A Survey on Recent Theories and Empirical Analyses Regarding Currency Crises

--The Role of Liquidity Provision as a Policy Measure in Currency Crisis Management--

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in Currency Crisis Management

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Summary

1.　CCL, established by IMF in 1999, and intra-regional swap agreements among the ASEAN+3 countries are considered to be frameworks for foreign liquidity provision when a country experiences a liquidity crisis.　It is probable that such movements would see further progress in the future, involving more member economies (the members of already existing international organizations, regional members, members at different stages of economic development) and applying different schemes (fund lending, currency swaps, currency swaps by currency).　The role of central banks in such an environment is likely to be an issue as well.　Thus, having considered the situation, I believe it indispensable to thoroughly evaluate the importance of liquidity provision as well as the role that should be played by central banks.

　In this paper, as background material for such discussion, I have surveyed the theories and empirical analyses put forward to explain the outbreak of past currency crises, the aggravation of crises, and the mechanism that leads to a drop in total output of a crisis-hit country.　As for the scope of the survey, I have mainly focused on the Asian currency crisis (1997), which shares the closest relation with our economy.

2.　As for the theories that explain the formative background of the Asian currency crisis, there are two opposing views.　One is "fundamentals-driven crisis theory", and the other is "financial panic-driven crisis theory".　Lately, a theory regarding the relation between the formation of investors' expectations and economic fundamentals has also been advocated.　The idea that "economic fundamentals and the formation of investor expectations are not independent of each other" is receiving theoretical support.　As for the mechanism of currency crisis (depreciation of the currency) leading to a drop in total output, theories such as the twin-crisis hypothesis, the agency theory, and debt-overhang theory are referred.

3.　Empirical analyses regarding currency crises have attempted to examine the validity of the aforementioned theories by measuring the influence of the followings: (1) fundamentals-related variables, (2) contagion channels, and (3) changes in investors' expectations.　The major results are as follows:

(i) Fundamentals-related variables can explain to some extent the probability of a currency crisis occurrence and the depth of the crisis.   Among the fundamentals-related variables, the influence of external short-term debt is substantial.   However, fundamentals-related variables alone can not explain the development of currency crises.

(ii) Inclusion of financial panic elements and contagion channels in quantitative analysis significantly improves explanatory power of quantitative estimations.

(iii) Among plausible contagion channels, neighborhood effect is the most significant in improving the explanatory power of quantitative estimations.

 Such results seem to support the theory that some kind of relation exists between investors' expectations and economic fundamentals.

4.   Looking at past currency crises, we can arrive at the conclusion that there have been cases where a country, which should not have had a problem servicing external debt in the long run, has fallen into a situation of temporary illiquidity (i.e. solvent but illiquid).   There has also been a case where the magnitude of a crisis went beyond the degree that could be explained by a deterioration of fundamentals.   The existence of such cases is supported not only by theory but also by the results of empirical analyses.   It can thus be said that the results of academic studies would support the "necessity of liquidity provision as an emergency measure in a crisis."

5.   In considering desirable ways of providing liquidity at the outbreak of a crisis, further discussion on the following points is necessary; (I) the need for surveillance to prevent moral hazard and to verify the cause of a crisis; (ii) the allocation of roles between international organizations and regional cooperation in the provision of liquidity; and (iii) the role of central banks in the provision of liquidity in international financial crisis management.

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1.   Aim and Organization of this Paper

The Asian currency crisis that broke out in 1997 re-activated discussion about the mechanism behind currency crises and the factors that determine the magnitude of a crisis as well as their effect on aggregate output.   The re-activation of studies, which attempt to explain the outbreak of a currency crisis in terms of economic "models", alleged "failure" of already-existing theories in accounting for the Asian currency crisis.

As more and more researchers have investigated the causes of currency crises, the number of empirical analyses that include the Asian crisis has increased as well.   In addition, financial market turmoil as represented by the 1997 Asian currency crisis and the 1998 Russian crisis have prompted discussion focusing on the following questions.   What is a desirable international financial architecture?   How should the public sector tackle a currency crisis?   Should we or should we not involve the private sector in handling a currency crisis?   Discussion of these questions has also prompted study of currency crises.   In order to answer the aforementioned questions, it is necessary to clarify the causes and mechanism of currency crises.

Currently, the Global Economic Research Division of the Bank of Japan is investigating the causes of currency crises.   In this process, we are also examining appropriate preventive measures, ways of handling a currency crisis, and the role of central banks in handling a crisis. This paper reviews theories and recent empirical analyses, which is the first step in answering the above questions.

This paper attempted to re-organize theories and empirical analyses (conducted mainly after the outbreak of the Asian currency crisis) on causes and magnitude as well as effect on aggregate output.   Many papers surveying theoretical aspects of the topic have already been published. Therefore, rather than going into detailed explanation for each theory, this paper focuses on the background of each theory as well as the position of each in the development of theoretical investigations into currency crises.   As for empirical analyses, those that include the Asian currency crisis have been reviewed.   This paper pays particular attention as to whether it is

possible to blame deteriorated economic fundamentals for the outbreak and depth of a currency crisis.   Perception of this problem can greatly influence establishment of an appropriate and effectiveness preventive measures and remedies.   Financial markets comprise participants with conflicting interests, and it is often quite difficult to reach a consensus.   Thus, in order to implement concrete measures, it is necessary to form opinions based on the accumulation of facts, such as the results of empirical analyses, in addition to theoretical support.

Next, as one of the measures to counter currency crises, this paper studies liquidity provision by the international organizations and other international frameworks.   It will examine if such liquidity provision can be supported as a policy measure, based on existing results of theoretical and empirical analyses.

The organization of this paper is as follows: Section 2 reviews economic theories regarding the mechanism behind the outbreak of currency crises and a plunge in aggregate output. Section 3 looks at recent empirical studies on the causes and the depth of currency crises.   The results of such empirical analyses also contribute to the examination of the mechanism behind the outbreak of currency crises as discussed in Section 2.   Section 4 discusses the effectiveness and appropriateness of liquidity provision as a policy measure to counter a currency crisis, based on the results of theoretical and empirical analyses,

2.   Economic Theory on Currency Crises (See Appendix 1)

Economic theories explaining currency crises before the Asian currency crisis are well known as *first* and *second generation models*.   After the Asian currency crisis, many theoretical evaluations were presented.   These theories have already been reviewed by others, thus in this section, I rather focus on aspects relating to the Asian currency crisis as well as the position of each theory in the development of theories on the subject.   Also, I attempt to explain the situation when the terms "insolvent" or "illiquid" are used, using a simple model.

2.1   Currency Crisis Theories Before the Asian Currency Crisis

2.1.1   First and second generation models

Theories on currency crises before the Asian currency crisis are known as first and second generation models.   Since it became apparent that they could not fully explain the outbreak of the Asian currency crisis, attempts to build theories that explain its outbreak have been made.

First generation models such as those cited by Krugman[1979] and Flood and Garber[1984] explain the relation between fiscal deficit and a currency crisis. This is considered effective in explaining the debt and currency crises in Latin American countries during the 1980s. According to these models, a government suffering from a large fiscal deficit will try to monetize the deficit by extending domestic credit, thus making it difficult to maintain a fixed foreign exchange rate system. This is because in order to maintain a fixed foreign exchange rate system, money supply (the sum of domestic credit and foreign reserves) needs to be maintained at a certain level. The extension of domestic credit leads to a fall in foreign reserves by the same amount. When foreign reserves fall below a certain level, investors come to anticipate a depreciation of the currency and start to sell it, and the economy can no longer maintain the fixed foreign exchange rate system.

Second generation models such as those cited by Obstfeld[1994, 1996] are often characterized by multiple equilibria occasioned by self-fulfilling expectations. This paper focuses on their implications concerning the relation between monetary policy and currency crises.

After the unification of former East and West Germany, Germany resorted to a tight monetary policy. Other countries followed suit in order to maintain the ERM. As a result, the member countries of the ERM suffered from low growth rate and high unemployment rate. In 1992, the ERM crisis made the UK and Italy leave the ERM. Spain also devalued its currency. Other countries ended up losing a substantial amount of foreign reserves.

Second generation models can effectively explain the mechanism behind the ERM crisis. They are viewed as emphasizing the opposite purposes of a fixed exchange rate system and an expansionary monetary policy. Suppose a case where monetary policy is employed to maintain a fixed foreign exchange rate, but the incentive for the central bank in the economy to resort to temporary expansionary monetary policy to boost domestic demand (e.g. high unemployment rate) is mounting. Expectations for an expansionary monetary policy lead to expectations for exchange rate depreciation. In addition, more depreciation pressure will be seen if it is thought that the authority will find it difficult to counter such pressure by intervention. To maintain a fixed foreign exchange rate system, the central bank needs to raise interest rates. However, this only offsets the effects of expansionary monetary policy. As a result of such contradicting policy aims, the cost of maintaining a fixed exchange rate system could exceed the benefits. In such case, the authority will abolish the system.

2.1.2 Applicability of the first and second generation models to the Asian currency crisis

After the Asian currency crisis, a consensus reached that first and second generation models could not fully explain the crisis (Table 1). The fiscal situation of each country was all found to

be running fiscal surpluses except for Taiwan.   As for the economic growth rate, though they were showing slight signs of a slowdown, they were still maintaining high growth rate.   Hence, it did not appear that they need to adopt an expansionary monetary policy to stimulate domestic demand at the sacrifice of exchange rate policy.   Yet in Thailand, where the Asian currency crisis was touched off, the increasing current account deficit was becoming a serious problem and the baht had frequently come under speculative attack even before 1997.   It also took many by surprise to see Korea, which seemed to have had no problem in terms of such statistics, was also struck by the crisis.   This has led researchers to either build new theoretical models or to expand the existing theories to explain the causes of the outbreak of the Asian crisis.

(Table 1) Economic Situation in Asian Countries Before the Outbreak of the Asian Crisis   (%)

	Korea	Taiwan	Hong Kong	Singapore	Thailand	Indonesia	Malaysia	Philippines
GDP growth rate								
90-96 average	7.7	6.3	5.0	8.9	8.5	7.3	8.8	2.5
95-96 average	8.0	5.9	4.3	8.0	7.2	8.0	9.0	5.3
CPI growth rate								
90-96 average	6.4	3.7	n.a	2.5	5.2	8.6	3.7	10.7
95-96 average	4.7	3.4	n.a	1.6	5.7	8.7	3.4	8.3
Ratio of fiscal balance to nominal GDP								
90-96 average	-0.2	-6.3	n.a	12.1	2.9	0.8	-0.2	-0.9
95-96 average	0.2	-6.4	n.a	13.8	2.1	1.8	0.8	0.4
Ratio of current account balance to nominal GDP								
90-96 average	-1.7	4.3	n.a	12.5	-7.0	-2.6	-5.7	-4.0
95-96 average	-3.3	3.1	-2.6	16.4	-8.1	-3.4	-7.2	-3.7

Source: national statistics

2.2   Theories on the Asian Currency Crisis

2.2.1   Theory explaining the plunge in currency values

As for the theories to explain the causes of the Asian currency crisis, initially two main views were developed, namely (1) "fundamentals-driven crisis theory", and (2) "financial panic-driven crisis theory".   These two views were seen as opposing theories.   However, to view them as totally opposing theories seems to be against our intuition that, "economic fundamentals and the formation of investors' expectations are not independent of each other".   Subsequently, such intuition received theoretical support from the development of game theory, which eventually led to a theory underlining the relation between the formation of investors' expectations and economic fundamentals.

(1) Fundamentals-driven crisis theory

Krugman[1998][1], Corsetti, Pesenti, and Roubini[1999] point out that implicit guarantee by the government for liabilities of domestic banks leads to moral hazard in domestic banks' lending policy. Non-performing loans will increase, and as a result, lead to a currency crisis. To be more specific, they regard the considerable amount of non-performing loans held by domestic banks as future government expenditure since people expect the government to bail out troubled domestic banks because of their close relationship. Thus, it can be said that the bad loans of private banks are essentially equivalent to the fiscal expenditures of the government. Expectations by international investors that governments will monetize the resulting budget deficits lead to expectations of currency devaluation. In this way, this theory claims that the crisis in Asia occurred even though there had been no serious fiscal deficit. As for the process of fiscal deficits triggering a currency crisis, the logic in the first generation model is employed in essence.

(2) Financial panic-driven crisis theory

Although Radelet and Sachs[1998] and Chang and Velasco[1998a,b] have different approaches in focusing on economic variables or developing detailed models, they both point out the possibility of the undesirable equilibrium (an equilibrium where a depreciation of the currency occurs) materializing within multiple equilibria (an equilibrium where "everyone expects currency depreciation and thus sell the currency, resulting in the actual depreciation of the currency" and an equilibrium where "everybody expects the maintenance of the value of the currency, and thus do not sell the currency, resulting in the actual maintenance of its value") in the economy, depending on investors' expectations. The idea is basically based on coordination-failure theory or bank-run theory. They claim the occurrence of an equilibrium such as the breaking out of a currency crisis i.e. "for some reason investors expect devaluation and start to sell the currency, making it impossible for the country to maintain a fixed exchange rate system, actually resulting in currency devaluation". Advocates of this theory claim that the massive reversal of capital flows from Asia cannot be explained by changes in fundamentals (such as fiscal deficit, unemployment rate, money supply) of the crisis-hit countries. They also point out various financial variables (yield spread between national issued US dollar-denominated bonds and US treasury notes, etc.), market projections (foreign exchange rate projections by investment banks, consensus forecasts, etc.), and the ratings of rating agencies did

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[1] Krugman later changed his views regarding the causes of the Asian crisis in Krugman[1999]. He moves on from a view placing importance on the deterioration of economic fundamentals to a view based on a theory of multiple equilibria.

not provide any early warning at the time of the Asian currency crisis.   Thus, they claim that the crisis is triggered by a sudden change in the expectations of market participants.

(3) Theory regarding the relation between the formation of investors' expectations and economic fundamentals

The above mentioned explanation on currency crises (application of coordination failure theory or bank-run theory) does not provide an answer to the problem as to which equilibrium of multiple equilibria would hold.   Depending on investors' expectations, both equilibria with a crisis and without a crisis can exist at a certain state of economic fundamentals.   This is because these theories do not provide an answer to the cause of a change in investors' expectations. Morris and Shin[1998] first theoretically analyze how the formation of investors' expectations (and the decision making that accompanies it) is linked with the state of economic fundamentals. They then apply this to the financial crisis theory.   The conclusion of the theory is: when expressing the state of economic fundamentals with a parameter, there exists a threshold value of economic fundamentals that triggers the selling of a currency.

According to this paper (Morris and Shin), the existing theory (the application of the coordination failure theory or the bank-run theory) allows multiple equilibria (an equilibrium where "everyone expects currency depreciation and thus sell the currency, resulting in the actual depreciation of the currency" and an equilibrium where "everybody expects the maintenance of the value of the currency, and thus do not sell the currency resulting in the actual maintenance of its value") to exist under a certain state of fundamentals, because these theories assume that all investors have perfect information and common knowledge with respect to fundamentals (i.e. everyone knows the state of fundamentals and everyone knows "everyone knows the state of fundamentals" and everyone knows… *ad infinitum*).   On the other hand, by assuming a more realistic hypothesis that each investor would have different information regarding economic fundamentals, we can solve the problem of indetermination of equilibrium.   This hypothesis can also prove that a threshold exists between the state of economic fundamentals with or without the outbreak of a crisis.

The intuitive explanation of the logic behind the above claim would be as follows.   Under a situation where each investor's payoff is influenced by not only his/her own action but also economic fundamentals and the action of other investors, each investor needs to consider how other investors view the economic fundamentals.   If one tries to predict other investors' view of economic fundamentals based on the attained signal regarding economic fundamentals (the true value plus noise), one can estimate the proportion of investors holding a more pessimistic view. Based on such information, investors can calculate their payoff and decide their course of action.

The signal here is disseminated from the state of economic fundamentals.   Therefore, economic fundamentals are linked with formation of investor expectations and the action that accompanies it.

As shown above, this theory goes beyond the question of "fundamentals crisis vs. self-fulfilling crisis" and considers the relation between economic fundamentals and the formation of expectations, which previously was not given enough theoretical foundation.   According to this theory, under a certain state of fundamentals, a certain equilibrium is uniquely determined: either one situation of the two, that is equilibrium with or without the crisis, will emerge.   If fundamentals deteriorate and approach the threshold situation, the possibility of a crisis occurring in response to even a slight change in fundamentals will emerge.   It also implies that even a small shock occurring in a situation which is close to the threshold can trigger drastic selling by investors.

2.2.2   Reviewing the concept of solvency and illiquidity

The above mentioned idea of a "fundamentals crisis vs. self-fulfilling crisis" can be put in another way as the difference between the following two views.   It can be said that a country is hit by a crisis as a consequence of the country in question being insolvent.   It can also be said that a crisis occurs as a country is "solvent but illiquid", lacking in temporary liquidity.   This section thus review the concept of solvency and illiquidity in relation with the above theories.

Suppose that a country is investing in an investment project[2] and it is also funded by many foreign investors.   The larger the amount invested, the bigger the output of the project. However, it takes some time for such a project to yield an output (for example, it takes time for a factory to be completed), and foreign investors can withdraw their money before completion of the project.   Let us suppose that the withdrawal of funds before the completion of the project has a lowering effect on the project's output.   The oversea borrowings are to be returned when the project is completed.   If the output is not large enough to repay such borrowings, the borrower defaults.   The economic fundamentals of the country are considered equivalent to the productivity of the investment project and are expressed as variable θ.   What is the relation between economic fundamentals, and the concept of solvency and illiquidity?

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[2] According to convention in this type of economic theory we use the term "investment project", but actually it refers to a situation where a country funds its excess investment with external borrowings. The profitability of the project depends on an increase in the productivity of the macroeconomy brought about by the development investment in the country as a whole.

First, we consider a case where almost all overseas investors withdraw their loans before completion of the project.　Because of the withdrawal, the output of the country will plunge. Yet, if the fundamentals are very strong (θ takes a very large value), the economy will produce enough output to repay the loans and thus the country will not face default.　If we express such a level of fundamentals as $\bar{\theta}$, the economy will not face default even if nearly all investors withdraw their loans as long as $\theta > \bar{\theta}$.　The fundamentals are so strong and there will be no default.　Investors who know this will not withdraw their loans before completion of the project, and try to earn interest income.　In such a case, "a solvent country will not be attacked by crisis".
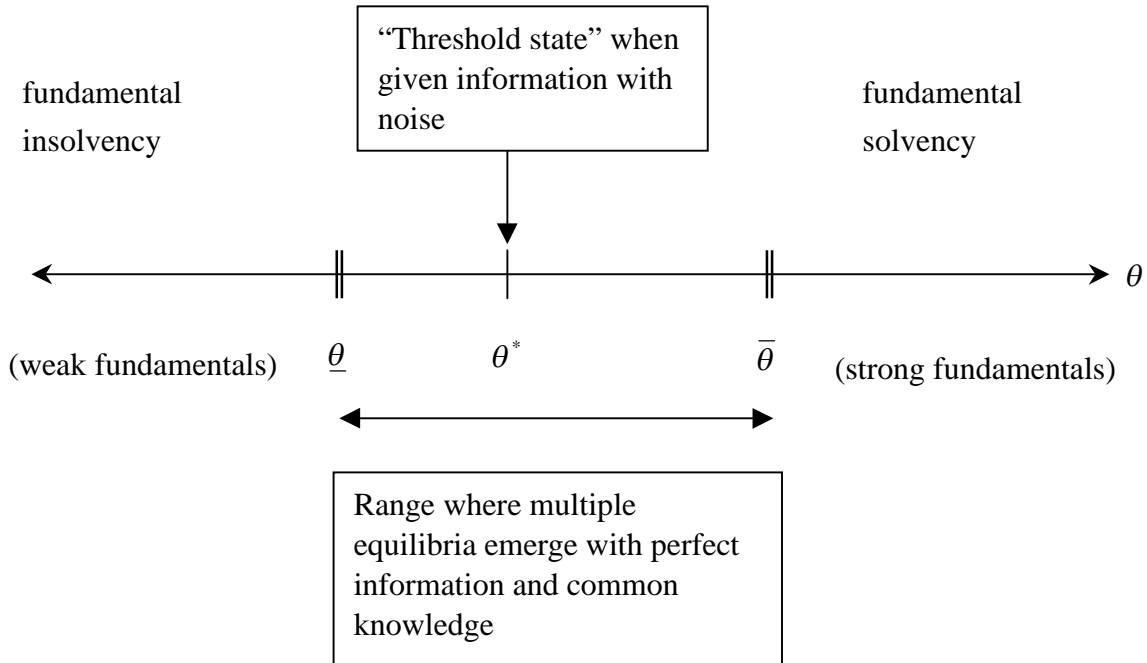
Next, we consider a case where all overseas investors roll over their loans.　There will be no lowering of output caused by the withdrawal of such loans.　Yet, if fundamentals are very weak, the economy cannot produce enough to repay, leading to default.　Let us express such fundamentals as $\underline{\theta}$.　When the fundamentals are so weak as $\theta < \underline{\theta}$, there will be default. Investors who know this will withdraw their loans before completion of the project.　In this case, the country is insolvent, or in other words "the reason for the currency crisis is a deterioration in fundamentals of the borrowing country ".

Lastly, an interesting situation is when fundamentals are neither too strong nor too weak. This can be expressed as $\underline{\theta} < \theta < \bar{\theta}$.　With fundamentals in such a situation, the country will face default if the withdrawn amount is large, but if the amount is small, the default will not occur.　Thus under this situation, temporary illiquidity due to the withdrawal of loans could lead to insolvency i.e. default.　Under $\underline{\theta} < \theta < \bar{\theta}$, it can be proved that under a certain state of economic fundamentals, the two situations (i.e. "Everybody expects default and thus everyone withdraw his/her capital, which finally led to actual default" and "No one expects default and thus all investors roll over their lending thus default does not occur") are possible.　In this sense, the scope of economic fundamentals that accept the multiple equilibria theoretically exist as in (2) above.　As opposed to this, Morris and Shin[1998], as mentioned in (3), assume a situation where each investor observes the fundamentals differently, and if θ is less than the threshold value θ^* ($\theta < \theta^*$), withdrawal of the loans will be the optimal course of action.　If $\theta^* < \theta$, the optimal action will be continuing the loans.　It can be proved that the threshold state of fundamentals, θ^*, is in the scope of $\underline{\theta} < \theta < \bar{\theta}$ (Chart 1).

According to this theory, even if a country is not in an insolvent situation ($\theta > \underline{\theta}$), if the fundamentals fall below the threshold value θ^*, the action of the investors will change,

triggering the crisis.   This results in the insolvency.   It is also plausible that once the crisis breaks out, the productivity will drop because of the withdrawal of capital, leading to the further deterioration of the fundamentals.

(Chart 1) The Concept of "Solvency" and "Illiquidity"

fundamental
insolvency

"Threshold state" when given information with noise

fundamental
solvency

$$\longleftarrow \qquad\qquad\qquad\qquad\qquad\qquad \longrightarrow \theta$$

(weak fundamentals) $\underline{\theta}$ θ^{*} $\bar{\theta}$ (strong fundamentals)

Range where multiple equilibria emerge with perfect information and common knowledge

Explanation using the model

Let us review a simplified version of the model discussed by Chui, Gai, and Haldane[2000].   (The explanation below is for the assistance of a more concrete understanding of the above concept, but it is not necessarily required for an intuitive understanding).

There are three stages in time (t= 0, 1, 2).   The discount factor is discarded.   At $t = 0$, a country has internal financial resources E that can be used for productive investment.   This country borrows from overseas investors to increase its level of production.   There are n overseas investors.   Each one of them lends L amount to this country (total amount: nL) at $t = 0$.   The country agrees to pay back $L(1+r)$ to each investor at an interest rate of r at $t = 2$.   At stage 1 ($t = 1$), overseas investors can reclaim the funds they lent at stage 0 ($t = 0$).   Here, let λ ($0 \leq \lambda \leq 1$) be the proportion of foreign investors who decide to withdraw their lending at stage 1.

The payoff of each foreign investor is influenced by their own action and also that of the debtor. The following matrix summarizes the payoff of each foreign investor.

(Table 2) Payoff of Overseas Investors

		Debtor's action	
	Time of payoff	Repay	Default
Investors action	$t = 1$	L	L
	$t = 2$	$L(1+r)$	0

The production technology of the debtor country produces an output that can be calculated from multiplying the amount of capital used at $t = 0$ by a constant θ. θ expresses the productivity of production technology and the value of this parameter can be thought as the state of the country's fundamentals in our model. Production technology requires funds at stage 0, but "time to build" is needed so that there will be no output until stage 2. Suppose that the funds are withdrawn at stage 1, then the production level drops and its marginal effect is expressed by the parameter k. Therefore, the total decrease in production is $k\lambda(nL)$. Under such a setup, the capital that is available to meet repayments at stage 2 is given by:

$$\theta(E + nL) - k\lambda nL$$

On the other hand, the repayment amount at stage 2 is the sum of funds that was not reclaimed at stage 1 plus the interest, and can be expressed as $(1 - \lambda)nL(1 + r)$. Thus, at stage 2, the condition for the country to service its debt is as follows:

$$\theta(E + nL) - k\lambda nL \geq (1 - \lambda)nL(1 + r) \qquad \text{(solvency condition)}$$

This expresses the relation between the productivity of production technology, θ (fundamentals), and λ (the degree of liquidity dry up at the intermediary stage) regarding the condition for a country to be solvent.[3]

If we change the above solvency condition to an equality, and suppose that $\lambda = 1$, then θ is $\bar{\theta}$ when all investors have withdrawn their loans at stage 1,

$$\bar{\theta} = \frac{KnL}{E + nL}$$

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[3] Here, we suppose that $k > 1 + r$, where the marginal loss of output because of the withdrawal of funds is larger than the marginal borrowing cost of funds. In this case, $\underline{\theta} < \bar{\theta}$ holds.

On the other hand, if we suppose that $\lambda = 0$ in the equality, then θ is $\underline{\theta}$ when all investors do not withdraw loans at stage 1.   The value of $\underline{\theta}$ is as follows.

$$\underline{\theta} = \frac{(1+r)nL}{E+nL}$$

Suppose that $\theta > \overline{\theta}$, the fundamentals will produce enough output to service remaining debt at stage 2, even if almost all external debt is withdrawn at stage 1.   Thus, the borrower country will not face default due to investor's withdrawing funds.   Therefore, no matter how other investors behave, the return will be larger by rolling over loans until stage 2 than by withdrawing them at stage 1 (individual overseas investor's payoff: $L(1+r) > L$).   On the contrary, if $\theta < \underline{\theta}$, fundamentals are very weak and even if all investors roll over their loans until stage 2, the borrower country will face default.   Under such a situation, the optimal investor action at stage 1 will be to withdraw loans no matter how other investors behave (individual overseas investor's payoff: $L > 0$).

On the other hand, when $\underline{\theta} < \theta < \overline{\theta}$, that is when fundamentals are not too weak nor too strong, the optimal action of each investor depends on the size of λ.   If many investors withdraw their loans at stage 1, i.e. when the value of λ is large, there will be default at stage 2, thus causing the withdrawal of loans to be the optimal action.   On the contrary, if the value of λ is small, there will be no default, so the roll over of loans will be the optimal choice[4].   This suggests that the optimal action of investors will be different depending on how each expects other investors to behave.   This is a situation where the claim, "there is the possibility that a country would become illiquid although the country would be solvent if investors rolled over their loans" holds.   If we suppose that there will be perfect information about fundamentals and common knowledge holds, multiple-equilibria will emerge with $\lambda = 1$ (an equilibrium where all investors withdraw loans) and $\lambda = 0$ (an equilibrium where all investors roll over loans).   Morris and Shin[1998] prove the existence of θ^*, that is the threshold state of fundamentals, where investors have to choose either to withdraw or roll over their loans in the presence of noisy information about the fundamentals (Chart 1).

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[4] Strictly speaking, it will be as follows: when the value of θ is given, if we suppose that the value of λ to be $\lambda^*(\theta)$ under a situation where the solvency condition is held as an equality,

$\lambda^*(\theta) = \frac{(1+r)}{(1+r)-k} + \frac{E+nL}{nL(k-(1+r))}\theta$ will be given.   It will be $\frac{\partial \lambda^*}{\partial \theta} > 0$ with our assumption

$k > 1+r$, giving a result that "when fundamentals are stronger, the payback of loans will be easier at stage 2, even if an increasing number of investors withdraw their loans at stage 1. " This result fits our intuition.   Under a situation where $\underline{\theta} < \theta < \overline{\theta}$ holds, if an individual investor expects $\lambda < \lambda^*(\theta)$ under a certain θ, his optimal action is to roll over loans.   And if he expects $\lambda^*(\theta) < \lambda$, his optimal action is to withdraw loans.

As seen above, theories regarding the mechanics behind the occurrence of a currency crisis were developed reflecting the characteristics of past crises, but after the Asian crisis, they have developed mainly in two directions.   One strand is the group of theories that places importance on the relation with economic fundamentals (economic growth rate, fiscal deficit, alignment between foreign exchange rate and inflation, current account balance, the amount of foreign debt, etc.).   The another is the group of theories that tries to explain sudden capital outflow and currency devaluation based on the coordination-failure theory or bank-run theory.   Theories comprising the former group, seem to disregard the seemingly irrational drastic action taken by investors in financial markets, while those comprising the latter group appear to contradict the perception of "a crisis has never hit a country with perfectly healthy economic fundamentals. Rather, countries with problematic economic fundamentals seem to be more susceptible to a financial crisis."   As a consequence, it can be said that it is in response to these insufficiencies of these theories that the theory that considers both fundamentals and the formation of investors' expectations has evolved.

2.3   The Mechanics of Currency Crisis that Lead to a Plunge in Aggregate Output

When a national currency depreciates, the price competitiveness of that nation's products will increase, leading to an increase in exports.   As a result, there will be an increase in the aggregate output of countries with a high share of exports to its aggregate output.   Yet, in the case of the Asian crisis, a plunge in aggregate output was observed following a plunge in the currency values.   The observed phenomenon was that: an abrupt increase of interest rate after the crisis led to a drop in capital investment; there was a rapid outflow of capital, which led to the liquidation of investment projects as well as the depletion of operating funds for companies that depended on foreign capital.

The *twin crisis hypothesis*, which holds that the crisis in the domestic banking sector augments the impact of the currency crisis, stresses the fact that in the past many currency crises accompanied a crisis in the domestic banking sector (Kaminsky and Reinhart[1999a]).   In the case of the Asian crisis, the level of non-performing loans of domestic banks was already high even before the outbreak of the currency crisis.   Also, when the crisis broke out, domestic banks had trouble rolling over foreign debt.   As a result, non-performing loans increased and some banks failed.   As for the reason for such bank crises leading to a lowering of total output, Chinn and Kletzer[1999] and Diamond and Rajan[2000] point to diminished monitoring and loan collection abilities on the part of domestic banks.   Domestic banks should have an ability to monitor the profitability of the projects of domestic companies and be able to collect loans with the background of domestic laws and existing corporate relations.   In the situation where information about profitability of a project is asymmetrical between lenders and borrowers, the

banks guide the investors' capital to projects by employing their knowledge and skill.   When such banks go bankrupt, the provision of capital will stagnate because no substitute institution with the necessary knowledge appear quickly enough to fill the gap.

According to *the agency theory*, employed in Bernanke and Gertler[1989] for instance, it is claimed that, in imperfect financial markets, the maximum amount a company can borrow is determined based on the level of its net worth.   An intuitive explanation of this theory is as follows.   When a manager of a firm can choose investment projects or his/her effort level, the larger the financial loss of the default for him/her personally, the more careful he/she is to avoid risky investment and the more effort he/she puts into the business.   Therefore, lenders of capital who only have imperfect information regarding the course of actions of managers, would raise the amount of lending to borrowers with higher levels of net worth.   Krugman[1999] and Aghion, Bacchetta, and Banerjee[2000] go further by explaining the mechanics of a crisis which causes a simultaneous drop in both aggregate output and currency value in terms of the size of foreign-denominated debt held by firms i.e. the depreciation of the national currency causes an increase in the repayment amount of foreign-denominated debt in terms of domestic currency, leading to a drop in profit.   As a result, firms' net worth shrinks, leading to a fall in the maximum borrowing of firms.   Firms have difficulty to raise operating funds and capital for new investment, resulting in a contraction of aggregate output.   This theory explains capital outflow and a drop in aggregate output in crisis-hit countries following the Asian crisis, and is in line with the fact that a large amount of foreign-denominated debt existed before the crisis.

Lastly, *the debt-overhang theory* is examined.   Suppose a company is suffering from a large amount of debt, and repayment is stagnating.   Even if the company has a highly profitable new investment project, lenders may not lend capital.   This is because, when investors consider the probability of repayment, they also consider the fact that the profit generated by this project will first be used to pay back overdue debt.   Such a situation is termed *debt-overhang*.   This is not a phenomenon unique to a currency crisis but the skyrocketing of foreign debt in terms of domestic currency due to massive devaluation is likely to have been a cause of the stagnation of new investment.

An understanding of the mechanics behind a currency crisis leading to a drop in aggregate output is important when considering how to handle such a currency crisis.   For example, consider a case where a drop in aggregate output is triggered by a drop in corporate net worth resulting in a drop in borrowing amount.   The raising of interest rates increases the interest payment burden, further squeezing corporate profit.   This can lead to a further lowering of a limit of corporate borrowing, causing a further drop in total production.   Another example is as follows.   The closing down of domestic banks with a huge amount of non-performing loans can

lead to improved overall confidence of the domestic financial sectors. At the same time, it also means that companies doing business with such banks lose their source of funding thus, leading to an increase in the number of bankruptcies. Therefore, it can be said that in order to consider the costs and benefits that accompany the respective measures, it is important to understand the mechanics with which a currency crisis brings about changes in aggregate output.

3. Empirical Analyses on Currency Crises (See Appendix 2)

3.1 The Objective of Empirical Analyses

The purpose of empirical analyses on the currency crises is to quantitatively analyze what factor (for example, current account deficit, a ratio of foreign short-term debt to foreign reserves), alone or in tandem with other factors, contributes to the occurrence of a crisis and its depth. To be more specific, previous empirical analyses sought answers to the question as to whether the fundamentals-related variables could fully account for the probability of a crisis occurring and its depth. The reasons for this question being widely shared are as follows:

(1) As seen in Section 2 of this paper, there are two main strands of the theoretical explanation regarding the mechanics behind a crisis breaking out: one that tries to explain it in terms of economic fundamentals; one that places more importance on the formation of investors' expectations. The question is which theory has a better explanatory power.

(2) Policy implications will vary considerably depending on which theory one supports. If one believes deterioration in economic fundamentals being the cause of a drastic depreciation of a currency, it is only through an improvement in economic fundamentals that its value can be restored. On the other hand, if the drastic depreciation is caused by financial panic (sudden change in market participants' expectations) or contagion (spillover of the crisis), the implementation of a policy that aims to calm down market sentiment, such as, a temporally limitation on capital movements or liquidity provision by international organizations etc., would be worth considering.

3.2 Methods of Empirical Analyses and Results

3.2.1 Variables in the analyses

Many papers examine the explanatory power of each country's economic fundamentals regarding the probability of a crisis occurring and its depth. They move on to analyses from the viewpoint of "how can the parts that cannot be explained by fundamentals be accounted for?"

These studies include analyses of plausible contagion channels, and they try to gauge quantitatively the effect of a sudden change in investors' expectations.

The influence of the respective variables regarding the probability of a crisis breaking out is measured by quality dependent variable methods such as Probit.   As for the depth of a crisis, it is usually expressed in terms of changes in the weighted average of changes in the foreign exchange rate and foreign reserves.   This weighted average is often referred to as *the crisis index*, which shall be used from hereon in this paper.

The modeling methods of fundamentals-related variables, contagion channels and changes in investor expectations in empirical analyses are as follows:

(1) Fundamentals-related variables

Fundamentals-related variables can be divided largely into two groups: figures related to "fundamentals that are related to the domestic macroeconomy"; figures related to the "fundamentals of external positions".   Typical figures employed in the studies are as follows[5]:

Fundamentals in relation to the domestic macroeconomy:

-- *GDP growth rate*: the drop in GDP growth rate can lead not only to a drop in the capability to service debt but also motivates the government to employ an expansionary monetary policy.

-- *inflation rate*: the acceleration of the inflation under fixed foreign exchange rate system increases pressure on currency to devalue.

-- *fiscal deficit/GDP ratio*: an increase in this ratio results in the increased inflationary pressure.

-- *increase in bank lending*: same as above

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[5] In this paper, only typical figures used for empirical analyses are raised.   For example, Milesi-Ferretti and Razin[2000] uses following figures: "*Macroeconomic variables* such as economic growth, real consumption growth, rate of investment, fiscal balance, and level of GDP per capita. *External variables* such as the current account balance (exclusive and inclusive of official transfers), real effective exchange rate, degree of real exchange rate overvaluation, degree of openness to trade, and level of external official transfers as a fraction of GDP. *Debt variables* such as the ratio of external debt to output, interest burden of debt as a fraction of GNP, shares of concessional debt, short-term debt, public debt, multilateral debt in total debt, and ratio of FDI flows to debt outstanding. *Financial variables* such as the ratio of M2 to GDP, credit growth rate, and ratio of private credit to GDP. Foreign variables such as the real interest rate in the United States (as a proxy for world interest rates), rate of growth in OECD countries, and terms of trade. *Dummy variables* such as regional dummies, a dummy for the exchange rate regime that takes the value 1.0 if the country's exchange rate is pegged and zero otherwise, and a dummy that takes the value 1.0 if the country has an International Monetary Fund (IMF) program in place for at least six months during the year."

-- *banks' non-performing loans/GDP ratio*: if a government tries to bailout banks by using fiscal funds, future fiscal debt will increase.

Fundamentals in relation to external positions:

-- *current account balance/GDP ratio*

-- *changes in terms of trade*

-- *short-term external debt/foreign reserves outstanding ratio*: an increase in this ratio is likely to increase the possibility of liquidity drain.

-- *direct investment/foreign debt ratio*: an inflow of long-term capital for production facilities could lower the possibility of a crisis breaking out.

-- *foreign debt/GDP ratio*

-- *US interest rates*: used as a proxy for cost of raising the foreign funds.

(2) Contagion channel

In econometric analyses, contagion channels are quantified and their influence on the depth of a crisis is estimated.

First, the degree of linkage between each country in the estimated channel is transformed into index. Then the indices of the sample countries are standardized so that the sum of total sample countries' indices becomes 1. The crisis index of each sample country multiplied by the standardized index is included in the regression estimation which has the crisis index of a country as the dependent variable. One of the simplest examples is as follows. If we take geographical distance as a contagion channel, for the crisis index we use the reciprocal of the geographical distance between dependent variable countries and independent variable countries as raw indices before standardization.

The typical contagion channels that are expected to have influence, and those that are included in the scope of analyses are as follows:

-- *direct trade relations*: a channel through which deterioration in the economy of a trading partner country leads to a drop in exports, influencing the economy of the exporting country.

-- *export competition in third markets*: a channel through which depreciation of the currency of one country leads to a lowering of other countries' price competitiveness when those countries are in export competition, influencing the economies of those countries.

-- *common lender channel (common lender hypothesis)*: a view that "in a situation where both country A and B are borrowing from a common lender, Bank X; when a crisis occurs in country A, Bank X will not only decrease the amount of lending to country A but also lower the lending amount to country B".　In the analyses of currency crises, Bank X does not refer to a single bank but refers to a group of banks in certain countries, such as banks in the US, Japan etc.　For Latin American countries, US banks are the major common lenders.　At the time of the Asian currency crisis, Japanese banks were the major common lenders to Asian countries.　This channel has a great influence since the need to reduce exposure becomes essential for the lenders in a financial crisis through such ways as: maintenance of the risky asset ratio, and risk management by VaR.　In VaR, exposure to a country whose variation of the financial variables shows a historically high correlation with the crisis-hit country is treated as exposure with high risk.

-- *neighborhood effect*: a view claiming that investors consider countries in the neighboring area as alike and this causes contagion in the area as a whole.　For example, with respect to the Asian crisis, we could suppose that the selling of a country's currency, stocks, and bonds might have happened just because it was an "Asian" country.　In empirical analyses, quantification based on the geographical distance as well as one based on the dummy variable are performed.

(3) Changes in investors' expectations

As regards to an influence of sudden changes in investors' expectations, a Markov-switching regime model is often referred.　In a Markov-switching regime model, a variable (Markov-switching variable) realizes different values given exogeneously with a certain probability.

3.2.2　Results of empirical analyses

Here, I would like to show some notable results of empirical analyses by referring to some selected papers.　First, the results of the explanatory power of fundamentals-related variables are examined.　In particular, the influence of short-term debt, which is one of the most noted variables, is underlined.　Then the results of analyses on contagion channels and changes in the investors' expectations are examined.　Lastly, I will examine the results of analyses on respective contagion channels.

a. Explanatory power of fundamentals-related variables

Although there are some differences regarding the explanatory power of fundamentals-related variables in respective studies, it can be said that the explanatory power is acknowledged with

respect to individual variables such as the current account to GDP ratio, the ratio of foreign short-term external debt to foreign reserves, and terms of trade.

Yet, the explanatory power of the estimation function as a whole is not substantial in any combination of fundamentals-related variables (in the case of OLS, R^2 is low and the residual is large). These results suggest that factors other than differences in fundamentals-related variables are also influencing the outbreak and depth of a crisis.

Among many such results, Corsetti, Pesenti, and Roubini[2000] sees a close relation between fundamentals-related variables and the depth of a crisis. They claim that, within emerging market economies meeting the condition[6] that "the ratio of the current account deficit to GDP is very high, or the ratio of domestic banks' non-performing loans is pretty high", the depth of a crisis is strongly influenced by the ratio of short-term external debt to foreign reserves, current account deficit to GDP ratio, and the ratio of non-performing loans. These results can be considered to suggest the following; no single figure is a trigger; the influence of changes in the figures is non-linear (i.e. the marginal effect varies with the level of variables).

b. Influence of short-term external debt

One feature garnering attention during the Asian crisis has been the high level of short-term external debt in the countries which have been greatly influenced by the crisis. In particular as the correlation between the ratio of short-term external debt to foreign reserves and the depth of the crisis has been predicted to be high, the relation between those has been extensively examined. The results of these studies show that when this ratio is low, unfavorable changes, such as an increase in current account deficit and rise in real foreign exchange rate have limited effect. Busssière and Mulder[1999] examine the relation between the crisis index and the ratio of short-term external debt to foreign reserves. The results show that when the latter becomes larger than around 1.0, the relation between the two becomes stronger (i.e. the effect of the ratio on the crisis index increases). Greenspan[1999] suggests keeping the ratio below 1.0, as a guideline for the liquidity management policy of emerging market countries. This suggestion is in line with the empirical results of Busssière and Mulder[1999].

c. Contagion channels and the influence of changes in expectations

Fundamentals-related variables that are reported periodically do not appropriately account for the daily changes in financial variables (foreign exchange rate, stock price, and sovereign spread

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[6] To be specific, this refers to a situation where they are included in the top quartile of the sample countries.

<the spread between dollar-denominated bonds and US Treasury notes>). Baig and Goldfajn[1999] formulates dummy variables as a proxies for changes in economic fundamentals by using news from Reuters and Bloomberg. The news is sorted into "good" and "bad" news according to certain criteria. The regression estimation using these dummy variables as proxies shows that the dummy variables possess explanatory power to some extent. However, the residuals of the estimation are still quite large. The results also show that the correlation between the residuals of the estimation for each country is quite high. This shows the existence of contagion under the definition "the correlation between the financial variables of countries that cannot be explained by their fundamentals". Fratzscher[1999] examines the effect of changes in investors' expectations by the Markov-switching regime model, attaining a result that shows the effect significantly raises the estimation's explanatory power.

d. Influence of contagion channels

Empirical analyses examining contagion effects such as De Gregorio and Valdes[1999], and Cho and Hong[1999] give results where by adding contagion channels to fundamentals-related variables, the explanatory power of the regression increases. Among the contagion channels, neighborhood effect channel has the highest explanatory power. In the case of other channels, when the direct trade relation channel alone is used in the regression, its explanatory power is high. However, when the neighborhood effect channel is also included in the same regression, the explanatory power of the direct trade relation channel disappears. This suggests the possibility that the direct trade relation channel is only a proxy for the neighborhood effect channel. Regarding this point, Kaminsky and Reinhart[1999b] examines the variation in the interest rates and exchange rates in five countries (Thailand, Indonesia, Malaysia, the Philippines and Korea) using VAR and shows that the correlation increased during the Asian currency crisis period compared to the pre-crisis period. They claim that this result shows the possibility of investors' recognition of these countries as a single group during the crisis.

Van Rijckeghem and Weder[1999] examines the contagion effect through the common lender channel. This study examines whether the dependency of a country on the common lender with the crisis origin (in the case of the Asian financial crisis, Thailand) increases the probability of a crisis breakout to the country. The results of Kaminsky and Reinhart[1999b] also show that Japanese banks' withdrawal of lending from Asian countries after the crisis in Thailand is a factor in transmitting the crisis to Indonesia, Malaysia and Korea. Van Rijckeghem and Weder[1999] also proves high explanatory power to the common lender channel in the Mexican crisis (1995). However, in the case of Russian crisis (1998), the explanatory power of this channel is not high. They provide the reason for this low explanatory power in the Russian

crisis as follows; due to a worldwide flight to quality and liquidity during the Russian crisis, credit crunch took place even in countries that did not share lenders with Russia.

We can sum up the results of the analyses as follows:

(1) Fundamentals-related variables have some explanatory power concerning the probability of a currency crisis occurring and its depth.   However, there is much about the development of a currency crisis, which cannot be explained by fundamentals-related variables.

(2) The effect of deterioration in fundamentals on the probability of the occurrence of a currency crisis and its depth would be non-linear.   The larger the degree of deterioration, the greater the marginal effect of any worsening.

(3) The unfavorable effect of factors such as a high current account deficit to GDP ratio and rise in real foreign exchange rate can be mitigated by a low ratio of short-term external debt to foreign exchange reserves.   At the same time, an increase in the ratio would deepen a currency crisis.   It seems that there is a threshold beyond which an unfavorable effect of an increase in the ratio becomes significant.   A ratio of around 1.0 seems to be the range where the threshold exists.

(4) Inclusion of financial panic elements and contagion channels in quantitative analysis significantly improves explanatory power.

(5) Among possible contagion channels, neighborhood effect is the most significant in improving the explanatory power of estimations.

The results of these major analyses suggest the inefficiency of theory that attempts to explain the breakout of a crisis only by fundamentals alone ((1) in 2.2.1).   It is also shown that theory that advocates the breakout of a crisis due to the close interaction between economic fundamentals and investor expectations ((3) in 2.2.1) seems to have more validity than multiple-equilibria theory ((2) in 2.2.1)[7].   The latter part of this paper will discuss how to deal with a currency crisis based on the above theories and empirical analyses.

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[7] Even in the theory of multiple-equilibria, fundamentals and the breakout of a crisis are not necessarily totally independent of each other.   In Chart 1, fundamentals that were in the region of "fundamental solvency" deteriorate and when they do so to the range where the multiple equilibria are allowed, it means that the possibility of a crisis now arises.   Yet, in the region where multiple equilibria are allowed, the relation between changes in fundamentals and the probability of a crisis breaking out no longer exists. Therefore, taking the multiple equilibrium theory, if a significant relation arises between fundamentals and the probability of a crisis breaking out, we must be aware that the region that allows multiple equilibria is not large.

4. The Policy Implications: The Role of Liquidity Provision as a Policy Measure in Currency Crisis Management

Looking at past currency crises, we can arrive at the conclusion that there have been cases where a country, which should not have had a problem servicing external debt in the long run, has fallen into a situation of temporary illiquidity (i.e. solvent but illiquid). There has also been a case where the magnitude of a crisis went beyond the level that could be explained by a deterioration of fundamentals. The existence of such cases is supported not only by theory but also by the results of aforementioned empirical analyses. In fact, such intuition existed before theories and empirical analyses proved the possibility[8]. It can be said that the results of academic studies have been accumulated to a degree that they provide sufficient evidence to support such intuition.

The results of these precedents would support the "necessity of liquidity provision as an emergency measure in a crisis." The following will re-examine this point using the model used in Section 2 of this paper (see Chart 1).

Assume a case where fundamentals are expressed as $\underline{\theta} < \theta < \bar{\theta}$. This is a case where people are concerned to a certain degree about the strength of fundamentals to service debt (not in fundamental solvency $\theta > \bar{\theta}$), but fundamentals are not so bad that default is inevitable (not in fundamental insolvency $\theta < \underline{\theta}$). In such a case, there will be no crisis until the fundamentals parameter exceeds threshold value θ^*. However, when fundamentals worsen and as soon as the parameter value falls below the threshold value, all investors will try to withdraw funds. Once a crisis breaks out, withdrawal of funds affects the production of an economy that would otherwise produce enough to service debt. In addition, the mechanics of currency depreciation that lowers total output described in 2.3 would worsen the situation, eventually leading to a plunge in output. As a result, debt servicing becomes impossible, and illiquidity ends up becoming insolvency.

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[8] For example, IMF[1998] refer to the possibility as follows: "Several factors---mainly domestic but also external, operating to different degrees in different countries, and exacerbated by contagion and spillovers among the countries involved---seem to have contributed to the dramatic deterioration in sentiment by foreign and domestic investors." And as for the price drop in the financial products and the depreciation of the currency, they reported as follows: "well beyond what was justified by any reasonable reassessment of economic fundamentals, even in the light of the crisis."

In such a case, if provision of liquidity from international organizations and other countries is implemented in order to prevent the worsening of liquidity dry up[9], it is possible to keep the overall plunge in output in check and maintain solvency. The fact that liquidity was provided by international organizations or other countries, as well as the announcement of measures accompanying liquidity provision to rectify the deterioration of fundamentals, would change market participants' expectations on economic fundamentals (shift in the threshold value, θ^*). Moreover, as a consequence of liquidity provision, time can be bought. If policies can be implemented to improve economic fundamentals (change in θ), it might even be possible to resolve the crisis (reconstruction of the situation $\theta > \theta^*$)[10].

It seems that some concrete measures with respect to the provision of liquidity are materializing based on the thoughts mentioned above. For example, IMF established CCL in 1999 and made enhancements in 2000. Intra-regional swap agreements among the ASEAN+3 countries, which idea is initiated in 2000 and is planned to be concluded in the near future, seem to share the same spirit. It is probable that such movements would see further progress in the future, involving more member economies (the members of already existing international organizations, regional members, members at a different stage of economic development) and applying different schemes (fund lending, currency swaps, currency swaps by currency).

With respect to such initiatives, it seems important to consider the following, which remain issues to be answered in the future:

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[9] In order to prevent liquidity drying up, capital controls that prohibit or limit the withdrawal of funds can also be considered. However, regarding the provision of liquidity and this option, we could not reach a conclusion from the studies and analyses shown in this paper to determine which is more desirable. More details are needed to evaluate this option. Here, the problems attaching to such an option will be pointed out: (1) Is it possible to establish efficient controls without any loopholes? (2) The timing of removing controls is difficult to determine (removal could trigger a speculative attack). (3) The possibility of implementing capital controls could increase investors' caution vis-à-vis investing in the country, hindering fund inflows, or lead to a premium on fund from overseas.

[10] In this paper, discussion has proceeded based on the theory that claims the existence of a threshold in terms of the state of fundamentals that triggers a crisis (2.2.1 theory (3)). However, even if we change the prerequisite theory to a *theory of multiple equilibria* (2.2.1 theory (2)), it can be said that we can support "emergency provision of liquidity when a crisis breaks out". The fact itself that liquidity has been provided can influence investors' expectations. This could facilitate a jump from "bad" equilibrium (investors sell the currency) to "good" equilibrium (investors do not sell the currency). That is, liquidity provision can play the role of a *coordinating device*. Next, even if liquidity provision itself does not influence investor expectations, provision can *buy time* to prevent aggravation of a crisis. Meanwhile, the government could implement policies that improve fundamentals or control capital transactions, and show its commitment to such policies, influencing the expectations of investors and thus facilitating a jump from "bad" equilibrium to "good" equilibrium.

(1) Preventive measures against moral hazard

   As the empirical analyses in Section 3 show, it is thought that there is a close relation between the ratio of short-term external debt to foreign reserves and the probability of a crisis breaking out.   If the expectation that "during a crisis, liquidity will be provided by the facility" lowers the incentive of debtor countries to seriously manage their own liquidity, it could increase the possibility of a crisis breaking out through the lowering of foreign reserves.   Ideas which prevent such moral hazard from materializing should be built into the facility.

(2) The need for surveillance

   When providing liquidity for countries that are "solvent but illiquid", it is necessary to verify whether the crisis-hit country is insolvent (a state where the fundamentals are so bad that debt cannot be serviced even if a liquidity crisis does not break out) or not.   Thus, surveillance is necessary for the operations of an institution providing liquidity.   Since surveillance makes sure that liquidity provision to insolvent countries will not occur, such surveillance can also lead to the prevention of moral hazard <mentioned above in (1)>.   In addition, grasping the true state of each country can lead to effective implementation of liquidity provision <refer to (3) below>.

(3) The allocation of roles between international organizations and regional cooperation in the provision of liquidity

   Based on the observations that "a regional institution can obtain more information about the situation in its region than an international institution" and "in international institutions where there would be conflicts of interest, prompt and appropriate action to deal with a currency crisis in a certain region is unlikely to be taken", the importance of liquidity provision through regional financial cooperation is often emphasized.   Yet, we should also pay attention to a certain aspect of regional financial cooperation which could be a drawback.   As we have seen in Section 3, "neighborhood effect" as a contagion channel seems to be important.   Therefore, there is a possibility that regional cooperation may not function effectively.   However, if a regional institution has an anchor country, whose fundamentals are good enough (θ is large in Chart 1) and which is not likely to be a victim of a currency crisis, or there is financial support from a country or an institution outside of the region, the regional institution would work effectively.

(4) The role of central banks in provision of liquidity for international financial crisis management

   Existing academic literatures do not sufficiently address the nature of "liquidity" to be provided to remedy a currency crisis.   Would the liquidity provided by countries with excess

reserves be sufficient?   Is there any need to create liquidity in some sort of form so that central banks need to come in?   Further discussion on this subject is necessary and desirable.

Bibliography

Aghion, P., Bacchetta, P. and Banerjee, A [2000] "Capital Markets and the Instability of Open Economies." Swiss National Bank, Study Center Gerzensee.

Aliber, R.Z [2000] "Rules and Authorities in International Monetary Arrangements: The Role of the Central Bank." *American Economic Review Papers and Proceedings*, 43-47.

Bernanke, B. and Gertler, M [1989] "Agency Costs, net Worth, and Economic Fluctuations." *American Economic Review* 79, 14-31.

Baig, T. and Goldfajn, I [1999] "Financial Market Contagion in the Asian Crisis." IMF Staff Papers Vol.46, No. 2.

Bussière and Mulder [1999] "External vulnerability in Emerging Market Economies: How High Liquidity Can Offset Weak Fundamentals and the Effects of Contagion." IMF Working Paper WP/99/88.

Chang, R. and Velasco, A [1998a] "Financial Crises in Emerging Markets: A Canonical Model." NBER Working Paper No.6606.

Chang, R. and Velasco, A [1998b] "The Asian Liquidity Crisis." NBER Working Paper No.6796.

Chinn, M.D. and Kletzer, K.M [1999] "International Capital Inflows, Domestic Financial Intermediation and Financial Crises under Imperfect Information." Federal Reserve Bank of San Francisco.

Cho, D. and Hong, K [1999] "Currency Crisis of Korea: Internal Weakness or External Interdependence?" the 10th NBER East Asian Seminar on Economics.

Chui, M., Gai, P. and Haldane, A [2000] "Sovereign Liquidity Crises: Analytics and Implications for Public Policy." Forthcoming in *Journal of Banking and Finance*.

Corsetti, G., Pesenti, P. and Roubini, N [1999] "Paper Tigers? A Model of the Asian Crisis." *European Economic Review*, June, 1211-36.

Corsetti, G., Pesenti, P. and Roubini, N [2000] "Fundamental Determinants of the Asian Crisis: the Role of Financial Fragility and External Imbalances." the 10th NBER East Asian Seminar on Economics, 1999 (first draft).

De Gregorio, J. and Valdes, R.O [1999] "Crisis Transmission: Evidence from the Debt, Tequila, and Asian Flu Crises." the WIDER Conference at the World Bank.

Diamond, D. and Dybvig, P [1983] "Bank Runs, Deposit Insurance, and Liquidity." *Journal of Political economy*, 91, 401-419.

Diamond, D.W. and Rajan, R.G [2000] "Banks, Short Term Debt and Financial Crises: Theory, Policy Implications and Applications." *mimeo*.

Dornbusch, R., Park, Y.C. and Claessens, S [2000] "Contagion: How It Spreads and How It can be Stopped?" the WIDER Conference at the World Bank.

Flood, R.P. and Garber, P.M [1984] "Collapsing Exchange Rate Regimes: Some Linear Examples." *Journal of International Economics*, 17, 1-13.

Forbes, K. and Rigobon, R [1999] "Measuring Contagion: Conceptual and Empirical Issues" the WIDER Conference at the World Bank.

Fratzscher, M [1999] "What Causes Currency Crises: Sunspots, Contagion or Fundamentals?" EUI Working Paper ECO No.99/39.

Greenspan, A [1999], "Currency Reserves and Debt." FRB.

Hahm, J. and Mishkin, F.S [2000] "Causes of the Korean financial Crisis: Lessons for Policy." NBER Working Paper No.7483.

Goldfajn, I. and Valdes, R.O [1997] "Capital flows and the Twin Crises: the Role of Liquidity."IMF Working Paper, 97/98.

IMF [1998] *World Economic Outlook*, May.

Kaminsky, G. and Reinhart, C [1999a] "The Twin Crises: the Causes of Banking and Balance-of-Payments Problems." *American Economic Review*, June, 473-500.

Kaminsky, G. and Reinhart, C [1999b] "Bank Lending and Contagion: Evidence from the Asian Crisis." the 10th NBER East Asian Seminar on Economics.

Kaminsky, G. and Reinhart, C [2000] "On Crises, Contagion, and Confusion." *Journal of International Economics*, Vol.51 (1), 145-168.

Krugman, P [1979] "A Model of Balance-of-Payments Crises." *Journal of Money, Credit, and Banking*, August, 11(3), 311-25.

Krugman, P [1998] "What Happened to Asia?" *mimeo*.

Krugman, P [1999] "Balance Sheets, the Transfer Problem, and Financial Crises." *mimeo*.

Masson, P.R [1999] "Multiple Equilibria, Contagion and the Emerging Market Crises." Allied Social Sciences Association annual meeting in 1999.

Milesi-Ferretti, G.M. and Razin, A [2000] "Current Account Reversals and Currency Crises." in *Currency Crises*, edited by Paul Krugman, the University of Chicago Press.

Miller, V (1996) "Speculative Currency Attacks with Endogenously Induced Commercial Bank Crises." *Journal of International Money and Finance*, Vol.15, No.3, 383-403.

Morris, S. and Shin, H.S [1998] "Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks." *American Economic Review*, June, 587-597.

Obstfeld, M [1994] "The Logic of Currency Crises." NBER Working Paper No.4640.

Obstfeld, M [1996] "Models of Currency Crises with Self-fulfilling Features." *European Economic Review*, April. 40(1), 1037-47.

Park, Y.C. and Song, C [2000] "Financial Contagion in the East Asian Crisis – With Special Reference to the Republic of Korea." the WIDER Conference at the World Bank.

Radelet, S. and Sachs, J [1998] "The Onset of the East Asian Financial Crisis." NBER Working Paper No.6680.

Van Rijckeghem, C. and Weder, B [1999] "Financial Contagion: Spillovers Though Banking Centers" the WIDER Conference at the World Bank.

(Appendix 1) Theories on the Causes of Asian Financial Crisis

Theories on the Onset of the Crisis

Currency Crisis Theories Before the Asian Financial Crisis
Not appropriate to explain the Asian financial crisis (?)

First Generation Theory: appropriate for the Latin American Crisis in the 1980s. Large budget deficit would motivate the government to resort to inflation. This expectation leads to devaluation pressure.

Second Generation Theory: appropriate for ERM Crisis in 1992. Need for expansionary monetary policy (due to for example a high unemployment rate) leads to devaluation pressure.

Theories for the Asian Financial Crisis

Fundamentals-driven Crisis
Lax loan standards of domestic banks lead to the accumulation of bad loans. The government will eventually bail-out troubled banks with budgetary expenditure which results in budget deficit. The logic that links the deficit with a currency crisis is the same as in the First Generation Theory.

Financial Panic-driven Crisis
It is not plausible to explain the massive reversal of capital flow by change in fundamentals. The proponents emphasize the role of sudden change in investors' expectation and point out the possibility of jump to bad equilibrium among possible multiple-equilibria.

Theory on the Relation Between Fundamentals and Investors' Expectation Formation
Even in usual bank-run set-up, there is the threshold in the state of fundamentals.

Theories on the Decline in the Aggregate Outputs after the Onset of the Currency Crisis

The accumulation of bad loans would be a cause of the currency crisis and leads to the decline in the real outputs after the crisis.

Observed Phenomena
Increased interest rates reduced investment. The reversal of capital flows forced long-run projects to be liquidated before their completion.

Domestic Banking Sector Crisis
Loss of special skills for monitoring debtors and troubleshooting leads to disintermediation.

Decreased "net-worth" of corporations
Devaluation of domestic currency leads to increase in debt denominated in foreign currency. This reduces "net-worth" of corporations. As a result, availability of loans to these corporations declines.

Debt-overhang
Revenue from a profitable new project will be used for repayment to already existing debt. This would prevent loans to be used for new project. High-leveraged balance sheet of corporations exacerbates "debt-overhang" phenomenon.

(Appendix 2) Empirical Studies on the Asian Financial Crisis

Methodologies and Variables

Methodologies
Qualitative Dependent Variable Model (e.g.. Probit), Regression Model (OLS) and Markov-switching regime Model are used. The first method quantifies the relationship between the **probability** and the variables in the analysis. The second method quantifies the relationship between the **depth** of a crisis and the variables. Last method attempts to include the effect of "financial panic" as "regime switch" in the dynamics. The variables used in these analysis are fundamentals-related variables, term to express "regime switch", and one to express "contagion channels".

Fundamentals-related Variables

(Internal Macroeconomic Variables)
--GDP growth rate
--inflation rate
--ratio of budget deficit to GDP
--loan growth rate
--ratio of bad loans to GDP

(External Positions Variables)
--ratio of current account to GDP
--terms of trade
--ratio of external debt to foreign exchange reserves
--ratio of short-term external debt to foreign exchange reserves
--ratio of direct foreign investment to GDP

Contagion Channels
--direct trade linkage
--export competition in third countries
--common lender channel
--neighborhood effect ("reputation externalities")

"Financial Panic" term
--Markov-switching regime term

Results of Empirical Studies

Attempts to Explain the Crisis with **Fundamentals-related Variables**
--The fundamentals-related variables have some explanatory power on the probability of a currency crisis occurrence and its depth.
--However, the explanatory power is limited.
--The effect of deterioration of fundamentals would be non-linear: The deeper the magnitude, the higher their marginal effect of their worsening.
--The ratio of short-term external debt to foreign exchange reserves has high explanatory power. It seems that there is a threshold beyond which its unfavorable effect rapidly increases. The ratio around one seem to be the range where the threshold exists.

Exploration for **other factors** than fundamentals-related variables.

Contagion Channels
Including effect of contagion channels in quantitative analysis improves its explanatory power significantly.

Among plausible contagion channels, **neighborhood effect** is most influential.

"Financial Panic" Element
Including possibility of change in investors' expectation (or any other elements leading to sudden "regime switch") in quantitative analysis improves its explanatory power significantly.