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On Determinants of the Depth of Currency Crisis: Fundamentals, Contagion, and Financial Liberalization

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Abstract

This paper contains an empirical analysis of the "depth" of the Mexican Currency Crisis (1994-1995) and the East Asian Currency Crisis (1997). The purpose is to attempt to gauge the degree of impact of 1) deterioration in economic fundamentals and 2) the function of contagion channels on the above two crises.

Below is a summary of the main conclusions reached from this empirical analysis.

1) The significance of economic statistics hitherto emphasized as important in currency crisis theory to explain the depth of a currency crisis differs from crisis to crisis. Just because a certain economic statistic has a high degree of explanatory power for one crisis does not necessarily mean that it will be significant to explain another.

2) The hypothesis that "deterioration in fundamentals will exacerbate the depth of currency crisis only in those cases in which fundamentals are extremely poor and, at the same time, there is a high likelihood of liquidity drying up" can not be accepted for the East Asian Currency Crisis sample, but can be for the Mexican Currency Crisis.

3) Contagion channels have been confirmed to have explanatory power. In particular, the addition of contagion channels for the East Asian Currency Crisis, where fundamentals have little explanatory power, substantially improves the explanatory power of the regression analysis.

4) Economic fundamentals and contagion channels alone can not satisfactorily explain the depth of the currency crises experienced. We gave initial consideration to the

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potential correlation between financial liberalization and depth of currency crisis for several leading East Asian countries. Our findings indicate the possible existence of a relationship in which the crisis is deeper the greater the liberalization of international capital transactions.

These findings indicate that the way to minimize the impact of a currency crisis is to maintain sound domestic economic policies (IS balance, sound bank lending etc.) and strong external liquidity positions. The analysis in this paper also indicates the importance of the relationship between liberalization of international capital transactions and depth of currency crisis, although this has not yet been sufficiently analyzed.

1. Introduction

This paper contains an empirical analysis of the "depth" of the Mexican Currency Crisis (1994-1995) and the East Asian Currency Crisis (1997). The analysis examines a number of economic statistics related to the fundamentals of the countries involved and also "contagion channels" (i.e., the channels by which the currency crisis is transmitted) and evaluates the impact that these factors have on the depth of the currency crises.

Analysis of two distinct currency crises--the Mexican Currency Crisis and the East Asian Currency Crisis--enables us to pinpoint several exacerbating factors common to both. The comparison of empirical findings for the two crises also highlights the features of the individual crises. In point of fact, the empirical analysis in this paper finds strong indications that different economic statistics impact the depth of the two crises.

The empirical analysis in this paper also indicates that economic statistics and contagion channels alone do not fully explain the depth of the currency crises experienced by individual countries. We therefore make some initial observations on another factor that would impact the depth of the currency crisis. The factor is the degree of liberalization of international capital transactions. We investigate how this affected several leading East Asian countries at the time of the East Asian Currency Crisis. East Asian countries were chosen for this analysis because of the pronounced impact on their crises from speculative transactions by hedge funds and others. Indeed, differences in their liberalization of international capital transactions have long been pointed to as a factor in the differing degree to which local currencies were subjected to speculative attacks.

Below is an outline of the structure of this paper. Section 2 explains our definitions of the "crisis period" in the Mexican Currency Crisis and the East Asian Currency Crisis and our concept of the "depth" of a currency crisis. Section 3 contains an empirical analysis of a sample of 22 emerging countries using economic statistics that have been deemed important in explaining the occurrence and depth of currency crises in existing currency crisis theory. We examine the extent to which these statistics are able to explain the depth of currency crises. Section 4 builds on the results of analysis in Section 3 to examine the hypothesis that "deterioration in economic fundamentals will exacerbate the depth of currency crisis only in those cases in which fundamentals are extremely poor and, at the same time, there is a high likelihood of liquidity drying up." Section 5 analyzes the impact of "contagion through export competition" and "contagion through financial linkage." Sections 3 through 5 begin by using a "full sample" that

combines the two currency crises and examine the impact from economic statistics and contagion channels on the depth of the crises. Following the general analysis, these sections also analyze individual currency crisis samples to elucidate the specific features of each crisis. Section 6 considers the relationship between the degree of liberalization of international capital transactions and the depth of the currency crisis for several leading East Asian countries at the time of the East Asian Currency Crisis. Section 7 concludes with a summary of the findings of this paper.

2. Methodologies employed in the quantitative analysis

In Sections 3 through 5 we examine a sample of 22 emerging countries (Figure 1) to verify the extent to which economic statistics and contagion channels are able to explain the "depth" of the Mexican and East Asian Currency Crises. More specifically, we perform a cross section regression analysis using the "depth" of the currency crisis in individual countries during the "crisis period" as the explained variable and national economic statistics immediately prior to the crisis period and contagion channel indices as explanatory variables.[1, 2]

As data for calculating the depth of currency crises we use monthly data on nominal exchange rates of local currencies against the U.S. dollar and national foreign exchange reserves. As data on economic fundamentals and contagion channels we use date from appropriate points in time in light of the nature of these factors. This is explained in more detail in the pages that follow.

The countries in the sample used for this paper are those countries acknowledged by international investors (as evidenced, for example, by reports published by investment banks) for which we were able to obtain the necessary data. These are largely the same countries that have been included in analyses found in prior research. [3]

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1 Hattori [2002] surveys the techniques and major findings of the empirical analyses into currency crises that have been performed since the East Asian Currency Crisis.

2 The regression analysis in this paper takes the economic conditions of each country immediately prior to the crisis period and the strength of the contagion channels as given and attempts to verify the depth of the currency crisis experienced by each country during the crisis period, when there was increased stress in international financial markets. Because of this, the regression analysis does not need to take account of the effects of changes in economic conditions or the strength of contagion channels caused by changes in nominal foreign exchange rate and foreign exchange reserves during the crisis period.

3 The samples in this analysis do not include Hong Kong and Singapore. Hong Kong serves as the center for trade relay in East Asia, while Singapore serves as its money center, and this gives their economies markedly different ways of operating than those of other emerging East Asian countries. In this regard, the reader is referred to the discussion in Section 6 of the limits to what can be achieved through the approach of seeking greater explanatory power for quantitative analyses merely by increasing the number of countries in the sample.

Two definitions are required for our quantitative analysis:

1) The period during which the Mexican Currency Crisis and the East Asian Currency Crisis occurred (the "crisis period"), and
2) The "depth" of the currency crisis in individual countries.

(1) The crisis period

We define the "crisis period" for the Mexican Currency Crisis as November 1994 to April 1995; for the East Asian Currency Crisis, July to December 1997. We chose these periods by assessing the fluctuations in the nominal exchange rate of the local currencies against the U.S. dollar, the content of news articles, and the treatment found in preceding empirical studies.

(2) The depth of currency crises

We calculate the "depth" of currency crises in individual countries during the crisis periods from the rate of depreciation in the nominal foreign exchange rate of the local currencies against the U.S. dollar and the rate of decrease in foreign exchange reserves. Monthly data is used in these calculations.

We begin by comparing each month of the crisis period against the months immediately prior to the crisis period (October 1994 for the Mexican Currency Crisis, June 1997 for the East Asian Currency Crisis) in the way below. For each month of the crisis period we calculate rates of depreciation in the nominal foreign exchange rate of local currency against the U.S. dollar and decrease in foreign exchange reserves. We then create a "crisis index" as a weighted average of these for each country. The weightings used in the calculation of the crisis index are created from standard deviation for monthly rates of change in the nominal foreign exchange rate of the local currency against the U.S. dollar and monthly rates of change for foreign currency reserves over the 5 years immediately prior to the crisis period. Below are the specifics of the monthly crisis index (*CI*) calculated for each country:

$$CI = (DE/E) + (s_E / s_R)(DR/R)$$

$\Delta E/E$: Rate of depreciation in the nominal foreign exchange rate of the local currency against the U.S. dollar compared to the month immediately prior to the crisis period (%)

$\Delta R / R$: Rate of decrease in national foreign exchange reserves compared to the month immediately prior to the crisis period (%)

s_E : Standard deviation of the monthly rate of change in the nominal foreign exchange rate of the local currency against the U.S. dollar for the 5 years immediately prior to the crisis period

s_R : Standard deviation of the monthly rate of change of national foreign exchange reserves for the 5 years immediately prior to the crisis period

Calculations of the rate of depreciation of the local currency against the U.S. dollar (*DE /E*) and the rate of decrease in foreign exchange reserves (*DR / R*) will return positive values for the month's crisis index if the nominal value of the local currency depreciates and the foreign exchange reserves decrease in comparison with the month immediately prior to the crisis period. This is because the crisis index calculation treats both of these events as positive values. On the other hand, calculations will return a negative value if, for example, the local currency appreciates in comparison with the month immediately prior to the crisis period. The weightings utilized in the crisis index make adjustments so that "changes during the crisis period in variables that have experienced large fluctuations in the past have less weight than changes in variables that have experienced smaller fluctuations in the past."

Having calculated crisis indices for each country in the manner described above, we find the maximum value for the monthly crisis index of each country during the crisis period and define this as the "depth" of the currency crisis experienced. Figure 2 contains depths for the currency crises experienced by individual countries as found for these calculations.

Below is our rationale for measuring the depth of the currency crisis in this manner. When a currency crisis occurs in a country, devaluation pressure is brought to bear on the country's local currency which, if not counteracted, will cause the currency to progressively lose value. If national governments step in and use their foreign exchange reserves to prop up their currencies, local currencies will not exhibit as much of a decline as they otherwise would, but foreign exchange reserves will decline instead. One must therefore take account both of changes in nominal foreign exchange rates against the U.S. dollar and changes in foreign exchange reserves in order to measure the devaluation pressure on a currency.

To be more specific, countries have two means of defending the value of their currencies: they can either use their foreign exchange reserves to intervene or they can raise domestic interest rates. One might therefore argue that changes in domestic interest rates should also be included in the crisis index if one is to accurately measure the depreciation pressure experienced by a currency in crisis. However, statistical data on market interest rates is not available for many emerging countries, which makes it difficult to use interest rates in quantitative analysis; most preceding research has not, in fact, done so.[4] This paper likewise does not attempt to reflect changes in domestic market interest rates in calculations of the crisis index.

3. Analysis using only statistics on economic fundamentals

3.1 Basic Model

This section examines the extent to which the depth of a currency crisis can be explained using only statistics on economic fundamentals. More specifically, we perform a regression analysis using the depth of a country's currency crisis as the explained variable and economic statistics that have hitherto been emphasized as important in currency crisis theory as explanatory variables. We call this regression analysis our "Basic Model." Sections 4 and 5 expand upon this Basic Model for further analysis.

Basic Model uses the following explanatory variables: the ratio of the current account balance to nominal GDP (*CAGDP*), the ratio of the fiscal balance to nominal GDP (*FDGDP*), the 4 year change in the ratio of outstanding domestic private credit to nominal GDP (*CRGDP*), and the ratio of external short-term debt to foreign exchange reserves (*ESDFR*).

The ratio of the current account balance to nominal GDP has long been considered an important economic statistic in the empirical analysis of currency crises because a current account deficit is thought to increase the pressure for currency depreciation.

The ratio of the fiscal balance to nominal GDP is important because, as the first generation currency crisis models in Krugman [1979] and Flood and Garber [1984] demonstrate, fiscal deficits give governments an incentive to increase inflation.

[4] De Gregorio and Valdes [1999], Corsetti, Pesenti, and Roubini [1999, 2000] etc.

The 4 year change in the ratio of outstanding domestic private sector credit to nominal GDP is used as a proxy variable for the rate of bad loans in domestic bank lending. In other words, we assume that a rapid increase in bank lending indicates that loan-screening standards have been relaxed, which will result in the approval of more loans that will eventually end up in default. The reason we use this economic statistic in our analysis is because of the conclusion reached by Corsetti, Pesenti, and Roubini [1999]. The study shows that high rates of bad loans on bank loans are a factor in the East Asian Currency Crisis. They assert there are extremely close ties between governments and domestic banks in East Asian countries prior to the crisis and an "implicit guarantee" that the government would rescue any banks undermined by accumulated defaults in their loans existed. This leads to the hypothesis that banks' bad loans can be considered the same as future fiscal outlays, which in turn requires us to consider banks' bad loans in analysis of currency crisis.

The ratio of external short-term debt to foreign exchange reserves is included because of the view (Radelet and Sachs [1998] etc.) that the Asian currency crisis can be considered to be a rapid "drying up" of liquidity.

Below is the regression equation for "Basic Model:"

Basic Model

$$DC = C(1) + C(2) * CAGDP + C(3) * FDGDP + C(4) * CRGDP + C(5) * ESDFR + e$$

DC : Depth of the currency crisis for the individual country (maximum value of crisis index during the crisis period)

$C(\bullet)$: Coefficient ($C(1)$ is a constant)

$CAGDP$: Ratio of current account balance to nominal GDP

$FDGDP$: Ratio of fiscal balance to nominal GDP

$CRGDP$: 4 year change in ratio of outstanding domestic private sector credit to nominal GDP

$ESDFR$: Ratio of external short-term debt to foreign exchange reserves

e : Error term (a standard distribution with zero mean and a certain variance)

Our calculations utilize data on economic fundamentals tabulated at the most appropriate time for the explanation of individual currency crises. For the Mexican Currency Crisis, we use annual data for 1994 for *CAGDP* and *FDGDP*, and the change in ratio between 1990 and 1994 for *CRGDP*. The currency crisis was already in progress by the end of 1994, but we assume that it did not have a substantial impact on the annual economic statistics which we use as our explanatory variables. However, for *ESDFR*, we use data from the end of 1993 even though it diverges slightly from the crisis period. This point in time is chosen because of the sharp outflow of short-term credit observed in the data from the end of 1994. For the East Asian Currency Crisis, we use annual data from 1996 for *CAGDP* and *FDGDP*, and the change from 1992 to 1996 for *CRGDP*. For *ESDFR*, we use data from the end of 1996.

3.2 Results of Basic Model analysis

3.2.1 Full sample analysis

Figure 3 contains results of Basic Model regression analysis for the full sample (i.e., both the Mexican Currency Crisis and the East Asian Currency Crisis). We arrive at a coefficient of determination adjusted for degree of freedom of 0.170, which is low. This indicates that economic statistics, which have been assumed to be influential in currency crisis theory, are vastly inadequate to the task of explaining the depth of a currency crisis.

In reviewing the individual economic statistics, we find that the signs for all statistics are as theory would predict. In other words, rises in *CAGDP* and *FDGDP* result in smaller values for the depth of a currency crisis, while rises in *CRGDP* and *ESDFR* result in larger depth values.

Turning to the ability of individual economic statistics to explain the depth of a currency crisis, we find a 5% significance level for *CRGDP* and approximately a 5% significance level for *ESDFR*. We are unable to find explanatory power for either *CAGDP* or *FDGDP*.

3.2.2 Comparison between the two currency crises

We performed regression analyses for the samples for the Mexican Currency Crisis and the East Asian Currency Crisis individually in order to explore the differing natures of the two currency crises.

The regression analysis for the Mexican Currency Crisis sample shows a coefficient of determination adjusted for degree of freedom of 0.358 (Figure 3), which is higher than the result of the full sample analysis but still very low. However, the sign conditions are fulfilled for all economic statistics, and all are found to have explanatory power at the 5% significance level. Even *CAGDP* and *FDGDP*, which are not found to have explanatory power in the full sample, have relatively high explanatory power for the Mexican Currency Crisis. This indicates that, to some extent, the Mexican Currency Crisis can be explained in terms of economic fundamentals, which is especially in line with the first-generation theory that emphasizes the influence of large fiscal debts.

Turning to the East Asian Currency Crisis sample, we find a coefficient of determination adjusted for degree of freedom of 0.181 (Figure 3), which is low and an indication that economic fundamentals have very little explanatory power for the East Asian Currency Crisis.

A review of the individual economic statistics shows that all economic statistics fail to achieve explanatory power at the 10% significance level, and the sign of the *FDGDP* coefficient is actually opposite to what theory would predict (it should be negative). In short, the analysis of the East Asian Currency Crisis yields largely contrasting results to the analysis of the Mexican Currency Crisis.

In point of fact, after the East Asian Currency Crisis there were many who pointed to a sudden change in the formation of investor expectations as an important factor, and the results of our quantitative analysis seem to bear this out.

4. The effect of extremely poor fundamentals

4.1 Expanded Model 1

Emerging economies in general tend to have problems of one sort or another in their domestic macro economies or external balances, though there will of course be differences of degree. One would intuitively think that the countries visited by currency crisis would be those with extremely poor fundamentals. In this section, we examine the validity of this hypothesis.

Hypothesis on the effect of deteriorating fundamentals: Deterioration in economic fundamentals will exacerbate the depth of currency crisis only in those cases in which fundamentals are extremely poor and, at the same time, there is a high likelihood of liquidity drying up.

To verify this hypothesis, we expand Basic Model with dummy variables to express the state of "extremely poor fundamentals" and "high likelihood of liquidity drying up." The following regression equation is used ("Expanded Model 1"):

Expanded Model 1

$$DC = C(1) + C(F_{-X}) * F_{-X} + C(F_X) * F_X + C(F_X)' * F_X * LD + C(F_X)'' * F_X * LD * FD + e$$

F_X , F_{-X} : F_X is one statistic on economic fundamentals (*CAGDP*, *FDGDP*, *CRGDP*, or *ESDFR*). F_{-X} expresses statistics on economic fundamentals excluding F_X .

Example: F_X = *CAGDP*, F_{-X} = *FDGDP, CRGDP, ESDFR*

LD : Dummy variable with a value of 1 when the country's ratio of external short-term debt to foreign exchange reserves is 100% or more, and a value of 0 in all other cases.

FD : Dummy variable with a value of 1 when a country's ratio of current account deficit to nominal GDP is higher than it was 2 years ago and, at the same time, its ratio of domestic private sector credit to nominal GDP is 5% or more above what it was 3 years ago. If either one of these conditions is not met, it has a value of 0.

e : Error term (a standard distribution with zero mean and a certain variance)

Greenspan [1999] and others provide the rationale for assuming there is a high likelihood of liquidity drying up when the ratio of external short-term debt to foreign exchange reserves is 100% or more. Studies indicate that the maintenance of this ratio below 100% is one merkmal for currency crisis prevention by emerging countries. Empirical research by Brussière and Mulder [1999] validates this merkmal.

The assumption in determining fundamentals to be extremely poor is that there has been a substantial imbalance in the IS balance, and bad loans are on the increase.

The following two conditions on "coefficient restriction" and "sign condition" must be met in order to conclude that our hypothesis on the effect of poor fundamentals is correct.

Coefficient restriction[5]:

$C(F_X) = 0,\ C(F_X) + C(F_X)' = 0$

and

$C(F_X) + C(F_X)' + C(F_X)'' \neq 0$

Sign condition: Same sign as $C(F_X)$ would be theoretically predicted for

$C(F_X) + C(F_X)' + C(F_X)''$

The remainder of this section reviews the results of coefficient restriction and sign condition tests using the full sample and the individual currency crisis samples.

4.2 Results of Expanded Model 1 analysis

4.2.1 Full sample analysis

When F_X is *CAGDP*, *CRGDP* or *ESDFR*, the hypotheses $C(F_X) = 0$, $C(F_X) + C(F_X)' = 0$ is not rejected with a 10% significance level (Figure 4:1-4). However, when F_X = *FDGDP*, both hypotheses are rejected with a 10% significance level. The hypothesis $C(F_X) + C(F_X)' + C(F_X)'' = 0$ is rejected with a 5% significance level when F_X is *CAGDP*, *CRGDP* or *ESDFR*; with a 10% significance level when it is *FDGDP*. The sign condition is fulfilled in all cases except F_X = *FDGDP*.

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[5] The interpretation of the coefficient restriction is as follows. It should be noted that the regression equation for Expanded Model 1 contains two dummy variables: one for the high possibility of liquidity drying up and another for extremely poor economic fundamentals. The first equation in the coefficient condition means that a variable F_X does not have any influence on the depth of currency crisis alone. The second equation, which adds the high possibility of liquidity drying up on the first equation, means that a variable F_X does not have any influence either. Those two equations being held true, verifying the third condition by assessing a null hypothesis $C(F_X)+C(F_X)'+C(F_X)''=0$ leads to a conclusion that our "hypothesis on the effect of deteriorating fundamentals" holds true.

These results indicate that the hypothesis regarding the effect of deteriorating fundamentals is virtually acceptable.

However, we should also note that the results when F_X = *FDGDP* indicate that deteriorating fiscal conditions have the potential to exacerbate the depth of a currency crisis even in countries where fundamentals are not extremely poor and there is not a particularly high likelihood of liquidity drying up.

4.2.2 Comparison between the two currency crises

We also analyze the individual currency crises. For the Mexican Currency Crisis we find that the hypotheses $C(F_X) = 0$ and $C(F_X) + C(F_X)' = 0$ are not rejected with a 10% significance level when F_X is *CAGDP* or *ESDFR*. If F_X = *FDGDP*, $C(F_X) = 0$ is rejected with a 5% significance level, but $C(F_X) + C(F_X)' = 0$ is not rejected with a 10% significance level. When *CRGDP*, the hypothesis $C(F_X) = 0$ is rejected with a 10% significance level, but not with a 5% significance level. The hypothesis $C(F_X) + C(F_X)' = 0$ is not rejected with a 10% significance level. For all statistics, the hypothesis $C(F_X) + C(F_X)' + C(F_X)'' = 0$ is rejected with a 5% significance level. The sign condition is fulfilled for all statistics (Figure 4:1-4).

These results indicate that for the Mexican Currency Crisis sample, our hypothesis on the effect of deteriorating fundamentals is acceptable in virtually all cases.

Our analysis of the East Asian Currency Crisis yields different results from the Mexican Currency Crisis case. We find that our hypothesis on the effect of deteriorating fundamentals can not be validated. When F_X = *CAGDP*, the hypothesis $C(F_X) + C(F_X)' + C(F_X)'' = 0$ can not be rejected with a 10% significance level. When F_X = *CRGDP*, it can not be rejected with a 5% significance level. The sign condition is not fulfilled. When F_X = *FDGDP*, $C(F_X) + C(F_X)' + C(F_X)''$ produces a positive sign where theory would indicate a negative sign. Only when F_X = *ESDFR* are both the coefficient restriction and the sign condition adequately fulfilled (Figure 4:1-4).

These results lead us to reject, for the East Asian Currency Crisis, the hypothesis that extremely poor fundamentals coupled with a high likelihood of liquidity drying up are required in order for deteriorating statistics on economic fundamentals to exacerbate the depth of currency crisis.

5. Impact of contagion channels

5.1 Contagion channels

The Mexican Currency Crisis and the East Asian Currency Crisis involved a number of countries simultaneously going into crisis. Many commentators have noted the effect of "contagion," the spread by some channels of currency crisis from one country to another. This section attempts to verify the "contagion" effect for two channels considered the most likely culprits: "trade competition" and "common lenders." We focus on the fact that the first is deeply related to the real economy while the second is deeply related to financial markets. We create the following indices in order to quantitatively analyze the effect of the contagion channels.

Index of Trade Competition (ITC)

Below are the calculations for the Index of Trade Competition (*ITC*) that we use to verify the impact of the trade competition contagion channels.

$$ITC_i \equiv \sum_k \left\{ \left[(x_{0k} + x_{ik}) / (x_0 + x_i) \right] \left[1 - \left| (x_{ik} - x_{0k}) \right| / (x_{ik} + x_{0k}) \right] \right\}$$

x_i : Gross export value for Country *i*

x_{ik} : Value of exports from Country *i* to Country *k*

This index examines exports to a common 3rd country (Country *k*) from the "ground zero country" (Country 0) where the currency crisis initially starts and from another country (Country *i*). It takes account of two factors: 1) the extent of competition between Country 0 and Country *i* for exports to Country *k*; and 2) the importance to Country 0 and Country *i* of exports to Country *k*. The higher the *ITC*, the greater the competition between Country 0 and Country *i* in an export market and the more important the position of the contested export market within the gross exports of the two countries. As an example, Figure 5 shows the export competition between Indonesia and ground zero Thailand for exports to the United States.

This paper assumes export competition between emerging countries for the markets of developed countries. We calculate the *ITC* using the G7, Spain and China as export markets (Country *k*) and our sample countries as export competitors (Country 0, Country *i*) (Figure 7). Mexico is the ground zero country for the Mexican Currency Crisis; Thailand for the East Asian Currency Crisis. The reason that Spain is included in the export markets is to reflect in the *ITC* the depth of its

economic relations with Latin American countries. Likewise, China is included in export markets because of the relationship between the Chinese and other East Asian economies.

Index of Common Lenders (ICL)

We calculate the following Index of Common Lenders (*ICL*) to verify the impact of financial contagion channels.

$$ICL_i \equiv \sum_c \left\{ \left[(b_{0c} + b_{ic}) / (b_0 + b_i) \right] \left[1 - \left| \left\{ (b_{0c} / b_0) - (b_{ic} / b_i) \right\} \right| / \left\{ (b_{0c} / b_0) + (b_{ic} / b_i) \right\} \right] \right\}$$

b_i : Total borrowings of Country i [6]

b_{ic} : Borrowings of Country i from Country c

This index looks at a situation in which the ground zero country where the currency crisis begin (Country 0) and another country (Country *i*) borrow from a common lender (Country *c*). It considers two factors: 1) the extent to which there is competition between Country 0 and Country *i* for loans from Country *c*, and 2) the importance of borrowings from Country *c* to Country 0 and Country *i*. The higher the *ICL*, the greater the dependence of Country 0 and Country *i* on the lender and the higher the weight of Country *c* in gross external borrowings. As an example, Figure 6 depicts the competition between Indonesia and ground zero Thailand for borrowings from United States.

This paper assumes that emerging countries borrow funds from the banks of developed countries. To calculate the *ICL*, we use countries furnishing reports for BIS lending statistics as the "common lender" (Country *c*) and our sample countries as the countries borrowing from developed country banks (Country 0, Country *i*) (Figure 8). Ground zero countries are the same as for the *ITC* calculations.

Expanded Model 2 verifies the contagion channels quantified in *ITC* and *ICL*. The following regression is used. As before, we analyze both the full sample that combines the two currency crisis samples and also the samples for the individual currency crises.

[6] The BIS Consolidated International Banking Statistics used for the analysis in this paper tabulate "international claims" as an aggregate of cross-border bank lending and bond holding. Strictly speaking, the term "borrowing" in this paper would be better expressed as "claims" including bank borrowings and funds raised by the sale of bonds. The term "borrowing" is used because it is intuitively easier to grasp.

Expanded Model 2

$$DC = C(1) + C(2) * CAGDP + C(3) * FDGDP + C(4) * CRGDP + C(5) * ESDFR$$
$$+ C(6) * ITC + C(7) * ICL + e$$

DC : Depth of currency crisis in individual countries

C(•) : Coefficient (*C* (1) is constant)

CAGDP : Ratio of current account balance to nominal GDP

FDGDP : Ratio of fiscal balance to nominal GDP

CRGDP : 4 year change in ratio of outstanding domestic private sector credit to nominal GDP

ESDFR : Ratio of external short-term debt to foreign exchange reserves

ITC : index of trade competition for individual countries

ICL : index of common lenders for individual countries

e : Error term (a standard distribution with zero mean and a certain variance)

The data for *CAGDP, FDGDP, CRGDP* and *ESDRF* is the same as used in Basic Model. For *ITC* calculations, we use aggregate monthly data from November 1993 to October 1994 for the Mexican Currency Crisis; aggregates for July 1996 to June 1997 for the East Asian Currency Crisis. For *ICL* calculations, we use end of first half 1994 data for the Mexican currency crisis; end of 1996 data for the East Asian Currency Crisis. [7]

5.2 Results of Expanded Model 2 analysis

5.2.1 Full sample analysis

For the full sample analysis that combines the Mexican Currency Crisis sample and the East Asian Currency Crisis sample (excluding the ground zero countries

[7] In calculating the *ICL* for the East Asian Currency Crisis it would be possible to use the data from the end of the first half of 1997 as the data immediately prior to the crisis period (July-December 1997). However, it is likely that the data from this point in time already reflects to a certain extent the impact of outflows of money from East Asian countries, so data from the end of 1996 is used instead.

from each currency crisis sample), the regression results of Basic Model analysis formulated in Section 3 (Figure 9-1, Row 3) show an extremely low coefficient of determination adjusted for degree of freedom of 0.057.

Turning to individual economic statistics, the signs for all economic statistics are as theory would predict. *ESDFR* and *CRGDP* have explanatory power at the 10% significance level, but no explanatory power is found for *CAGDP* or *FDGDP*.

The results of Expanded Model 2 analysis, which adds *ITC* and *ICL* as explanatory variables in the regression equation (Figure 9-1, Row 4), raises the coefficient of determination adjusted for degree of freedom to 0.344. Individual economic statistics fulfill their sign conditions; *ESDFR* has higher explanatory power than before, and explanatory power at the 5% significance level is found for *CAGDP*. On the other hand, the explanatory power of *CRGDP* is lower. Between *ITC* and *ICL*, *ITC* has the higher explanatory power; no explanatory power is found for *ICL*.

To summarize, the full sample regression analysis indicates contagion channel effects via trade competition. Analyses for the individual Mexican and East Asian Currency Crisis samples also hint that common lender contagion channels played a part. This is discussed in more detail below.

5.2.2 Comparison between the two currency crises

Basic Model regression analysis for the Mexican currency crisis sample excluding the ground zero country (Mexico) (Figure 9-2, Row 3) fulfills sign conditions for all economic statistics. *FDGDP* has explanatory power at the 5% significance level; *CRGDP* at the 10% significance level. The other two economic statistics are also found to have explanatory power at close to the 10% significance level. However, the coefficient of determination adjusted for degree of freedom is extremely low at 0.162.

In Expanded Model 2, which adds *ITC* and *ICL* as new explanatory variables (Figure 9-2, Row 4), the coefficient of determination adjusted for degree of freedom rises to 0.534. The explanatory power rises significantly for individual economic statistics as well. Both *ITC* and *ICL* were found to have explanatory power for contagion channels.

Basic Model for the East Asian Currency Crisis sample excluding the ground zero country (Thailand) (Figure 9-3, Row 3) has an extremely low coefficient of determination adjusted for degree of freedom of 0.072. None of the economic

statistics is found to have explanatory power, and *FDGDP* does not fulfill sign conditions.

In Expanded Model 2, which adds *ITC* and *ICL* as explanatory variables (Figure 9-3, Row 4), the coefficient of determination adjusted for degree of freedom rises to 0.541. This rise in the coefficient of determination adjusted for degree of freedom is larger than that seen for the Mexican Currency Crisis. As before, none of the economic statistics achieves explanatory power at the 10% significance level, but *ITC* is found to have explanatory power at the 5% significance level. *ICL* is not found to have explanatory power. However, if only *ITC* or only *ICL* is added to Basic Model explanatory variables, both are found to have high levels of explanatory power. This indicates that there may be multicollinearity between *ITC* and *ICL*. In point of fact, the coefficient of correlation for *ITC* and *ICL* is extremely high at 0.760 (Figure 11). The Mexican Currency Crisis sample does not show any indications of this multicollinearity (Figure 10). To summarize the results of analysis in this section, Basic Model (excluding ground zero countries) coefficient of determination adjusted for degree of freedom is extremely low, but increases in Expanded Model 2 when *ITC* and *ICL* are added as explanatory variables. This indicates that contagion channels exacerbate the depths of the currency crises. For individual currency crises, the coefficient of determination adjusted for degree of freedom experiences a greater rise for the East Asian Currency Crisis sample. The conclusion to be drawn from this is that the East Asian Currency Crisis has a stronger element of "chain reaction" via contagion than the Mexican Currency Crisis.

6. Approaches to expansion of empirical analysis: Relationship between liberalization of international capital transactions and depth of currency crisis

6.1 Approaches to expansion of empirical analysis in existing studies

The quantitative models used for empirical analysis in the preceding sections can hardly be considered comprehensive in terms of samples and explanatory variables. One possible approach would be to increase the sample and the number of explanatory variables so as to boost the explanatory power of the quantitative model.

Existing studies has taken one of two approaches in expansion. The first approach is to increase the number in the sample by considering a greater number of currency crises. The second is to increase the number of countries analyzed. These increases in the sample enable the regression analysis to maintain its degree of freedom even when a larger number of explanatory variables are used. In other words, it becomes possible to verify the explanatory power of a greater number of variables. However, the author sees a limit to what can be achieved with these kinds of expansions.

Expanding the number of currency crises and therefore the size of the sample raises the question of the criteria used to define "currency crisis." For example, one might define a currency crisis as a loss of X% or more over a set period of time in the nominal exchange rate against the U.S. dollar, and then reduce X so as to increase the sample. Unfortunately, a lower X means that more moderate movements in the international financial markets will be designated "currency crises." One of the reasons that there is interest in the analysis of currency crises is because of the upheavals caused to domestic economies by sharp changes in nominal exchange rates. Including moderate exchange-rate movements in the currency crisis sample is unsuited to this analysis.

The inclusion of a larger number of countries in the sample also has problems because it assumes that currency crises are generated by the same mechanisms regardless of the stage of development. For example, the results would likely be skewed were one to include the least developed countries of Africa in our East Asian and Latin American sample just to arrive at a larger number of sample countries. In this regard, Milesi-Ferretti and Razin [2000] uses Probit model to estimate the probability of a sharp outflow of funds from countries. In its sample of 39 "middle income countries" in Latin America, Asia, the Middle East and Eastern Europe, it finds that the probability of an outflow of funds increases the higher the ratio of external debt to GDP. More specifically, this study finds that coefficient for the explanatory variable meets the theoretically predicted sign conditions (positive sign for the estimated coefficient) and is statistically significant. However, an estimate in their study using a sample of 105 countries, including "low income" countries, produces statistically significant results that have negative sign for the ratio. The sign is opposite to what theory would predict. This is presumably because countries are at different stages of development, and can be taken as an indication that there is a limit to the ability to expand models by increasing the sample countries.

This paper uses OLS techniques to analyze the depth of currency crises. Other techniques are possible, for example the use of qualitative response model such as Probit model to verify currency crisis probabilities. Preceding studies using this technique produces extremely low explanatory power for estimates that rely entirely on statistics on fundamentals. The addition of contagion channels as explanatory variables increases explanatory power but not to a level that would be considered sufficient. Even here, there are attempts to expand analysis by increasing the number of currency crises and the number of countries in the sample. Obviously, the same limitation applies to these approaches when used with qualitative choice models as when used with OLS. [8]

6.2 A new approach to expansion

6.2.1 Relationship between liberalization of international capital transactions and depth of currency crises

We have already noted that only looking at economic fundamentals is inadequate to explain the depth of the East Asian Currency Crisis. The addition of contagion channels does improve the explanatory power of the quantitative analysis somewhat, but not to levels that can be considered high enough. Because of this, we decided to consider the often-voiced opinion that one factor exacerbating the depth of the East Asian Currency Crisis is the sale of East Asian currencies by international speculators, of which hedge funds are the most prominent example.

If, for the sake of argument, we assume that this view is correct, we would anticipate that the currency crisis would have different depths for countries where speculative foreign exchange transactions are easy and countries where they are harder. For example, a country that allows local currency to be supplied to non-residents and therefore allows non-residents to take short positions in the local currency could be assumed to experience greater downwards pressure on its currency as the currency crisis deepens than a country that does not in effect allow non-residents to take short positions in its currency.

More specifically, there are three types of foreign-exchange transaction that would accelerate a decline in value for the local currency during a currency crisis:

1) Short positions in the local currency taken by non-residents

[8] Another technique would be to formulate the impact of sudden changes in investor expectations using a Markov-switching model (Fratzscher [1999], Cerra and Saxena [2000]). However, there is still very little research that quantitatively analyzes the effect of sudden changes of investor expectations, and results could differ depending on the model formulation (Hattori [2002]).

2) A rapid withdrawal of funds by non-residents (withdrawal of portfolio investments and short-term bank loans etc.)
3) Increased foreign currency holdings by residents

In past currency crises, all three types of transactions can be assumed to have an impact, but different types of transactions will have stronger impact for different crises. For example, it was Transaction 1 that is thought to have had the strongest impact in the East Asian Currency Crisis (1997); Transaction 2 in the Mexican Currency Crisis (1994-1995); and Transaction 3 in the Russian crisis (1998). Up to now, however, this has only been intuitively grasped; there has been no rigorous verification attempted.

6.2.2 Index of Financial Liberalization

Most East Asian countries relaxed their regulations on international capital transactions and internationalized their financial markets prior to the currency crisis in 1997. However, they deregulated to differing degrees, and some countries like China maintained stiff regulations on international capital transactions.

Building from the concepts discussed in the preceding section, we attempt to class stages of international capital liberalization of individual countries at the time of the East Asian Currency Crisis and, having done that, examine correlation between degree of financial liberalization and depth of currency crisis. Our classing of financial liberalization focuses on the liberalization of the two factors deemed to have had the greatest impact during the East Asian crisis: 1) "speculative transactions by non-residents" and 2) "rapid withdrawals of funds by non-residents (withdrawal of portfolio investments and short-term bank loans)."

The degree of liberalization for these two transactions can be divided into three stages as shown in Figure 12. Stage 1 is the lowest degree of liberalization for international capital transactions; Stage 3, the highest. Stage 2 represents an intermediate level.

Stage 1 countries do not allow non-residents to hold local currency, nor do they allow local currency to be used to settle international transactions. For example, even today China does not allow international transactions to be settled in yuan.

Stage 2 countries allow non-residents to hold local currency and to invest in local currency-denominated financial products (i.e., bonds and stocks etc.) but do not allow residents to loan the local currency to non-residents. During the crisis,

Stage 2 countries may have experienced downward pressure on their currencies because non-residents sold local currency-denominated financial products that they held and converted the local currency to foreign currency. However, local currencies in these countries did not encounter downwards pressure from speculative transactions, for example, by non-residents raising funds in local currencies to take short positions.

Stage 3 countries allow non-residents to invest in local currency-denominated financial products and also allow residents to loan funds in the local currency to non-residents. In other words, stage 3 countries allow their currencies to circulate in offshore markets and allow them to be taken out in borrowing and lending transactions. Because of this, their currencies probably came under downward pressure as non-residents raised funds in local currencies and took short positions. As a more concrete examples, prior to the East Asian Currency Crisis, Thailand, Indonesia and Malaysia all allowed residents to loan local currency funds to non-residents, and during the currency crisis, non-residents borrowed local currency and exchanged it for the U.S. dollars (took short positions against local currency) as a speculative move (Figures 13 and 14).[9] Stage 3 countries were also likely to experience downward pressure on their currencies from the mechanisms at work in Stage 2, i.e., non-residents' sales of local currency-denominated financial products and subsequent foreign-exchange transactions.

To reflect these observations, we created an Index of Financial Liberalization (*IFL*) that expresses the degree of international capital liberalization in Thailand, Indonesia, Malaysia, the Philippines, South Korea, China and Taiwan at the time of the East Asian Currency Crisis. China, as a Stage 1 country at the time of the crisis, has an *IFL* of 1. Stage 2 countries South Korea, the Philippines and Taiwan have *IFLs* of 2. Stage 3 countries Thailand, Indonesia and Malaysia have *IFLs* of 3. The higher the number, the greater the degree of liberalization for international capital transactions.

It seems that there is a positive correlation between the depth of currency crisis experienced by individual countries and their *IFL* (Figure 17 and 18). In other words, the currency crisis was deeper for those countries that allowed non-

[9] In point of fact, most of the local currency funds raised were probably raised in the form of swaps between the local currency and U.S. dollars. For example, statistics on foreign exchange transactions for domestic Malaysian banks show a sharp rise in swaps in the first half of 1997. This reflects a sharp increase in non-resident transactions by foreign banks operating in Malaysia (Figure 15). The breakdown of currency trading in the Singapore foreign exchange market shows that trading in the U.S. dollars against "other currencies" (most likely Asian currencies since the Japanese yen, European currencies, Canadian dollar and Australian dollar are excluded) rose from 14% of market volume to 23% between April 1995 and April 1998 (Figure 16). This reflects active trading of the currencies of Thailand, Malaysia and Indonesia against the U.S. dollar in the Singapore market immediately before and after the East Asian Currency Crisis.

residents to hold local currency-denominated financial products than for those that did not, and was even deeper for those countries that allowed non-residents to raise funds in the local currency in order to take short positions.

If this positive correlation between the degree of financial liberalization and the depth of the currency crisis is accepted, then it behooves us to consider the implications. Emerging countries can turn to funds coming in from international sources to finance investment projects as a means of covering shortfalls in domestic savings. The degree of liberalization for capital transactions will influence the investment environment in that country for international investors. Countries can increase their liberalization in order to encourage a greater inflow of funds. This creates a motivation to relax regulations on international capital transactions and thereby achieve higher economic growth rates. That was presumably the intention behind the deregulation in East Asian countries prior to the crisis. However, while the purpose of deregulating international capital transactions may be to encourage more funds to flow in from overseas, it also means that a country tolerates the existence of a mechanism that will increase the depreciation pressure on its currency should crisis strike, and may therefore increase the cost of the currency crisis. In short, when one changes the degree of liberalization for international transactions, there is a trade-off between the inflow of funds from overseas and the costs incurred during currency crisis.[10] If this concept is accepted, then one could argue that countries should achieve an appropriate degree of liberalization for their stage of development.

We should point out, however, that the depth of a currency crisis is the result of many different factors. The positive correlation found in Figure 17 and 18 between *IFL* and depth of currency crisis is not controlled for the impact of other factors and should therefore only be seen as a hint that there may be some cause and effect relationship between the two variables. As was the case with the regression analysis results through Section 5, the phenomena observed during the East Asian crisis can not, in all likelihood, be generalized to observations of other currency crises. Before this can happen, more analysis of the impact of financial liberalization must be accumulated by studying a larger number of currency crises.

[10] This paper observes the possibility that there may be trade-offs between liberalization of international capital transactions and depth of currency crisis. It is of the utmost importance to also investigate the possibility of trade-offs between liberalization and the "probability of occurrence" of currency crisis.

7. Conclusions

Below is a summary of the conclusions reached from the empirical analysis described in this paper.

1) The ability of economic statistics heretofore emphasized as important in currency crisis theory to explain the depth of a currency crisis differs from crisis to crisis. Just because a statistic has a high degree of explanatory power for one crisis does not necessarily mean that it will be able to explain another.

2) The hypothesis that "deterioration in economic fundamentals will exacerbate the depth of currency crisis only in those cases in which fundamentals are extremely poor and, at the same time, there is a high likelihood of liquidity drying up" can not be accepted for the East Asian Currency Crisis sample, but can be for the Mexican Currency Crisis.

3) Contagion channels have been confirmed to have explanatory power. In particular, the addition of contagion channels for the East Asian Currency Crisis, where statistics on economic fundamentals have little explanatory power, substantially improves the explanatory power of the regression analysis.

4) Our verification of the correlation between financial liberalization and depth of currency crisis for several leading East Asian countries, while representing only limited sample, indicates the possible existence of a relationship in which the crisis is deeper the greater the liberalization of international capital transactions.

   These findings indicate that the way to minimize the impact of a currency crisis is to maintain sound domestic economic policies (IS balance, sound bank lending etc.) and strong external liquidity positions. The analysis in this paper also hints at the importance of the relationship between financial liberalization and depth of currency crisis. But there has been very little research accumulated on this topic. In light of the potential importance of its policy implications, the author would like to underscore it as an area for future study.

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no riron oyobi jitsushoukenkyu karano implication (The Significance of Liquidity Supplies as Countermeasures for Currency Crises: Implications of Recent Theoretical and Empirical Studies),” (in Japanese), *Kinyu-kenkyu*, Volume 21 No. 2, Institute for Monetary and Economic Studies, Bank of Japan, 2002, pp. 179-212.

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Sources of statistical data

Foreign exchange reserves: *IFS (International Financial Statistics, IMF)*, Reference rf (Exchange Rates, Principal Rate)

Foreign exchange reserves: *IFS*, Reference 1l.d (International Liquidity, Total Reserves minus Gold)

Outstanding domestic private sector credit: *IFS*, Reference 32 minus Reference 32an (Monetary Survey, Domestic Credit minus Claims On Central Government <net>)

Current account: *IFS*, Reference 78ald (International Transactions, Current Account)

Fiscal balance: *IFS*, Reference 80 (Government Finance, Deficit or Surplus)

GDP: *IFS*, Reference 99b (National Accounts, Gross Domestic Product)

External short term debt: *Joint BIS-IMF-OECD-World Bank statistics on external debt*, BIS, IMF, OECD, World Bank

Cross-border lending by banks: *The BIS Consolidated International Banking Statistics, BIS*

Export statistics by export market: *Direction of Trade Statistics Yearbook*, IMF

Economic statistics for Taiwan are not included in the statistics created by the IMF and were therefore obtained from the following sources. The definitions used for Taiwan's statistics can be considered to be the same as for the IMF's.

Taiwan exchange rate, foreign reserves, outstanding domestic private sector credit, current account, fiscal balance, GDP: *Financial Statistics, Central Bank of China*

Taiwan exports broken down by export market: *CEIC, CEIC Data Co. Ltd.*

Taiwan exports to China: *Industry of Free China, Council for Economic Planning and Development, Executive Yuan, Republic of China*

(Figure 1)List of sample countries

Latin American countries

Mexico
Argentina
Brazil
Chile
Peru
Venezuela
Columbia
Ecuador
Bolivia
Uruguay

East Asian countries

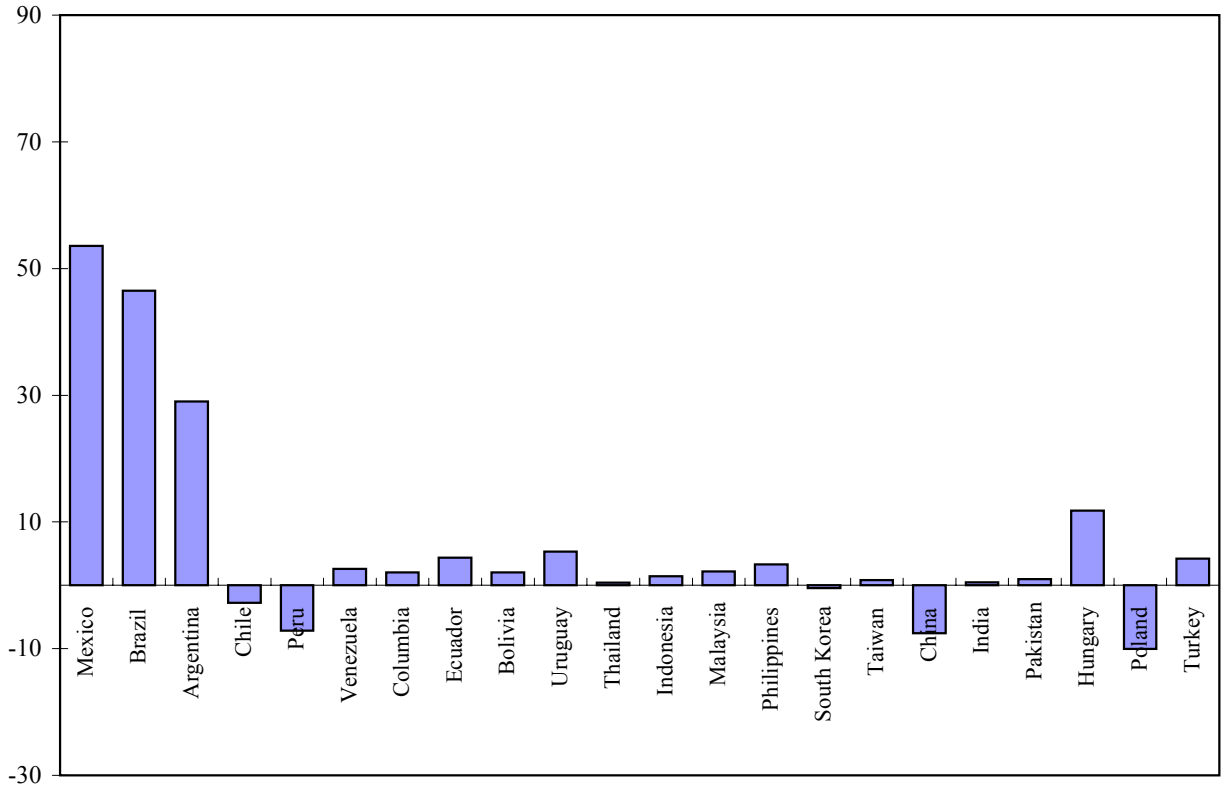
Thailand
Indonesia
Malaysia
Philippines
South Korea
Pakistan
India
Taiwan
China

Eastern European countries etc.

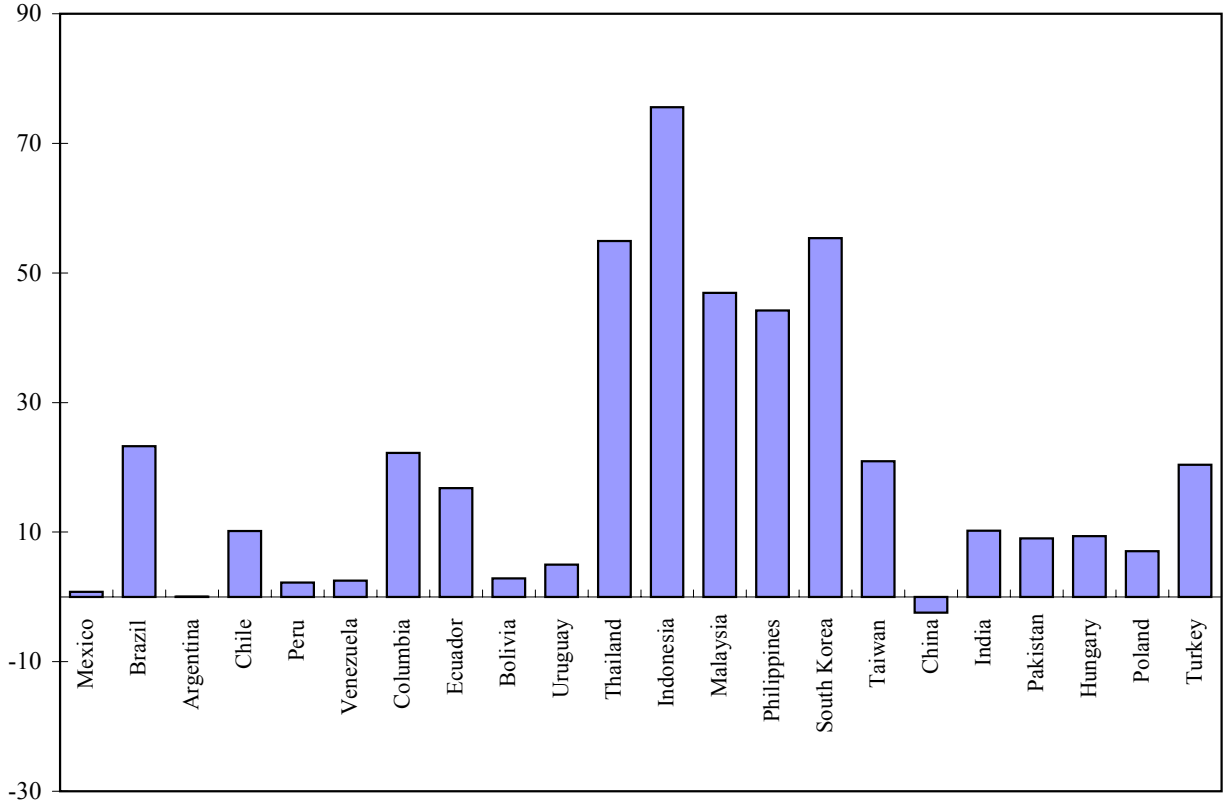
Hungary
Poland
Turkey

22 countries total

(Figure 2-1)Depth of currency crises during Mexican Currency Crisis



(Figure 2-2)Death of currency crises during East Asian Currency Crisis



(Figure 3)Regression analysis: Basic Model

	Explanatory variables	Full sample	Mexican Currency Crisis sample	East Asian Currency Crisis sample
C(1)	Constant	-1.780 (0.756)	-21.743 (0.017)	7.782 (0.323)
C(2)	CAGDP	-0.948 (0.204)	-2.403 (0.013)	-0.557 (0.644)
C(3)	FDGDP	-0.690 (0.498)	-3.096 (0.009)	0.763 (0.658)
C(4)	CRGDP	0.538 (0.018)	0.693 (0.008)	0.586 (0.131)
C(5)	ESDFR	0.092 (0.053)	0.145 (0.027)	0.092 (0.164)
Coefficient of determination adjusted for degree of freedom		0.170	0.358	0.181

Note: p values in parentheses.

(Figure 4-1)Regression analysis: Expanded Model 1 (*Fx = CAGDP*)

	Explanatory variables	Full sample	Mexican Currency Crisis sample	East Asian Currency Crisis sample
C(1)	Constant	-0.408 (0.947)	-13.758 (0.117)	0.862 (0.928)
C(2)	CAGDP	-0.506 (0.473)	-1.471 (0.119)	-0.202 (0.858)
C(3)	FDGDP	-0.837 (0.369)	-2.526 (0.025)	-0.314 (0.854)
C(4)	CRGDP	0.336 (0.118)	0.442 (0.091)	0.561 (0.154)
C(5)	ESDFR	0.080 (0.190)	0.091 (0.161)	0.184 (0.113)
C'(Fx)	CAGDP*LD	1.162 (0.654)	-0.227 (0.950)	5.405 (0.229)
C''(Fx)	CAGDP*LD*]	-6.436 (0.018)	-4.532 (0.282)	-8.035 (0.055)
Coefficient of determination adjusted for degree of freedom		0.320	0.465	0.289
Coefficient restriction Wald Test (null hypothesis)				
C(2)+C(6)=0		(0.796)	(0.651)	(0.266)
C(2)+C(6)+C(7)=0		(0.002)	(0.003)	(0.354)
Sign condition				
C(2)+C(6)+C(7)<0		-0.578	-6.231	-2.832

Note: *p* values in parentheses.

(Figure 4-2)Regression analysis: Expanded Model 1 (*Fx = FDGDP*)

	Explanatory variables	Full sample	Mexican Currency Crisis sample	East Asian Currency Crisis sample
C(1)	Constant	-6.894	-14.023	-0.343
		(0.238)	(0.111)	(0.959)
C(2)	CAGDP	-0.899	-1.443	-0.095
		(0.180)	(0.128)	(0.913)
C(3)	FDGDP	-1.741	-2.537	-1.780
		(0.080)	(0.022)	(0.222)
C(4)	CRGDP	0.536	0.430	0.636
		(0.010)	(0.095)	(0.039)
C(5)	ESDFR	0.146	0.098	0.158
		(0.009)	(0.143)	(0.034)
C'(Fx)	FDGDP*LD	5.636	0.700	7.290
		(0.022)	(0.814)	(0.022)
C''(Fx)	FDGDP*LD*I	16.079	-48.471	20.536
		(0.154)	(0.033)	(0.147)
Coefficient of determination adjusted for degree of freedom		0.333	0.467	0.575
Coefficient restriction Wald Test (null hypothesis)				
C(3)+C(6)=0		(0.089)	(0.549)	(0.049)
C(3)+C(6)+C(7)=0		(0.064)	(0.025)	(0.050)
Sign condition				
C(3)+C(6)+C(7)<0		19.974	-50.307	26.046

Note: *p* values in parentheses.

(Figure 4-3)Regression analysis: Expanded Model 1 (*Fx = CRGDP*)

	Explanatory variables	Full sample	Mexican Currency Crisis sample	East Asian Currency Crisis sample
C(1)	Constant	1.028	-13.773	9.357
		(0.848)	(0.117)	(0.236)
C(2)	CAGDP	-0.438	-1.475	-0.279
		(0.533)	(0.117)	(0.814)
C(3)	FDGDP	-0.678	-2.513	0.738
		(0.474)	(0.023)	(0.670)
C(4)	CRGDP	0.289	0.441	0.345
		(0.207)	(0.097)	(0.394)
C(5)	ESDFR	0.070	0.092	0.077
		(0.119)	(0.161)	(0.241)
C'(Fx)	CRGDP*LD	0.482	-0.021	1.193
		(0.501)	(0.974)	(0.402)
C"(Fx)	CRGDP*LD*I	0.972	1.532	-0.178
		(0.252)	(0.119)	(0.906)
Coefficient of determination adjusted for degree of freedom		0.297	0.465	0.214
Coefficient restriction Wald Test (null hypothesis)				
C(4)+C(6)=0		(0.257)	(0.517)	(0.264)
C(4)+C(6)+C(7)=0		(0.000)	(0.004)	(0.067)
Sign condition				
C(4)+C(6)+C(7)>0		1.744	1.953	1.360

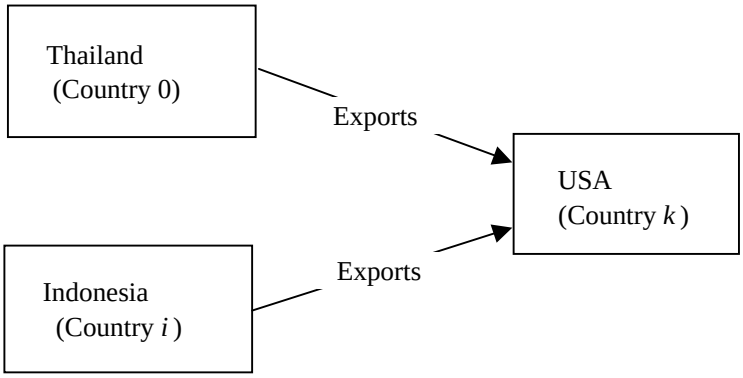
Note: *p* values in parentheses.

(Figure 4-4)Regression analysis: Expanded Model 1 (*Fx = ESDFR*)

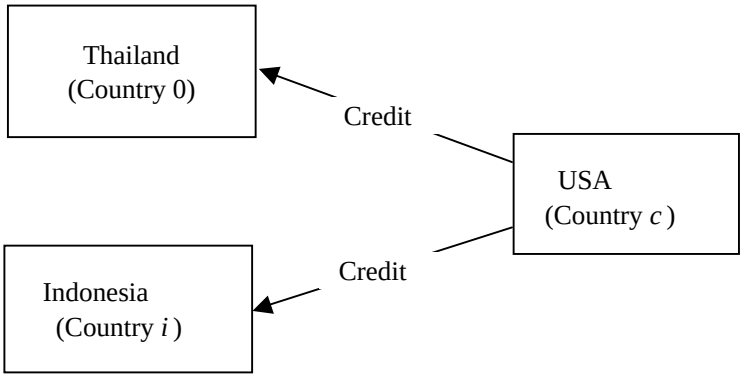
	Explanatory variables	Full sample	Mexican Currency Crisis sample	East Asian Currency Crisis sample
C(1)	Constant	-1.509 (0.807)	-15.645 (0.087)	-2.795 (0.775)
C(2)	CAGDP	-0.443 (0.472)	-1.309 (0.169)	0.011 (0.990)
C(3)	FDGDP	-0.949 (0.266)	-2.319 (0.037)	0.303 (0.833)
C(4)	CRGDP	0.317 (0.093)	0.384 (0.143)	0.443 (0.151)
C(5)	ESDFR	0.107 (0.254)	0.143 (0.145)	0.310 (0.104)
C'(Fx)	ESDFR*LD	-0.059 (0.403)	-0.049 (0.499)	-0.217 (0.128)
C"(Fx)	ESDFR*LD*F	0.313 (0.000)	0.294 (0.027)	0.274 (0.003)
Coefficient of determination adjusted for degree of freedom		0.454	0.481	0.498
Coefficient restriction Wald Test (null hypothesis)				
C(5)+C(6)=0		(0.257)	(0.132)	(0.171)
C(5)+C(6)+C(7)=0		(0.000)	(0.004)	(0.001)
Sign condition				
C(5)+C(6)+C(7)>0		0.361	0.388	0.367

Note: *p* values in parentheses.

(Figure 5)Conceptual diagram of Index of Trade Competition



(Figure 6)Conceptual diagram of Index of Common Lenders



(Figure 7)List of countries used in ITC calculations

Ground zero country (Country 0)	
Mexican Currency Crisis: Mexico	
East Asian Currency Crisis: Thailand	
Export markets (Country *k*)	
USA	Canada
U.K.	Japan
France	Spain
Germany	China
Italy	
Export competitors (Country *i*)	
Mexico	Indonesia
Argentina	Malaysia
Brazil	Philippines
Chile	South Korea
Peru	Taiwan
Venezuela	China
Columbia	India
Ecuador	Pakistan
Bolivia	Hungary
Uruguay	Poland
Thailand	Turkey

(Figure 8)List of countries used in ICL calculations

Ground zero country (Country 0)	
Mexican Currency Crisis: Mexico	
East Asian Currency Crisis: Thailand	
Lenders (Country *c*)	
USA	Hong Kong
U.K.	Ireland
France	Luxembourg
Germany	Netherlands
Italy	Norway
Canada	Portugal
Japan	Singapore
Spain	Sweden
Austria	Switzerland
Belgium	Taiwan
Denmark	Turkey
Finland	
Borrowers (Country *i*)	
Mexico	Indonesia
Argentina	Malaysia
Brazil	Philippines
Chile	South Korea
Peru	Taiwan
Venezuela	China
Columbia	India
Ecuador	Pakistan
Bolivia	Hungary
Uruguay	Poland
Thailand	Turkey

(Figure 9-1)Regression analysis: Expanded Model 2 (Full Sample)

	Explanatory variables		
C(1)	Constant	-0.194 (0.972)	-23.773 (0.011)
C(2)	CAGDP	-0.589 (0.428)	-1.305 (0.049)
C(3)	FDGDP	-0.649 (0.513)	-1.075 (0.202)
C(4)	CRGDP	0.396 (0.086)	0.190 (0.332)
C(5)	ESDFR	0.079 (0.089)	0.077 (0.052)
C(6)	ITC	- -	87.068 (0.000)
C(7)	ICL	- -	11.194 (0.411)
Coefficient of determination adjusted for degree of freedom		0.057	0.344

Notes:

1.Ground zero country (Mexico for the Mexican Currency Crisis, Thailand for the East Asian Currency Crisis) not included in sample.

2.*p* values in parentheses.

(Figure 9-2)Regression analysis: Expanded Model 2

(Mexican Currency Crisis sample)

	Explanatory variables		
C(1)	Constant	-13.797 (0.103)	-62.071 (0.000)
C(2)	CAGDP	-1.475 (0.105)	-2.753 (0.002)
C(3)	FDGDP	-2.512 (0.019)	-3.479 (0.000)
C(4)	CRGDP	0.439 (0.077)	0.412 (0.037)
C(5)	ESDFR	0.093 (0.127)	0.148 (0.006)
C(6)	ITC	- -	54.539 (0.040)
C(7)	ICL	- -	47.248 (0.003)
Coefficient of determination adjusted for degree of freedom		0.162	0.534

Notes:

1.Mexico (ground zero country) not included in sample.

2.*p* values in parentheses.

(Figure 9-3)Regression analysis: Expanded Model 2

(East Asian Currency Crisis sample)

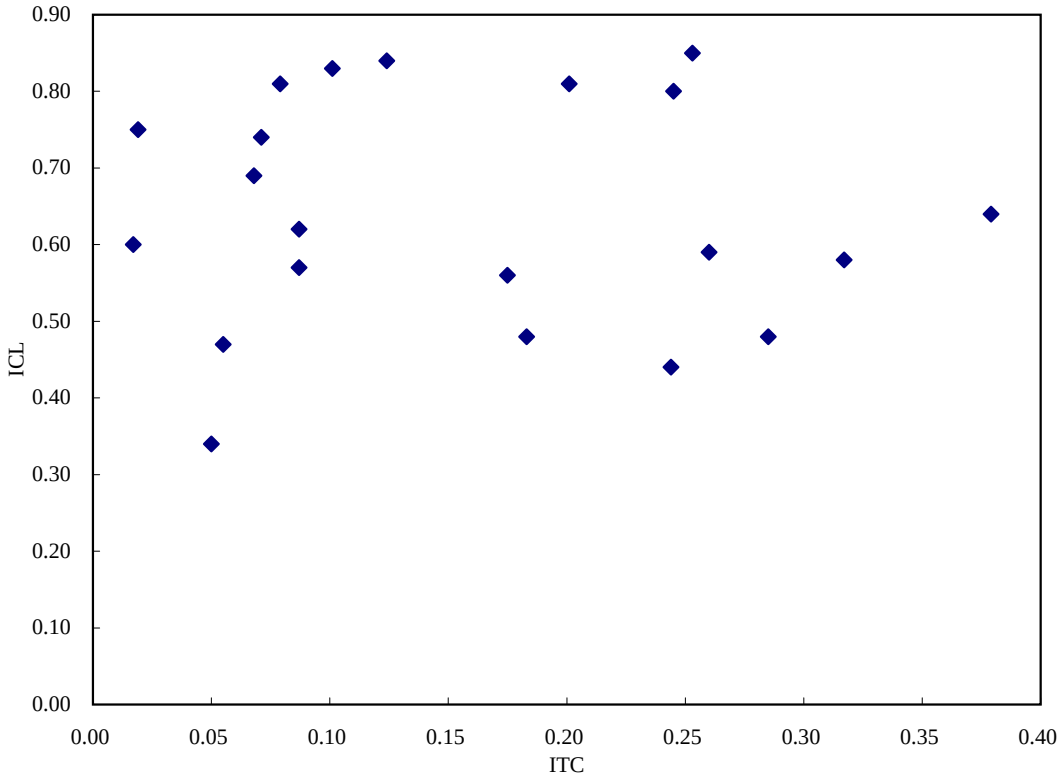
	Explanatory variables		
C(1)	Constant	7.982 (0.320)	-18.228 (0.081)
C(2)	CAGDP	-0.428 (0.730)	-1.020 (0.264)
C(3)	FDGDP	0.707 (0.687)	0.023 (0.985)
C(4)	CRGDP	0.514 (0.208)	0.393 (0.185)
C(5)	ESDFR	0.089 (0.187)	0.078 (0.129)
C(6)	ITC	- -	110.14 (0.025)
C(7)	ICL	- -	4.238 (0.891)
Coefficient of determination adjusted for degree of freedom		0.072	0.541

Notes:

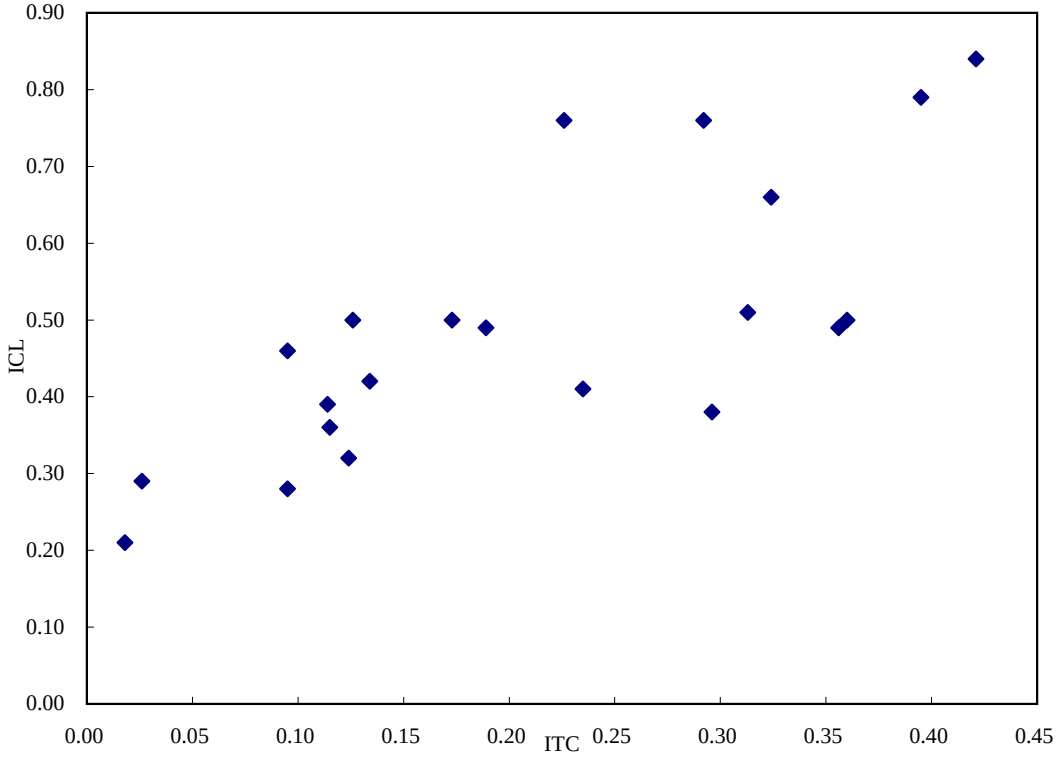
1.Thailand (ground zero country) not included in sample.

2. *p* values in parentheses.

(Figure 10)ITC/ILC relationship in Mexican Currency Crisis



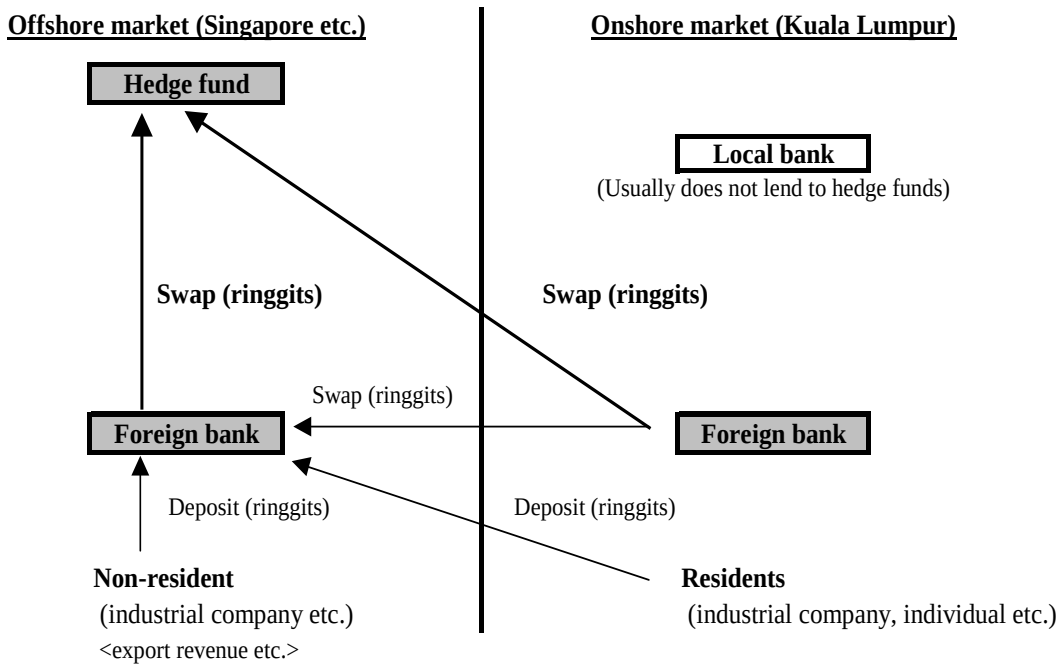
(Figure 11)ITC/ILC relationship in East Asian Currency Crisis



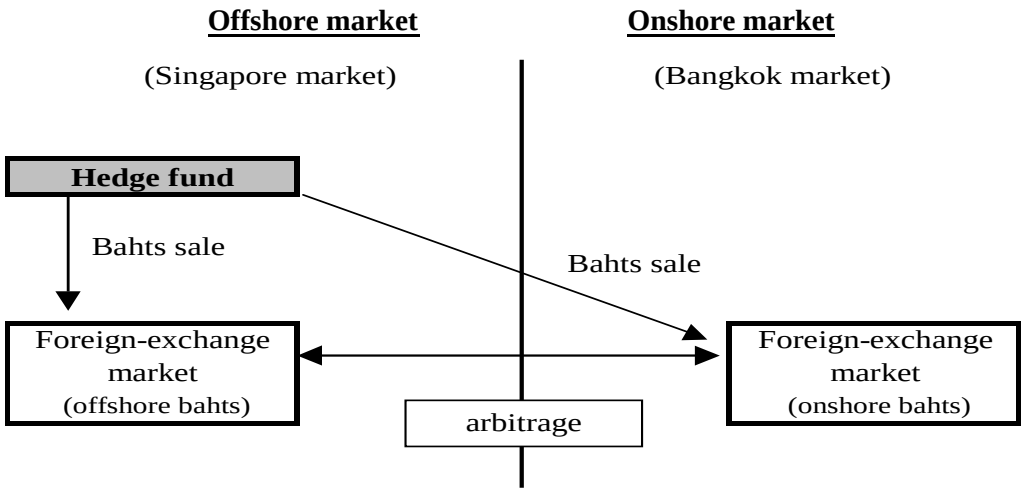
(Figure 12)Stages of liberalization of international capital transactions

High ↑ Degree of liberal-ization ↓ Low	Stage 3	Non-residents are allowed to invest in local currency-denominated financial products (bonds, stocks etc.) and residents are allowed to lend local currency to non-residents.
	Stage 2	Non-residents are allowed to invest in local currency-denominated financial products (bonds, stocks etc.), but residents are not allowed to loan local currency to non-residents.
	Stage 1	Non-residents are not allowed to hold local currency.

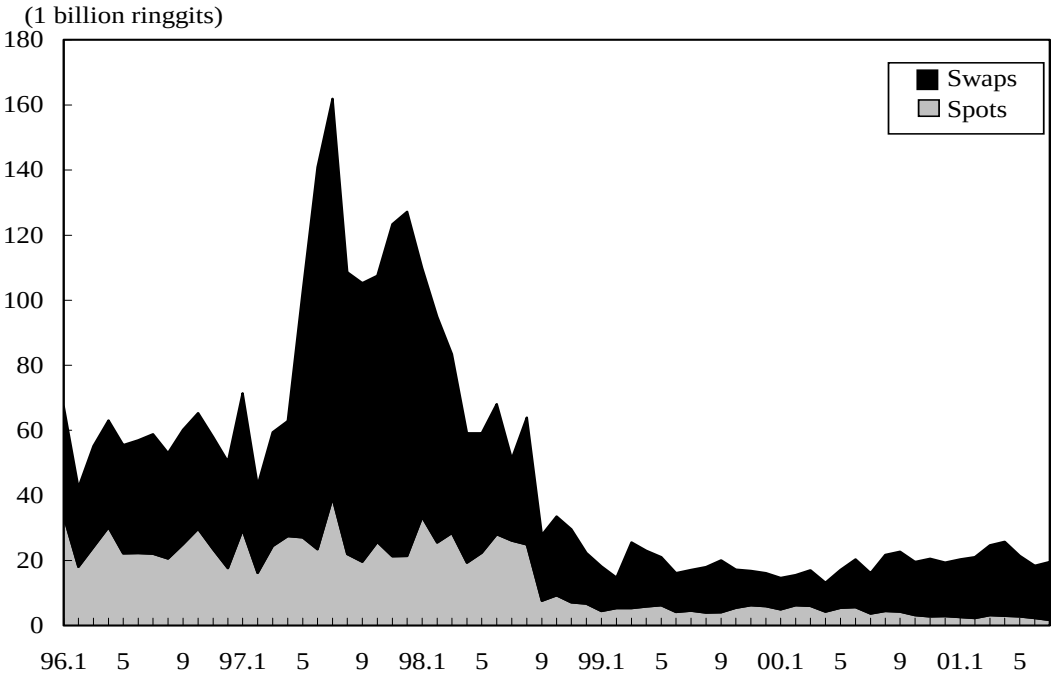
(Figure 13)Conceptual diagram of route by which funds flow to speculators (Malaysian example)



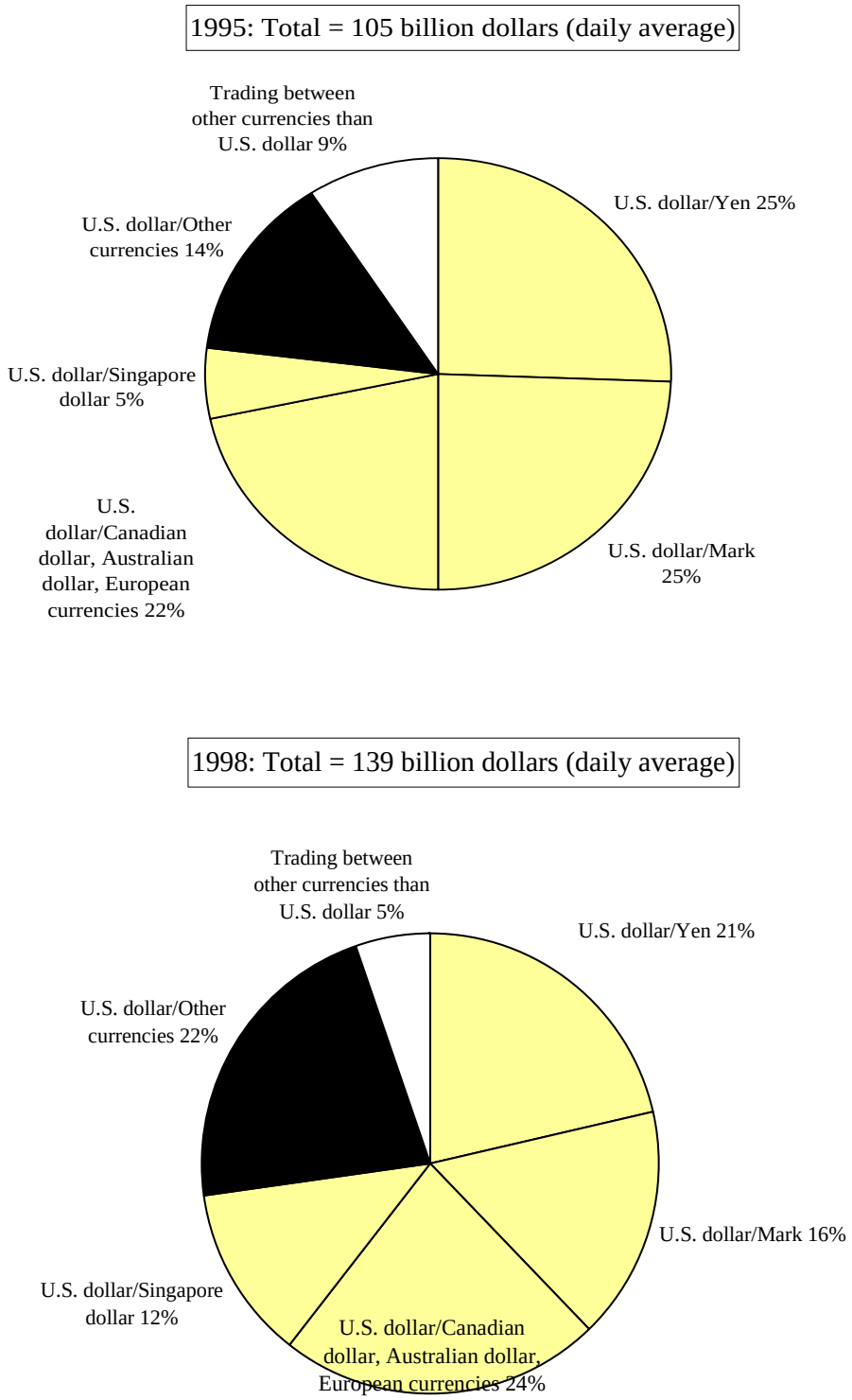
(Figure 14)Sale of local currency by speculators (Thailand example)



(Figure 15)Foreign exchange trading by Malaysian domestic banks



(Figure 16)Breakdown of trading on Singapore foreign exchange market



(Figure 17)Financial liberalization and depth of currency crisis in East Asian Currency Crisis

	Degree of liberalization	Depth of currency crisis
Indonesia	3	75.58
Thailand	3	54.91
Malaysia	3	46.91
South Korea	2	55.37
Philippines	2	44.22
Taiwan	2	20.93
China	1	-2.43

(Figure 18)Financial liberalization and depth of currency crisis in East Asian Currency Crisis