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Twin Crises
A Reexamination of Empirical Links

Jürgen von Hagen[*] and Tai-kuang Ho[**]

ZEI b, Center for European Integration Studies, University of Bonn

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1 Introduction

Twin crises refer to the association of banking crises and balance-of-payments crises, and the vice versa. We have witnessed several balance-of-payments crises that occurred in the midst of a banking crisis, like for instance, Chile in 1982, Finland in 1992, Sweden in 1992, Mexico in 1994, and the recent Asian financial crisis. It is commonly perceived that twin crises will become more frequent under the environment of increasing financial integration and volatile international capital mobility (Wyplosz, 1999).

Twin crises have attracted attention because they tend be more severe than individual banking and currency crises. Twin crises are associated with a larger economic recession and are more costly in terms of bailout cost. However, empirical research on twin crises is rather rare. Kaminsky and Reinhart (1996, 1999) were the first to investigate systematically the links between banking and currency crises. Subsequent work by Glick and Hutchison (2001) employed a much larger data set, which included 90 industrial and developing countries.

All these papers, however, suffer from a common methodological shortcoming. There is an asymmetry in the definition and identification of crises between the two fields of banking and currency markets. More specifically, they use market events like forced merger, bank closures or government intervention to identify banking crises. In contrast, they follow the recent literature on currency crises and develop an index of market pressure to identify currency crises. The currency-crises literature has shown that depending on market events to identify crises is problematic, as it identifies crises only, when they are severe enough to trigger market events such as large devaluations or the collapse of a fixed exchange rate regime. In contrast, crises that were successfully fended off are neglected. The index method is well accepted and considered superior. But if the reliance on market events biases the analysis of currency crises, it is likely to do so in the case of banking crises. We have showed in von Hagen and Ho (2003) that using an events method to identify banking crises is problematic, and the index method is applicable to the identification of banking crises. It is an interesting and important question whether such an unequal treatment of banking and currency crises had influenced the empirical results regarding twin crises. This is what we try to answer in this chapter. We treat banking and currency crises equally in terms of

[*] Center for European Integration Studies (ZEI B), Walter-Flex-Str. 3, D-53113, Bonn, Germany, Tel: +49-228-73-9199, Fax: +49-228-73-1809, E-mail: vonhagen@uni-bonn.de

[**] Center for European Integration Studies (ZEI B), Walter-Flex-Str. 3, D-53113, Bonn, Germany, Tel: +49-228-73-4929, Fax: +49-228-73-1809, E-mail: ho@united.econ.uni-bonn.de

identification, that is, we apply the index method to both the identifications of currency and banking crises. Then we follow the exercises of existing research and compare the empirical results.

This paper is organized as follows. Section 2 briefly reviews the empirical findings of existing research. Section 3 discusses the methodologies we employ to identify banking, currency, and twin crises. Section 4 reports the empirical results. We put all the estimate results and regression tables at the end of this paper. The last section concludes.

2 Twin Crises

Empirical work on twin crises can be counted on the fingers. The most important studies include Kaminsky and Reinhart (1996, 1999) and Glick and Hutchison (2001).

The first step in empirical work is to identify crises. To identify a currency crisis, Kaminsky and Reinhart (1996, 1999) constructed an index of speculative pressure,[1] which was calculated as a weighted average of exchange rate changes and foreign reserve changes. Glick and Hutchison (2001) used a similar method, which used the real exchange rate instead of the nominal exchange rate. In addition, they included changes in the nominal interest rate in the index. Using the real exchange rate has the advantage of capturing sizable devaluation and reserve losses in moderate inflation periods for countries that have experienced hyperinflation.

The prevailing method of identifying a banking crisis is to depend on market events such as bank closure, forced merger, government intervention, or bank holidays. Researchers use sources like newspapers and financial reports to decide the onset and end of a banking crisis. As we have showed in von Hagen and Ho (2003), this events method is the most problematic of all because it contains a lot of arbitrariness in crisis timing. Inconsistency arises in identifying the beginning and ending of a banking crisis by various studies. The inability to pinpoint more accurate timing of the crises also brings difficulties in interpreting the regression results. Having individually identified the banking and currency crises, one can determine the occurrence of twin crises. However, there is no consensus on an operation definition of twin crises. There is the suspect that researchers have used different operational definitions to fit their purpose. Kaminsky and Reinhart (1999), for instance, defined twin crises as "episodes in which the beginning of a banking crisis is followed by a balance-of-payments crisis within 48 months". The definition is somehow "endogenous" in the sense that in their sample, beginning of a banking crisis tended to precede the balance-of-payments crisis. Glick and Hutchison (2001) defined twin crises as "instances in which a bank crisis is accompanied by a currency crisis in either the previous, current, or following year". No explanation was given regarding the choice of operational definition.

What is known about twin crises? It is generally accepted that twin crises are new phenomena of the 1980's and 1990's. Kaminsky and Reinhart (1999) found that there was no apparent link between banking and balance-of-payments crises during the 1970s. Banking and currency crises firstly became closely entwined only in the 1980s. They argued that the liberalization of financial markets prevailing in the 1980s had given rise to twin crises. Glick and Hutchison (2001), using a larger sample that included both crisis- and noncrisis-country, found that the number and frequency of twin crises in the 1980s and 1990s had been threefold to fourfold than that of the 1970s. The number and frequency of twin crises had increased over time. Glick and Hutchison (2001) divided the countries into industrial countries, developing countries, and emerging markets. They found that individual banking and currency crises as well as twin crises had been more frequent in developing countries and emerging markets than in industrial countries.

What links the twin crises? Most research concludes that the onset of a banking crisis tended to lead the currency crisis. Using the signals approach, Glick and Hutchison (2001) found that the onset of banking crises was a leading indicator of coming currency crises, but the converse was not true.

1 Sometimes called *index of currency market turbulence* or *index of currency pressure*. This method is developed by Eichengreen, Rose, and Wyplosz (1994, 1995, 1996), and has become a standard method in identifying currency crises.

Kaminsky and Reinhart (1996) found that the occurrence of a banking crisis helped to predict a future currency crisis. They estimated a probit model where the binary measure of currency crisis was regressed against the binary measure of banking crisis with alternative lag specifications. It turned out that banking crises were significant in helping to predict currency crises. But the converse was not true. Glick and Hutchison (2001) confirmed this *asymmetric result*, although for only the emerging markets sample.[2] The asymmetric result hinted at the causality from banking problem to currency crisis. Bailout of troubled banks might lead to excessive credit creation and induced a Krugman-type currency crisis. A banking problem might also handicap the central bank's ability to defend the currency by its inability to raise the interest rates.

An interesting question is whether crises have become self-fulfilling. Although there was no direct attempt to test the fundament vs. sentiment thesis, it was found that economic fundamentals tended to be worse preceding the crises. In terms of reserve losses and bailout cost, twin crises were more severe than banking and currency crises individually. For instance, Kaminsky and Reinhart (1999) used the signals approach and found that indicators had accurately signaled the majority of crises. Self-fulfilling crises appeared to be quite rare. Variables such as real interest rate, M2 to foreign reserves ratio, exports, and real interest-rate differential were good indicators of twin crises. Glick and Hutchison (2001) examined the determinants of banking and currency crises individually. They found that currency crises were associated with overvaluation of domestic currency and high M2 to reserves ratio, while banking crises were associated with decline in output and financial liberalization. Table 1 summarizes the review of the literature.

Given the problem of using the events method to identify banking crises, one would question whether the above results remain true if a better method were employed. This is what we try to answer in this study.

3 Defining Currency and Banking Crises

3-1 Defining a Currency Crisis

A currency crisis is defined as a situation in which a sharp decline in the demand for the currency leads to substantial reserve losses, or to a sharp increase in short- term interest rates, or to a depreciation of the currency against another one, or a combination of all three (Goldstein et al., 2000). In this study we define an index of currency pressure as a weighted average of changes in real exchange rates, changes in reserves, and changes in nominal interest rate. The weights are the inverse of the standard deviation of individual component. This ensures that the three components have the same conditional volatility. We use nominal instead of real interest rates because nominal rates are what the authorities can directly control in order to fend off speculative attacks. The usage of real exchange rate instead of nominal exchange rate is based on the perception that periods of nominal depreciations that simply keep up with inflation differentials, even if fairly large, should not be considered as currency crises. We define the index as follows.

$$\text{ISP} = (\Delta q / q) \times (1/\sigma_q) - (\Delta FR / FR) \times (1/\sigma_{FR}) + (\Delta i) \times (1/\sigma_i) \qquad (1)$$

where q denotes real exchange rate, an increase in q means real depreciation; FR denotes foreign reserves; i denotes nominal interest rate; Δ is the difference operator; σ_q is the standard deviation of changes in real exchange rate; σ_{FR} is the standard deviation of changes in foreign reserve; and σ_i is the standard deviation of changes in nominal interest rate. We define the

2 Rossi (1999) also found this asymmetric result. Rossi estimated a logit regression for banking crises covering 15 developing countries over the period 1990-97. He found that currency crises did not help to predict banking crises. The author estimated a similar logit model for currency crises and found that lagged banking crises helped to predict currency crises. Eichengreen and Rose (1998) analyzed banking crises using a panel of 100 developing countries over 1975-92. They found that choice of exchange rate regimes had little impact on the probability of banking crises.

threshold in terms of country-specific moments. Periods in which the indices are two standard deviations or more above the mean are defined as currency crises.

3-2 Defining a Banking Crisis

A banking crisis is a situation, where doubt on the solvency of banking system leads to a large-scale withdrawal of deposits, or to requirement of large-scale liquidity support from monetary authorities, or to sharp increase in short-term interest rates, or to a combination of all of them. In this study we use an index of money market pressure to identify banking crises. We have discussed in details the theoretical justification and construction of the index of money market pressure in von Hagen and Ho (2003). Here is only a brief review of the index method. We define the central bank loans to bank deposits ratio as loans from the monetary authorities to deposit money banks divided by total deposits in deposit money banks. The index of money market pressure is calculated as a weighted average of changes in central bank loans to bank deposits ratio and changes in money market rate. We weight the two components by dividing each component by its own standard deviation so that the two components have equal conditional volatility. The index is formulated as follows.

$$\text{IMP} = \Delta\gamma / \sigma(\Delta\gamma) + \Delta r / \sigma(\Delta r) \qquad (2)$$

where γ denotes the central bank loans to bank deposits ratio; r denotes the money market rate in real terms; Δ is the difference operator; $\sigma(\Delta\gamma)$ and $\sigma(\Delta r)$ denote the standard deviations of the two components respectively. Banking crises are identified as periods where the index exceeds a predetermined threshold.

How is the threshold determined? As we have shown in von Hagen and Ho (2003), using a country-specific threshold is better than using a common threshold, although the crises identified by using both methods converge when the threshold value is high. We set the threshold to pick up the 2.5% upper-tail distribution of the index. Periods in which the indices exceed the threshold (fall in the 2.5% upper-tail) are cataloged as banking crises.

3-3 Defining Twin Crises

Twin crises are commonly defined as the association of a banking with a currency crisis. In empirical work, however, there is no commonly accepted definition. Since we do not know a prior which definition is more suitable, we try both definitions of the literature. The first one follows Kaminsky and Reinhart (1999) and defines twin crises as episodes in which a banking crisis is followed by a currency crisis within 8 quarters. The second one follows Glick and Hutchison (2001) and defines twin crises as instances in which a banking crisis is accompanied by a currency crisis in either the previous, current, or following year.

4 Empirical Results

4-1 Data Sources and Window Width

All the data employed in identifying currency and banking crises are taken from the CD-ROM version of the International Monetary Fund's *International Financial Statistics*. Our sample countries are determined by the availability of data. Transition economies are excluded from the sample. *The sample includes 49 countries and ranges from 1980 to 2001*. Following Glick and Hutchison (2001), we group the countries into three groups: industrial countries (16), emerging markets (18), and other developing countries (15). See Table 2 for details.

We use monthly data to identify currency crisis. In order to avoid counting the same crisis more than once, we impose a 12-month window for currency crisis. This eliminates the crises within the 12 months following the first identified crisis. A 12-month window also means that there can be maximum one currency crisis within one year. We then transform the monthly data into quarterly data. We have identified totally 72 currency crises. They are reported in Table 3. We employ quarterly data to identify banking crises and select a window width of 16 quarters. Quarterly data instead of monthly data are used to the identification of banking crises because this enables us to include more countries in the sample. There are 63 banking crises. They are reported in Table 4.

Kaminsky and Reinhart (1999) compare the occurrences of currency and banking crises on a monthly frequency. It is doubtful whether it is possible to identify banking crises with such precision by market events. Glick and Hutchison (2001) used annual timing, which might obscure the relative timing of currency and banking crises if the crises occur within the same year. In this paper we use quarterly timing, which seems to be more adequate.

4-2 Occurrences of Currency and Banking Crises

Table 7 reports the distribution of banking and currency crises over time. We also report the incidence of twin crises under two different definitions. Under the first definition, 20 of the 63 banking crises were twin crises. They are listed in Table 5. There were 28 twin crises under the second definition, which are reported in Table 6. There are more twin crises under the second definition. The difference comes from the fact that the second definition identifies more twin crises in developing countries, and especially during 1995-2001. To compare our timing of twin crises with other research, we include in the last columns of Table 5 and Table 6 the twin crises recorded by other research in countries for which we have identified twin crises. In general, our timing of twin crises is quite different from Kaminsky and Reinhart (1999), but more consistent with Glick and Hutchison (2001). Nearly 44 percent of banking crises have been twin crises. This result is similar to Glick and Hutchison (2001), who used the second definition of twin crises and found 41 percent of banking crises were twin crises. Although in their sample, the number of currency crises is twice more than the number of banking crises.

We observe that banking crises clustered around the early 1980s. The number and frequency of banking crises declined in mid 1980s, and was relative constant through the 1990s. Like banking crises, currency crises also clustered in the early 1980s. We also observe that the number and frequency of currency crises increased in the early 1990s. But they declined from mid 1990s on. Twin crises were most frequent in the early 1980s. Their frequency declined in the mid-1980s, and then increased again in early 1990s. Overall, we find that currency crises are more frequent than banking crises. Twin crises had a high incidence already in early 1980s. They were not new phenomena in the 1990s. Our finding is somehow different from Glick and Hutchison (2001), who found that the number and frequency of banking crises and twin crises had increased over time.[3]

Table 8 reports the distribution of banking and currency crises over different groups of countries. Individual currency crises as well as twin crises are more frequent in emerging markets and in developing countries than in industrial countries. However, banking crises are more frequent in industrial countries than in developing countries and in merging markets. This is different from Glick and Hutchison (2001) who found that industrial countries have less frequent financial crises than developing countries.

4-3 Banking Crises as Indicators of Currency Crises

Kaminsky, Lizondo and Reinhart (1998) use a signals approach to evaluate different early warning indicators of currency crises. Brüggemann and Linne (1999) apply the same methodology to evaluate the effectiveness of individual indicators for both banking and currency crises in Central and Eastern European countries. The signals approach monitors the evolutions of a set of selected economic variables. When the variables deviate from their normal paths and exceed some threshold values, they are perceived as revealing the deterioration of the economic fundamentals and signaling a coming crisis.

Here we follow the methodology of Glick and Hutchison (2001). Consider the following matrix.

	Currency crisis t	No currency crisis t
Banking crisis t	At,t	Bt,t
No banking crisis t	Ct,t	Dt,t

3 Similar to our results, Glick and Hutchison (2001) found that that number and frequency of currency crises were higher in the 1980s than in the 1990s.

The matrix considers the occurrence of a banking crisis as an indicator for a contemporaneous currency crisis. The cell $A_{t,t}$ denotes the number of instances in which a banking crisis is a *good signal* for the occurrence of a currency crisis, that is, a banking crisis is accompanied by a currency crisis in the same period. Cell $B_{t,t}$ denotes the number of instances in which a banking crisis is a *bad signal* for the occurrence of a currency crisis, that is, the banking crisis is not accompanied by a currency crisis. Cell $C_{t,t}$ denotes the number of instances, in which there is no banking crises but a currency crisis does occur. Cell $D_{t,t}$ denotes the number of instances in which there is neither a banking nor a currency crisis. Similar matrices can be constructed to show the number of instances in which a banking crisis in period *t* is preceded or followed by a currency crisis in period *t-1* or *t+1*.

A perfect indicator issues a signal if, and only if, there is a currency crisis. Thus a perfect indicator would have $A_{t,t}>0$, $D_{t,t}>0$, $B_{t,t}=0$ and $C_{t,t}=0$. In contrast, a bad indicator would have few entries in $A_{t,t}$ and $D_{t,t}$, and many entries in $B_{t,t}$ and $C_{t,t}$. The *signal-to-noise ratio* of an indicator is defined as $[A_{t,t}/(A_{t,t}+C_{t,t})]/[B_{t,t}/(B_{t,t}+D_{t,t})]$, that is, the ratio of good signals to all possible good signals, divided by the ratio of false signals to all possible false signals. A perfect indicator has a signal-to-noise ratio of infinity. The higher the signal-to-noise ratio is, the better the indicator. An indicator that issues signals in a random way does not contain any useful information and has a signal-to-noise ratio equal to one. Indicators with signal-to-noise ratios below one contain excessive noise and are not helpful in predicting crises.

Table 9 reports the signal-to-noise ratio of banking crises as indicators of currency crises. In general, banking crises are more likely to be leading and contemporaneous indicators of currency crises. The above approach employed by Glick and Hutchison (2001), however, has two defects. First, there tends to be a lot of entry under D_t, which makes the signal-to-noise ratio look much better than it actually is. In other words, a bad indicator, which has only few entries of A_t and many entries of B_t, can still have a high signal-to-noise ratio, simply because there are a lot of entries of D_t. Second, the approach does not allow a signaling window, which means that for a signal to be counted as good signal, it must happen exact *+l (-l)* periods prior to (after) the crisis. This seems unreasonable given that an indicator may have issued a signal within any of the periods prior to the crisis.

To correct these defects, we redefine the signal-to-noise ratio simply as A_t/B_t, the ratio of good signal to bad signal. We also allow for different signaling windows. A signaling window of quarter *N* prior to (after) the crises means that signals issued within *N* periods prior to (after) the crises are counted as good signal.[4] Table 10 reports the modified signal-to-noise ratio of banking crises as leading or lagging indicators of currency crises. As before, banking crises were more likely to lead, not to follow, currency crises.[5] Banking crises lead but are not generally a good indicator of a following currency crisis. It is evident from Table 10 that only for emerging markets were banking crises good leading indicators of currency crises.

4-4 Currency Crises as Indicators of Banking Crises

This section repeats the exercise of the last section, with currency crisis as indicator of banking crisis. Table 11 reports the performance of currency crises as indicators of banking crises. In general, currency crises are more likely to follow than to lead banking crises. The modified results in Table 12 indicate that currency crises are bad leading indicators of banking crises. Signal-to-noise ratios are lower than 0.5 in most cases.

Combining the results of the previous section, we find that banking crises are more likely to lead currency crises and currency crises are more likely to follow banking crises. But this tendency should not be overstressed. The signals approach shows that only for emerging markets were

[4] We set the maximum value of signaling window N equal to 8 quarters. Kaminsky and Reinhart (1999) used a signaling window of plus 24 months for currency crises, and a signaling window of plus and minus 12 months for banking crises.

5 In Table 10, signal-to-noise ratios of period T+N are higher than that of period T-N.

banking crises good leading indicators of currency crises. In no case were currency crises good leading indicators for banking crises.

4-5 Multivariate Probit Model

Kaminsky and Reinhart (1996) estimate bivariate probit regressions and find that banking crises help to predict currency crises, but the converse is not true. Here we estimate multivariate probit regressions which, in additional to the crisis dummy, include a set of macroeconomic variables in the explanatory variables. The explanatory variables for currency crises are overvaluation of the real exchange rate,[6] export growth in U.S. dollars, M2 to foreign reserves ratio, currency account to GDP ratio, growth rate of nominal M2, growth rate of real M2, growth rate of nominal domestic credit, growth rate of real domestic credit, M2 to reserve money ratio, and budget surplus to GDP ratio. The explanatory variables for banking crises are real GDP growth, inflation, a dummy for financial liberalization,[7] real credit growth, changes in nominal interest rate, changes in real interest rate, budget surplus to GDP ratio, and a dummy for existence of explicit deposit insurance. These variables are selected according to theory on banking and currency crises. We choose the variables to be as similar as those in Glick and Hutchison (2001) in order to compare the results. The currency and banking crises dummies are converted into annual frequency. Table 13 describes the definition and sources of the independent variables.

We have tried using the same independent variables as Glick and Hutchison (2001). They include overvaluation of real exchange rate, M2 to reserves ratio, and export growth as explanatory variables for currency crises. The first two variables are significant in most estimates. They include inflation rate, output growth, and a dummy for financial liberalization as explanatory variables for banking crises. Only the last two are significant. We find it difficult to replicate their results. Some of the variables suggested by Glick and Hutchison (2001) were not significant in the regressions. We then tried including all the possible variables in Table 13, and eliminated one by one the insignificant variables. Subsequently we include only a parsimonious set of variables that are significant in the regressions.

The results for currency crises are reported in Table 14 and Table 15. We include banking crises and a parsimonious set of macroeconomic variables in the regression. A composite crisis dummy that stands for occurrence of banking crisis in either period *t-1* or *t-2* is included in the explanatory variables. There is evidence that currency crises are preceded by overvaluation of the real exchange rate. Other research has found the real exchange rate to be among the best indicators of currency crises (Goldstein, Kaminsky and Reinhart, 2000). The M2 to foreign reserves ratio is a measure of the central bank's ability to defend a currency peg when there is adverse foreign exchange speculation. This variable is positively and significantly correlated with currency crises, which means that currency crises are more likely to happen when the central bank does not have sufficient foreign reserves to defend the currency. Current account deficits increase the possibility of a currency crisis. A rapid credit growth tends to precede a currency crisis. In general, these variables are consistent to what the fundamental-based currency crisis models predict (Krugman, 1979, Flood and Garber, 1984). Somehow oddly, we find that a higher M2 to reserve money multiplier is associated with less probability of a currency crisis. Having controlled for the effects of macroeconomic variables, we find that currency crises are significantly correlated with contemporaneous banking crises for all groups of sample. But banking crises occurring within the past year *do not* help predict the occurrence of currency crises. This is true for all groups of country.[8]

Multivariate probit regressions for banking crises are reported in Table 16 and Table 17. The probability of a banking crisis generally increases with a slowdown in real growth. Financial

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[6] Overvaluation of the real exchange rate is calculated as the deviation from the trend specified by the Hodrick-Prescott filter. Increase in the value means real depreciation.

[7] The financial liberalization is a dummy variable, which takes the value of one in periods during which interest rates were liberalized.

8 Glick and Hutchison (2001) find that past banking crises help to predict currency crises only in emerging markets.

liberalization makes banking crises more likely, although the variable is not significant. Banking crises are correlated with a slowdown of credit growth in the previous year, indicating that a phase of excessive credit expansion might end up well before the crisis broke out.

Again, there is a strong and contemporaneous correlation between banking crises and currency crises. In addition, currency crises occurring within the past year help to predict banking crises for the all countries and developing countries samples. This seems to suggest that, without any implication of causality, twin crises in developing countries tend to show up first as a currency crisis and then followed by a banking crisis. Together with Table 14 and Table 15, there is a *symmetric result* that banking crises help predict currency crises contemporaneously, and vice versa. This finding is different from Glick and Hutchison (2001), who find significant contemporaneous correlations between banking crises and currency crises only for developing countries and emerging markets, but not for the full sample of countries. In addition, for the samples of all countries and developing countries, there is an asymmetric result in which past currency crises increase the probability of banking crises, but the inverse is not true. This result is opposite to the finding of Kaminsky and Reinhart (1996), who find that past banking crises help predict currency crises, but past currency crises do not help predict banking crises. Glick and Hutchison (2001) likewise find that in none of their samples do past currency crises help to explain banking crises.[9]

5 Tests of Robustness

The above results are based on banking crises identified using a 2.5% threshold and a 16 quarters window width. We have tried different threshold value (1.5%, 2.5%, and 3.5%) and window widths (12 and 16 quarters) and found most of the above results are robust. Here we summarize briefly the robust test to save space.

The distribution of financial crises over time and the results of signal approach are robust to different specifications. Distribution of financial crises over different groups of countries remains the same. The only finding that requires further qualification is the asymmetric result, which means that past currency crises help predict banking crises, but the converse is not true. One sees that for the samples of all countries and of developing countries, this finding is robust. When a higher threshold is employed and more banking crises are identified, currency and banking crises help to predict each other. This implies that the asymmetric result is sensitive to the number of banking crises identified. However, in no case do we find that banking crises help predict currency crises, but the converse is not true.

6 Conclusion

This paper examines the empirics of twin crises. We treat banking and currency crises equally in terms of identification. We construct an index of money market pressure and an index of foreign currency market pressure to identify banking and currency crises, respectively. Our sample includes 49 countries spanning the period 1980-2001.

Our results display similarities to and show differences with existing research. Most of our findings are robust to different specifications. Our results shed some new light on twin crises. First, earlier research concludes that the frequency of banking crises and twin crises has increased over time. However, we find that banking crises and twin crises were more frequent in the early 1980s. Twin crises are new phenomena and appeared already in the early 1980s. Their frequency declined in mid-1980s but returned to the earlier level in the early 1990s. Second, existing research finds banking crises are good leading indicators of currency crises. We find that although banking crises are more likely to lead than to follow currency crises, but they are good leading indicators of currency crises only for emerging markets. Third, existing research finds an asymmetrical result

[9] The correlation between the currency and banking crisis dummies remains the same even if we simply regress the currency crisis dummy on the contemporaneous and lagged banking crisis dummy, and vice versa.

between banking and currency crises. It means that past banking crises help to predict currency crises, but the reverse is not true. We also find such an asymmetric character, but its causal direction is just opposite. In other words, we find past currency crises help to predict banking crises, and the converse is not true. Such an asymmetric result is sensitive to the threshold values used in the identification of banking crises.

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Table 1: A summary of the findings of existing research on twin crises

Study, Sample, and Frequency	Country Coverage	Methodology	Findings
Kaminsky and Reinhart (1996) 1970 to mid-1995 Monthly	20 countries, including 5 industrial countries and 15 developing countries.	(1) A probit model where the currency crisis dummy is regressed against the banking crisis dummy, under alternative specifications of 12-month lag and 36-month lag and a dummy for financial liberalization. A similar probit model for banking crises.	Banking crises are significant in helping to predict currency crises; the converse is not true.
		(2) Figures portraying the evolution of macroeconomic and financial variables around the time of currency crises. Similar figures for banking crises.	Conditions preceding the currency and banking crises: recession, export decline, high real interest rate, falling stock market, and decline of terms of trade. Conditions preceding currency crises: falling foreign reserves and rapid money growth. Credit expansions predate the banking crises.
Kaminsky and Reinhart (1999) 1970 to 1995 Monthly	20 countries, including 5 industrial countries and 15 developing countries.	(1) Figures portraying the pre- and post crises behavior of 16 macroeconomic and financial variables compared to the average behavior during tranquil periods, for currency, banking, and twin crises respectively.	Weak and deteriorating economic fundamentals typically preceded the twin crises. In comparison to currency or banking crises individually, economic fundamentals tended to be worse for the twin crises.
		(2) Signals approach by using 16 indicators for currency and banking crises respectively.	Best leading indicators of currency crises: real interest rate, real interest rate differential, exports, and M2 to foreign reserves ratio. Best leading indicators for banking crises: real interest rate, interest rate differential, terms of trade, foreign reserves, output, exports, and stock prices.
Glick and Hutchison (2001) 1975 to 1997 Annual	90 countries, including 21 industrial countries, 32 emerging markets, and 37 other developing countries.	(1) Signals approach: performance of bank crises as a signal of currency crises, and performance of currency crises as a signal of bank crises.	Banking crises tend to be contemporaneous or leading, rather than lagging, indicators of currency crises.
		(2) Multivariate probit model for currency crises that include the onset of banking crises and a parsimonious set of macroeconomic variables as explanatory variables.	Lagged as well as contemporaneous bank crises help to predict future currency crises in the emerging markets sample. But the bank crisis variable is not significant in the developing country and full country samples.
		(3) Multivariate probit model for the onset of banking crises that include currency crises and a parsimonious set of macroeconomic variables as explanatory variables.	The onset of bank crises is highly correlated with cotemporaneous currency crises. But lagged currency crises are not significant in explaining the onset of bank crises in any of the samples.
		(4) Simultaneous equation probit model for currency and banking crises.	Strong contemporaneous correlation between the onset of banking crises and currency crises in emerging markets even when controlling for simultaneous bias and other explanatory variables. However, no contemporaneous association is seen in the developing country sample or in the full group of countries.

Table 2: Countries included in the study and the grouping

Industrial countries	Emerging markets	Other developing countries
Austria	Argentina	Burundi
Denmark	Brazil	Guatemala
Finland	Chile	Jamaica
France	Ecuador	Nepal
Greece	Egypt	Niger
Italy	India	Senegal
Japan	Indonesia	Togo
Netherlands	Israel	Cyprus
Portugal	Kenya	Swaziland
Spain	Korea	Papua New Guinea
Sweden	Mexico	El Salvador
Switzerland	Peru	Honduras
Ireland	South Africa	Nigeria
Germany	Sri Lanka	Seychelles
United States	Thailand	Uganda
New Zealand	Turkey	
	Uruguay	
	Venezuela	
	Number of countries (totally 49 countries)	
16	18	15

Note:

1. The "all country" sample includes "industrial countries", "emerging markets", and "other developing countries". The "developing country" sample includes "emerging markets" as well as "other developing countries".
2. The classification follows Glick and Hutchison (2001), except for Israel, Niger, Senegal, Togo, Papua New Guinea, and Seychelles, which are not included in their sample.

Table 3: Occurrences of currency crises: 72 currency crises

THRESHOLD=2 STANDARD DEVIATIONS, WINDOW WIDTH=12 MONTHS

Country	Currency Crisis	Country	Currency Crisis	Country	Currency Crisis
Argentina	1982Q3	Israel	1985Q2	Sweden	1992Q3
Argentina	1989Q2	Italy	1981Q2	Switzerland	1981Q3
Brazil	1983Q2	Italy	1992Q3	Switzerland	1989Q1
Brazil	1990Q1	Jamaica	1983Q4	Thailand	1997Q3
Brazil	1999Q1	Jamaica	1992Q1	Togo	1994Q1
Burundi	1992Q2	Japan	1980Q1	Turkey	1994Q2
Burundi	1998Q3	Japan	1990Q2	Turkey	2001Q1
Burundi	2001Q1	Kenya	1993Q3	Uruguay	1982Q4
Chile	1982Q3	Korea	1997Q4	Venezuela	1999Q1
Chile	1984Q4	Mexico	1982Q3	Ireland	1981Q3
Denmark	1980Q1	Mexico	1995Q1	Ireland	1992Q4
Denmark	1982Q4	Nepal	1984Q4	Swaziland	1981Q4
Denmark	2000Q3	Nepal	1991Q3	Swaziland	1985Q1
Ecuador	1986Q3	Netherlands	1981Q3	Germany	1981Q3
Ecuador	1999Q1	Niger	1994Q1	United States	1987Q4
Egypt	1981Q3	Peru	1988Q3	New Zealand	1984Q3
Egypt	1990Q2	Peru	1990Q2	Papua New Guinea	1995Q2
Egypt	1991Q2	Portugal	1983Q3	Papua New Guinea	1998Q1
France	1981Q2	Senegal	1994Q1	El Salvador	1986Q1
Guatemala	1986Q4	South Africa	1982Q1	Honduras	1990Q2
Guatemala	1990Q3	South Africa	1984Q3	Nigeria	1986Q4
India	1991Q3	Spain	1982Q4	Seychelles	1982Q2
Indonesia	1998Q1	Spain	1993Q3	Uganda	1982Q2
Israel	1984Q1	Sril Lanka	1995Q4	Uganda	1989Q1

Table 4: Occurrences of banking crises: 63 banking crises

THRESHOLD=2.5%, WINDOW WIDTH=12 QUARTERS

Country	Banking Crisis	Country	Banking Crisis	Country	Banking Crisis
Argentina	1989Q2	Jamaica	1993Q1	Spain	1983Q3
Austria	1985Q1	Japan	1985Q4	Spain	1993Q2
Austria	1997Q4	Japan	1998Q3	Sri Lanka	1983Q3
Brazil	1987Q4	Kenya	1993Q1	Sri Lanka	1995Q4
Burundi	1998Q4	Korea	1981Q4	Swaziland	1982Q1
Chile	1984Q2	Korea	1998Q1	Sweden	1992Q3
Cyprus	1982Q4	Mexico	1989Q2	Switzerland	1998Q3
Denmark	1993Q1	Mexico	1995Q2	Thailand	1997Q4
Ecuador	1984Q2	Nepal	1984Q3	Togo	1980Q3
Finland	1989Q4	New Zealand	1983Q1	Togo	1995Q4
France	1981Q3	New Zealand	1988Q2	Turkey	2000Q4
France	1992Q3	Niger	1982Q3	USA	1981Q2
Germany	1980Q3	Nigeria	1989Q4	Uruguay	1982Q4
Germany	1991Q2	Nigeria	1996Q3	Venezuela	1999Q1
Guatemala	1991Q4	Papua New Guinea	1981Q2	Egypt	1990Q4
Guatemala	2001Q2	Peru	1990Q1	El Salvador	1987Q4
India	1984Q2	Portugal	1985Q2	Greece	1991Q4
India	1999Q4	Senegal	1995Q3	Honduras	1985Q1
Indonesia	1998Q1	Seychelles	1982Q1	Ireland	1992Q3
Israel	1984Q3	South Africa	1984Q1	Netherlands	1985Q2
Italy	1992Q2	South Africa	1990Q1	Uganda	1989Q2

Table 5: Occurrence of twin crises, definition 1: 20 twin crises

	This study		Kaminsky and Reinhart (1999)	
COUNTRY	BANKING CRISIS	CURRENCY CRISIS	BANKING CRISIS (onset of)	CURRENCY CRISIS
Argentina	1989Q2	1989Q2	March 1980	February 1981
			May 1985	September 1986
Chile	1984Q2	1984Q4	September 1981	August 1982
Germany	1980Q3	1981Q3		
Indonesia	1998Q1	1998Q1		
Israel	1984Q3	1985Q2	October 1983	October 1983
Italy	1992Q2	1992Q3		
Kenya	1993Q1	1993Q3		
Nepal	1984Q3	1984Q4		
New Zealand	1983Q1	1984Q3		
Peru	1990Q1	1990Q2		
Seychelles	1982Q1	1982Q2		
South Africa	1984Q1	1984Q3		
Spain	1993Q2	1993Q3	November 1978	December 1982
Sri Lanka	1995Q4	1995Q4		
Sweden	1992Q3	1992Q3	November 1991	November 1992
Turkey	2000Q4	2001Q1	January 1991	March 1994
Uruguay	1982Q4	1982Q4	March 1971	December 1971
			March 1981	October 1982
Venezuela	1999Q1	1999Q1	October 1993	May 1994
Egypt	1990Q4	1991Q2		
Ireland	1992Q3	1992Q4		

Note: Definition 1 defines twin crises as episodes in which a banking crisis is followed by a currency crisis within 8 quarters.

Table 6: Occurrence of twin crises, definition 2: 28 twin crises

	This study		Glick and Hutchison (2001)	
COUNTRY	BANKING CRISIS	CURRENCY CRISIS	BANKING CRISIS	CURRENCY CRISIS
Argentina	1989Q2	1989Q2	1989-1990	1989
Burundi	1998Q4	1998Q3		
Chile	1984Q2	1984Q4		
France	1981Q3	1981Q2		
Germany	1980Q3	1981Q3		
Indonesia	1998Q1	1998Q1	1997	1997
Israel	1984Q3	1984Q1, 1985Q2		
Italy	1992Q2	1992Q3		
Jamaica	1993Q1	1992Q1		
Kenya	1993Q1	1993Q3	1985-1989	1985
			1992-1997	1993
Korea	1998Q1	1997Q4	1997	1997
Mexico	1995Q2	1995Q1	1981-1991	1982
			1995-1997	1994
Nepal	1984Q3	1984Q4		
Peru	1990Q1	1990Q2		
Seychelles	1982Q1	1982Q2		
South Africa	1984Q1	1984Q3	1977	1978
			1985	1984
Spain	1983Q3	1982Q4	1977-1985	1976
Spain	1993Q2	1993Q3		
Sri Lanka	1995Q4	1995Q4		
Swaziland	1982Q1	1981Q4		
Sweden	1992Q3	1992Q3		
Thailand	1997Q4	1997Q3	1983-1987	1984
			1997	1997
Turkey	2000Q4	2001Q1	1994-1995	1994
Uruguay	1982Q4	1982Q4	1981-1984	1982
Venezuela	1999Q1	1999Q1	1994-1997	1994
Egypt	1990Q4	1990Q2, 1991Q2	1980-1985	1979
Ireland	1992Q3	1992Q4		
Uganda	1989Q2	1989Q1		

Note: Definition 2 defines twin crises as instances in which a banking crisis is accompanied by a currency crisis in either the previous, current, or following year.

Table 7: Distribution of currency and banking crises over time

	1980-2001	1980-1984	1985-1989	1990-1994	1995-2001
			Banking crises		
Number	63	20	13	14	16
Frequency %	5.8	8.2	5.3	5.7	4.7
			Currency crises		
Number	72	27	11	20	14
Frequency %	6.7	11.0	4.5	8.2	4.1
			Twin crises (Definition 1)		
Number	20	8	1	7	4
Frequency %	1.9	3.3	0.4	2.9	1.2
			Twin crises (Definition 2)		
Number	28	10	2	8	8
Frequency %	2.6	4.1	0.8	3.3	2.3

Note: Twin crises in definition 1 are defined as episodes in which a banking crisis is followed by a currency crisis within 8 quarters. Twin crises in definition 2 are defined as instances in which a banking crisis is accompanied by a currency crisis in either the previous, current, or following year (Glick and Hutchison, 2001). Frequency is defined as number of crises divided by total sum of country-years.

Table 8: Distribution of currency and banking crises over different groups of countries

	Industrial countries	Developing countries	Emerging markets
	Banking crises		
Number	22	41	23
Frequency %	6.3	5.6	5.8
	Currency crises		
Number	20	52	30
Frequency %	5.7	7.2	7.6
	Twin crises (Definition 1)		
Number	6	14	12
Frequency %	1.7	1.9	3.0
	Twin crises (Definition 2)		
Number	7	21	15
Frequency %	2.0	2.9	3.8

Note: "Developing countries" include "emerging markets" and "other developing countries" as defined in Table 2.

Table 9: Banking crisis as indicator of currency crisis

	Signal-to-noise ratio								
Groups	T-4	T-3	T-2	T-1	T	T+1	T+2	T+3	T+4
All	1.0	0.9	1.9	7.3	6.2	7.5	4.0	1.0	0.9
Industrial	0.0	3.4	0.0	3.3	3.3	12.1	0.0	0.0	3.5
Developing	1.4	0.0	2.7	9.3	7.6	5.9	5.8	1.4	0.0
Emerging	0.0	0.0	4.8	7.7	14.4	4.9	10.7	2.3	0.0

Note: T refers to quarter. Signal-to-noise ratio is defined as [A/(A+C)]/[B/(B+D)].

Table 10: Banking crisis as indicator of currency crisis, modified

	Signal-to-noise ratio								
Groups	T-4	T-3	T-2	T-1	T	T+1	T+2	T+3	T+4
All	0.4	0.3	0.3	0.3	0.1	0.3	0.4	0.4	0.4
Industrial	0.2	0.2	0.1	0.1	0.0	0.2	0.2	0.2	0.3
Developing	0.5	0.5	0.5	0.4	0.1	0.3	0.5	0.5	0.5
Emerging	0.8	0.8	0.8	0.5	0.3	0.4	0.9	1.1	1.1

Note:

1. T refers to quarter.
2. Signal-to-noise ratio is defined as A/B. T-N (T+N) refers to signaling window of quarter N after (prior to) the crises.

Table 11: Currency crisis as indicator of banking crisis

	Signal-to-noise ratio								
Groups	T-4	T-3	T-2	T-1	T	T+1	T+2	T+3	T+4
All	0.9	1.0	4.0	7.4	6.1	7.2	1.9	0.9	1.0
Industrial	3.5	0.0	0.0	12.5	3.3	3.3	0.0	3.4	0.0
Developing	0.0	1.4	5.7	5.8	7.4	9.0	2.7	0.0	1.4
Emerging	0.0	2.3	10.2	4.8	13.6	7.5	4.7	0.0	0.0

Note: T refers to quarter. Signal-to-noise ratio is defined as [A/(A+C)]/[B/(B+D)].

Table 12: Currency crisis as indicator of banking crisis, modified

	Signal-to-noise ratio								
Groups	T-4	T-3	T-2	T-1	T	T+1	T+2	T+3	T+4
All	0.4	0.3	0.3	0.2	0.1	0.2	0.3	0.3	0.3
Industrial	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2
Developing	0.4	0.4	0.3	0.2	0.1	0.3	0.3	0.3	0.4
Emerging	0.7	0.7	0.6	0.3	0.2	0.4	0.5	0.5	0.5

Note:

1. T refers to quarter.
2. Signal-to-noise ratio is defined as A/B. T-N (T+N) refers to signaling window of quarter N after (prior to) the crises.

Table 13: Description of variables and data sources, multivariate probit regression

Variable Name	Definition	Sources
	CURRENCY CRISES	
OVERRER	Overvaluation of real exchange rate (Increase in number means real depreciation)	IFS line RF, line 64, and line 64 of center country. We specify the trend by H-P filter
EXPORTGRO	Export growth (in U.S. dollars)	IFS line 78AAD
M2/RESERVES	M2 to foreign reserves ratio	M2 from IFS line 34 plus line 35; Foreign reserves from IFS line 11 (or 1d.d)
CA/GDP	Current account to GDP ratio	Current account from IFS line 78ALD; GDP from line 99b
M2GRON	Nominal M2 growth	M2 from IFS line 34 plus line 35
M2GROR	Real M2 growth	M2 from IFS line 34 plus line 35. Then deflated by line 64
CREDITGRON	Nominal credit growth	IFS line 32d
CREDITGROR	Real credit growth	IFS line 32d ÷ line 64
M2MUL	M2 to reserve money multiplier	M2 from IFS line 34 plus line 35; Reserve money from line 14 (For EURO countries, reserve money is line 14A plus line 14C)
SURPLUS/GDP	Budget surplus to GDP ratio	Surplus from IFS line 80; GDP from line 99b
	BANKING CRISES	
GROWTH	Real GDP growth	IFS line 99bvp or 99b.p
INFLATION	Inflation	IFS line 64
FL	Dummy for financial liberalization	Demirgüc-Kunt and Detragiache (1998), Glick and Hutchison (2001)
CREDITGROR	Real credit growth	IFS line 32d ÷ line 64
NIRC	Nominal interest rate changes	Nominal interest rates are from IFS line 60b
RIRC	Real interest rate changes	Nominal interest rates are from IFS line 60b; Inflation rates are from IFS line 64
SURPLUS/GDP	Budget surplus to GDP ratio	Surplus from IFS line 80; GDP from line 99b
DEPOSITEX	Dummy variable for existence of explicit deposit insurance	Garcia (1999), Demirgüc-Kunt and Detragiache (2000)

Note: All variables are compiled from IMF *International Financial Statistics*, except for FL and DEPOSITEX.

Table 14: Multivariate probit regression for currency crises

	ALL COUNTRIES					INDUSTRIAL COUNTRIES				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
OVERRER (T-1)	-0.0002**	-0.0002*	-0.0002*	-0.0002*	-0.0002*	-0.005**	-0.004*	-0.005**	-0.004	-0.004
	(-2.10)	(-1.94)	(-1.95)	(-1.91)	(-1.92)	(-2.13)	(-1.96)	(-2.05)	(-1.185)	(-1.21)
M2_RESERVES (T-1)	0.003	0.004	0.004	0.005*	0.005*	0.0009	0.002	0.002	0.005	0.005
	(1.24)	(1.58)	(1.61)	(1.83)	(1.86)	(0.13)	(0.22)	(0.23)	(0.70)	(0.76)
CA/GDP (T-1)	-2.36e-05	-3.10e-05	-3.18e-05	-3.20e-05	-3.25e-05	-0.06	-0.05	-0.05	-0.08*	-0.08*
	(-1.11)	(-1.41)	(-1.44)	(-1.45)	(-1.47)	(-1.53)	(-1.31)	(-1.31)	(-1.79)	(-1.71)
M2GROR (T-1)	-0.01*	-0.01	-0.01	-0.01	-0.01	-0.06*	-0.05	-0.04	-0.01	-0.01
	(-1.94)	(-1.22)	(-1.17)	(-1.15)	(-1.10)	(-1.95)	(-1.58)	(-1.46)	(-0.38)	(-0.41)
CREDITGRON (T-1)	0.0005*	0.0005	0.0005	0.0005*	0.0005*	-0.01	-0.006	-0.007	-0.03	-0.02
	(1.96)	(1.54)	(1.55)	(1.71)	(1.69)	(-0.46)	(-0.26)	(-0.31)	(-1.09)	(-0.89)
M2MUL (T-1)	-0.02	-0.03	-0.03	-0.04*	-0.04*	-0.03	-0.03	-0.026	-0.04	-0.035
	(-1.34)	(-1.58)	(-1.63)	(-1.71)	(-1.71)	(-0.86)	(-0.81)	(-0.76)	(-0.90)	(-0.86)
B_CRISIS (T)		1.39***	1.41***	1.47***	1.47***		0.94***	1.02***	1.01**	1.07***
		(7.13)	(7.17)	(7.16)	(7.16)		(2.59)	(2.75)	(2.47)	(2.59)
B_CRISIS (T-1)			0.30					0.75		
			(0.96)					(1.61)		
B_CRISIS (T-2)				-0.41					-6.67	
				(-0.93)					(-8.29e-06)	
B_CRISIS (T-1) or (T-2)					-0.11					0.04
					(-0.39)					(0.08)
	Summary statistics									
Nr. of crises	64	64	64	57	57	16	16	16	11	11
Nr. of observations	891	884	882	839	839	300	295	295	282	282
LR statistic	18.99***	67.40***	68.19***	72.19***	71.30***	16.79***	22.65***	24.95***	17.38**	16.10***
McFadden R^2	0.04	0.15	0.15	0.17	0.17	0.13	0.18	0.20	0.19	0.17
AIC	0.51	0.46	0.46	0.43	0.43	0.41	0.40	0.40	0.33	0.34
	Prediction classification (cutoff=25%)									
Percentage of observations correctly called	93	92	92	92	92	95	94	94	97	96
Percentage of crises correctly called	8	38	38	40	40	13	31	25	36	27
Percentage of non-crises correctly called	99	96	96	96	96	99	98	97	99	99
	Prediction classification (cutoff=10%)									
Percentage of observations correctly called	87	89	88	90	90	87	87	88	93	92
Percentage of crises correctly called	16	39	39	42	42	31	44	56	45	45
Percentage of non-crises correctly called	93	93	92	93	93	90	90	90	94	94

Note:

1. T refers to year.
2. The table reports the coefficients of probit estimation with the associated z-statistic in parentheses below. Significance at 10 percent level is denoted by "*"; at the 5 percent level by "**"; at the 1 percent level by "***". A constant term is included in estimates, but not reported.

Table 15: Multivariate probit regression for currency crises, continue…

	DEVELOPING COUNTRIES					EMERGING MARKETS				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
OVERRER (T-1)	-0.0002**	-0.0002*	-0.0002*	-0.0002*	-0.0002*	-0.0002**	-0.0002**	-0.0002**	-0.0002**	-0.0002**
	(-1.96)	(-1.79)	(-1.78)	(-1.76)	(-1.75)	(-2.13)	(-1.99)	(-2.01)	(-1.97)	(-2.00)
M2_RESERVES (T-1)	0.004	0.005*	0.005*	0.005*	0.005*	0.04*	0.03	0.03	0.03	0.03
	(1.57)	(1.85)	(1.85)	(1.85)	(1.84)	(1.94)	(1.45)	(1.45)	(1.23)	(1.26)
CA/GDP (T-1)	-2.45e-05	-3.24e-05	-3.21e-05	-3.04e-05	-3.02e-05	-3.80e-05	-5.02e-05*	-5.13e-05*	-4.95e-05*	-5.09e-05*
	(-1.13)	(-1.45)	(-1.44)	(-1.35)	(-1.34)	(-1.52)	(-1.77)	(-1.79)	(-1.72)	(-1.74)
M2GROR (T-1)	-0.01	-0.005	-0.005	-0.007	-0.007	-0.004	-0.002	-0.002	-0.004	-0.004
	(-1.59)	(-0.90)	(-0.91)	(-1.22)	(-1.22)	(-0.72)	(-0.37)	(-0.36)	(-0.64)	(-0.60)
CREDITGRON (T-1)	0.0005*	0.0004	0.0004	0.0004	0.0004	0.0006**	0.0005	0.0005	0.0005	0.0005
	(1.85)	(1.36)	(1.36)	(1.44)	(1.43)	(2.07)	(1.59)	(1.61)	(1.61)	(1.60)
M2MUL (T-1)	0.02	0.01	0.01	0.02	0.02	-0.007	-0.02	-0.02	-0.008	-0.01
	(0.73)	(0.29)	(0.29)	(0.58)	(0.60)	(-0.17)	(-0.41)	(-0.49)	(-0.17)	(-0.24)
B_CRISIS (T)		1.56***	1.56***	1.63***	1.63***		1.89***	1.92***	1.99***	2.02***
		(6.44)	(6.40)	(6.49)	(6.45)		(6.23)	(6.27)	(6.29)	(6.34)
B_CRISIS (T-1)			-0.08					0.51		
			(-0.16)					(0.91)		
B_CRISIS (T-2)				-0.31					0.14	
				(-0.67)					(0.27)	
B_CRISIS (T-1) or (T-2)					-0.21					0.33
					(-0.61)					(0.82)
	Summary statistics									
Nr. of crises	48	48	48	46	46	28	28	28	27	27
Nr. of observations	591	589	587	557	557	336	335	335	319	319
LR statistic	14.98**	55.83***	55.72***	59.70***	59.59***	14.05**	54.33	55.08***	56.09***	56.65***
McFadden R2	0.04	0.17	0.17	0.19	0.19	0.07	0.28	0.29	0.30	0.31
AIC	0.56	0.50	0.50	0.50	0.50	0.57	0.46	0.46	0.46	0.46
	Prediction classification (cutoff=25%)									
Percentage of observations correctly called	92	92	92	92	92	91	92	92	92	92
Percentage of crises correctly called	8	40	40	41	41	11	54	54	56	56
Percentage of non-crises correctly called	99	96	92	96	96	98	96	96	96	96
	Prediction classification (cutoff=10%)									
Percentage of observations correctly called	83	89	88	89	89	80	90	89	90	90
Percentage of crises correctly called	21	42	42	43	43	32	61	61	63	59
Percentage of non-crises correctly called	88	92	93	94	93	84	93	92	93	93

Note:

1. T refers to year.
2. The table reports the coefficients of probit estimation with the associated z-statistic in parentheses below. Significance at 10 percent level is denoted by "*"; at the 5 percent level by "**"; at the 1 percent level by "***". A constant term is included in estimates, but not reported.

Table 16: Multivariate probit regression for banking crises

	ALL COUNTRIES					INDUSTRIAL COUNTRIES				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
GROWTH (T-1)	-0.05***	-0.04*	-0.03	-0.02	-0.02	-0.09	-0.08	-0.08	-0.06	-0.05
	(-2.63)	(-1.73)	(-1.45)	(-1.10)	(-0.77)	(-1.25)	(-1.12)	(-1.12)	(-0.75)	(-0.71)
FL (T-1)	0.07	0.08	0.08	0.03	0.04	0.05	0.04	0.045	-0.11	-0.09
	(0.48)	(0.50)	(0.50)	(0.21)	(0.26)	(0.15)	(0.13)	(0.13)	(-0.30)	(-0.26)
CREDITGROR (T-1)	-0.01**	-0.01**	-0.01**	-0.01***	-0.013**	-0.03	-0.03	-0.03	-0.03	-0.03
	(-2.09)	(-2.28)	(-2.01)	(-2.63)	(-2.32)	(-1.34)	(-1.12)	(-1.12)	(-1.19)	(-1.19)
C_CRISIS (T)		1.245***	1.31***	1.32***	1.35***		0.92**	0.92**	0.99**	0.98**
		(6.43)	(6.69)	(6.52)	(6.64)		(2.47)	(2.46)	(2.34)	(2.33)
C_CRISIS (T-1)			0.66**					0.02		
			(2.52)					(0.03)		
C_CRISIS (T-2)				-0.06					-0.23	
				(-0.17)					(-0.37)	
C_CRISIS (T-1) or (T-2)					0.45**					-0.03
					(2.05)					(-0.06)
Summary statistics										
Nr. of crises	58	58	58	54	54	21	21	21	19	19
Nr. of observations	733	732	730	687	687	237	237	237	223	223
LR statistic	17.02***	56.33***	62.22***	56.32***	60.30***	7.96**	13.71***	13.71***	11.60***	11.46***
McFadden R2	0.04	0.14	0.15	0.15	0.16	0.06	0.10	0.10	0.09	0.09
AIC	0.54	0.49	0.49	0.49	0.48	0.60	0.58	0.59	0.58	0.59
Prediction classification (cutoff=25%)										
Percentage of observations correctly called	92	90	90	90	90	91	91	91	91	91
Percentage of crises correctly called	2	35	40	35	37	5	24	24	21	21
Percentage of non-crises correctly called	99	95	94	95	95	99	97	97	98	98
Prediction classification (cutoff=10%)										
Percentage of observations correctly called	76	86	86	87	84	69	75	75	79	80
Percentage of crises correctly called	48	43	52	44	50	67	57	57	53	53
Percentage of non-crises correctly called	79	90	88	90	87	69	76	76	82	82

Note:

1. T refers to year.
2. The table reports the coefficients of probit estimation with the associated z-statistic in parentheses below. Significance at 10 percent level is denoted by "*"; at the 5 percent level by "**"; at the 1 percent level by "***". A constant term is included in estimates, but not reported.

Table 17: Multivariate probit regression for banking crises, continue…

	DEVELOPING COUNTRIES					EMERGING MARKETS				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
GROWTH (T-1)	-0.04**	-0.02	-0.02	-0.01	-0.002	-0.07***	-0.06*	-0.06*	-0.04	-0.04
	(-2.16)	(-1.11)	(-0.68)	(-0.53)	(-0.10)	(-2.82)	(-1.92)	(-1.74)	(-1.38)	(-1.17)
FL (T-1)	0.03	0.008	-0.03	-0.03	-0.049	-0.18	-0.25	-0.26	-0.18	-0.19
	(0.17)	(0.04)	(-0.13)	(-0.14)	(-0.25)	(-0.75)	(-0.95)	(-0.96)	(-0.64)	(-0.67)
CREDITGROR (T-1)	-0.009*	-0.01**	-0.01*	-0.02**	-0.01**	0.003	0.0007	0.0006	-0.001	-0.001
	(-1.72)	(-2.07)	(-1.68)	(-2.50)	(-2.02)	(0.44)	(0.09)	(0.07)	(-0.12)	(-0.16)
C_CRISIS (T)		1.38***	1.50***	1.46***	1.54***		1.84***	1.85***	1.84***	1.86***
		(6.00)	(6.38)	(6.16)	(6.36)		(6.10)	(6.07)	(6.00)	(6.10)
C_CRISIS (T-1)			0.96***					0.17		
			(3.10)					(0.31)		
C_CRISIS (T-2)				-0.03					0.28	
				(-0.08)					(0.47)	
C_CRISIS (T-1) or (T-2)					0.70***					0.29
					(2.61)					(0.67)
	Summary statistics									
Nr. of crises	37	37	37	35	35	23	23	23	22	22
Nr. of observations	496	495	493	464	464	289	289	289	272	272
LR statistic	11.30***	45.92***	54.85***	48.17***	54.65***	9.20**	47.35***	47.44***	45.94***	46.17***
McFadden R^2	0.04	0.17	0.21	0.19	0.22	0.06	0.29	0.30	0.30	0.30
AIC	0.52	0.46	0.45	0.46	0.44	0.55	0.43	0.43	0.44	0.44
	Prediction classification (cutoff=25%)									
Percentage of observations correctly called	92	91	89	91	90	91	93	93	93	93
Percentage of crises correctly called	3	43	47	46	49	4	57	57	59	59
Percentage of non-crises correctly called	99	95	93	94	94	99	96	96	96	96
	Prediction classification (cutoff=10%)									
Percentage of observations correctly called	78	88	87	88	84	78	91	89	91	90
Percentage of crises correctly called	41	51	59	54	60	48	61	57	59	59
Percentage of non-crises correctly called	82	91	89	91	86	81	93	92	94	93

Note:

1. T refers to year.
2. The table reports the coefficients of probit estimation with the associated z-statistic in parentheses below. Significance at 10 percent level is denoted by "*"; at the 5 percent level by "**"; at the 1 percent level by "***". A constant term is included in estimates, but not reported.

Table 18: Simultaneous probit regression for currency and banking crises

	ALL COUNTRIES		INDUSTRIAL COUNTRIES		DEVELOPING COUNTRIES		EMERGING MARKETS	
Variables	Currency crisis	Banking crisis	Currency crisis	Banking crisis	Currency crisis	Banking crisis	Currency crisis	Banking crisis
OVERRER (T-1)	-0.0002**		-0.005**		-0.0002*		-0.0002*	
	(-1.97)		(-2.06)		(-1.84)		(-1.75)	
M2_RESERVES (T-1)	0.003		0.0008		0.005*		0.03	
	(1.35)		(0.11)		(1.67)		(1.21)	
CA/GDP (T-1)	-2.31e-05		-0.06		-2.41e-05		-3.66e-05	
	(-1.08)		(-1.53)		(-1.10)		(-1.47)	
M2GROR (T-1)	-0.007		-0.06*		-0.01		-0.002	
	(-1.18)		(-1.79)		(-0.88)		(-0.39)	
CREDITGRON (T-1)	0.0005		-0.01		0.0004		0.0004	
	(1.57)		(-0.47)		(1.45)		(1.27)	
M2MUL (T-1)	-0.03		-0.03		0.01		-0.03	
	(-1.44)		(-0.86)		(0.40)		(-0.65)	
B_CRISIS (T)	0.79		-0.25		0.83		1.91	
	(0.72)		(-0.11)		(0.73)		(1.21)	
GROWTH (T-1)		-0.05**		-0.08		-0.03		-0.06**
		(-2.21)		(-1.14)		(-1.45)		(-2.19)
FL (T-1)		0.07		0.01		0.04		-0.16
		(0.44)		(0.03)		(0.24)		(-0.66)
CREDITGROR (T-1)		-0.01**		-0.03		-0.01*		0.003
		(-2.03)		(-1.36)		(-1.662)		(0.45)
C_CRISIS (T)		0.47		0.44		1.25		1.44
		(0.48)		(0.41)		(1.02)		(1.21)
			Summary statistics					
Nr. of crises	63	57	16	20	47	37	28	23
Nr. of observations	877	730	300	235	577	495	336	289
LR statistic	16.95***	18.85***	8.05*	16.80***	14.80**	12.22**	15.48**	10.53**
McFadden R2	0.04	0.04	0.06	0.13	0.05	0.05	0.08	0.07
AIC	0.51	0.54	0.41	0.59	0.57	0.53	0.58	0.55
			Prediction classification (cutoff=25%)					
Percentage of observations correctly called	92	93	91	95	92	92	90	91
Percentage of crises correctly called	2	8	5	13	9	3	11	4
Percentage of non-crises correctly called	99	99	99	99	99	99	98	99
			Prediction classification (cutoff=10%)					
Percentage of observations correctly called	78	87	72	87	82	80	80	77
Percentage of crises correctly called	49	14	60	44	17	38	36	48
Percentage of non-crises correctly called	81	93	73	90	87	83	84	79

Note:

1. T refers to year.
2. The table reports the coefficients of probit estimation with the associated z-statistic in parentheses below. Significance at 10 percent level is denoted by "*"; at the 5 percent level by "**"; at the 1 percent level by "***". A constant term is included in estimates, but not reported.