ability to pay back foreign debt. At this point in time, they start to make a sudden withdrawal of foreign capital, followed by banking and economic crises.

Our model is observationally a complete equivalent to this kind of moral hazard model. In other words, ours can be reinterpreted as the moral hazard model without having to change any of the equations in the previous sections but only with a slightly different interpretation of equations and variables. The following reinterpretation will transform our model into the moral hazard one.

Assume a continuum of firms indexed by $i \in [0,1]$. In each period, half of the firms, chosen randomly, will have a good productivity shock of $(1+s)A_t$, while the other half a bad shock of $(1-s)A_t$. Thus on the aggregate, the average productivity is certain with A_t. Assume also that banks will provide loans of the amount of $2sA_t$ per one unit of capital to the bad productivity firms to compensate for their bad luck. At this point, firms and banks regard these bad loans as an implicit government bailout subsidy. These loans are financed by foreign capital which foreign investors provide as long as they consider to be backed by the government subsidy. Thus, at the aggregate level, all the firms behave as if they have the productivity shock of $(1+s)A_t$ at time t as in our model. We further assume that a pair of one firm and one bank is owned by an identical set of shareholders and managers, for simplicity. And this pair owns the real estate.

Then, the variable T_t in this newly reinterpreted economy equals the total amount of loans provided to all the firms with a bad productivity shock at time t. In other words, T_t denotes

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minimum level of reserve. For the reinterpretation of the model as a moral hazard model as in Corsetti et al., refer to Section 5.

the implicit bailout subsidy flow to bad-luck firms at time t. And the variable L_t represents the total accumulated foreign debt by banks which foreign investors believe will be paid by the government as bailout subsidy.

In this new reinterpreted economy, when foreign investors start to doubt the government's ability to pay back, then a sudden withdrawal of capital by the foreign investors will occur, leading to a banking and economic crisis. Then, the triggering mechanism in this new moral hazard economy is as follows. Assume that if the ratio of debt to government's asset, including its reserve, plus the bank's asset of real estate increase above a certain triggering point, then foreign investors will panic and make a sudden withdrawal of their invested capital. This triggering mechanism is plausible and similar to that in Corsetti et al.(1998). If the ratio of the government asset to foreign debt remains constant, or if the government's asset is negligible, then the triggering point will be the ratio of the real estate value to the debt, as in our model.

Thus, the reinterpretation of equations and variables transform our original model into a moral hazard one, as in Krugman(1998), Schneider and Torell(1998), and Corsetti et al.(1998)[23].

VI. Conclusion

This paper attempts to model the growth process of East Asian economies characterized by high growth and sudden financial crisis.

The model describes an economy in which firms, subsidized by government, are motivated to over-invest and banks recklessly lend money to the firms. The model shows that the higher growth economy caused by a higher government subsidy becomes more vulnerable to adverse shocks and more likely to become hostage to bank and foreign exchange crises when foreign investors stop lending money to domestic banks. This paper also demonstrates that capital market liberalization augments the likelihood of an even more severe crisis, especially in a higher growth economy

[23] Our model in the version of the moral hazard distinguishes itself from other models in the following aspects. The model in Corsetti et al. does not include the implications of asset bubble and bust. Even though Krugman, and Schneider and Torell focus on the mechanics of asset bubble and bust, their models do not have the features of a general equilibrium model as fully as ours.

The economic crisis presented in this paper has a feature similar to the self-fulfilling prophecy of a bank run. When foreign banks or foreign investors start to regard the economy risky, then it will surely become risky. One foreign investor's run on a domestic bank can trigger other investors' run on banks. The bank run feature of the model implies that the financial crises can be contagious among similar countries with high debts. Once foreigners have experienced a crisis in one country, they will become more cautious in making investments in economies with similar financial system, Further investigation into this self-fulfilling feature of financial crisis across the East Asian countries will be an important agenda for future research.

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Appendix Table

Table 1: Comparison between an Over-investment and a Normal Economy.

	Over-investment Economy	Normal Economy
Growth Rate of GNP and Real Estate Price	$\beta A_t(1+s)$	βA_t
Consumption / GNP	$(1-\beta)(1+s)$	$1-\beta$
Investment / GNP	$\beta(1+s)$	β
Land Value / GNP	$\theta(1+s)$	θ
Current Account Deficit / GNP	s	0
National Debt / GNP	Less than $\frac{s}{(1-\varepsilon)}$	0
Interest Rate	$A_t(1+s)$	A_t

Table 2: Comparison between Two Economies- One with Capital Market Liberalization and One Without

	No Liberalization	Liberalization
GDP	$A_t \overset{\circ}{k}_t$	$A_t(\overset{\circ}{k}_t + k_t^f)$
GNP	$A_t \overset{\circ}{k}_t$	$A_t(\overset{\circ}{k}_t + k_t^f) - r^f k_t^f$
Current Account Deficit	$sA_t \overset{\circ}{k}_t$	$sA_t(\overset{\circ}{k}_t + k_t^f)$
Interest Rate	$(1+s)A_t$	r^f
Growth Rate	$\beta(1+s)A_t$	$\beta(1+s)A_t$
Real Estate Price	P_{ht}	$P_{ht}^f = P_{ht}\frac{(1-\beta)r^f}{r^f - \beta(1+s)A}$