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Full Length Research Paper

An evaluation of leading indicators of currency crises

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This study tries to construct leading indicators for currency crisis using probit model, logit model and binary quantile regression. The empirical results show that the Inflation rate, Stock price index, Import growth rate, export/GDP, direct investment abroad, GDP growth rate, terms of trade changes, financial derivatives and domestic credit/GDP have significant effects on the occurrence of currency crisis. The Logit model is better than the probit model and binary regression quantiles which is certain, and the Financial derivatives and Direct investment abroad are useful for leading indicators of currency crises.

Key words: Currency crises, binary quantile regression, probit model, logit model.

INTRODUCTION

Pervasive currency turmoil, particularly in Latin America in the late 1970's and early 1980's, gave impetus to a flourishing literature on balance-of-payments crises. As stressed by Krugman (1979), crises occur because a country finances its fiscal deficit by printing money to the extent that excessive credit growth leads to the eventual the collapse of the fixed exchange-rate regime. The collapse of the European Exchange Rate Mechanism, the Mexican peso crisis, and the wave of currency crises sweeping through Asia have, however, rekindled interest in the topic. On July 2 1997, the monetary authorities of Thailand failed to maintain the pegged exchange rate, which then changed to floating exchange rate regime. This change led to sharp devaluation of the Thai bath, and the Asian currency crisis took place hereafter. Because a burst of a currency crisis will bring about critical problems in many aspects, it is necessary to find out the determinants of a currency crisis and its solution before it comes up. Therefore, we are interested in whether currency crises are predictable events with early warning signals.

Eichengreen et al. (1994, 1995, 1996) define crisis as a large movements in exchange rates, interest rates, and international reserves and then compare the behavior of a number of macroeconomic variables during crisis and tranquil periods. They find that the behavior of key macroeconomic variables for exchange rate mechanism (ERM) countries varies across periods, but that these differences do not appear for non-ERM countries. Kaminsky et al. (1998) propose the monitoring of several indicators that tend to exhibit unusual behavior prior to a crisis. A currency crisis is defined to occur when a weighted average of monthly percentage depreciations in the exchange rate and monthly percentage declines in reserves exceeds its mean by more than three standard deviations. The use of annual data permitted Frankel and Rose (1996) to look at variables such as the composition of external debt that are only available at that frequency and defined a currency crash as a nominal depreciation over 25%, exceeding previous year's depreciation of at least 10%. Sachs et al. (1996) concentrate on a more structured hypothesis about the cause of this particular episode, emphasizing interactions among weak banking systems, overvalued real exchange rates, and low reserves. Sachs et al. (1996) argue that countries had more severe attacks when their banking systems were weak and when the exchange rate was overvalued. Plausible modifications to the Sachs et al. (1996) and Frankel et al. (1996) models did not yield useful forecasts, even some, such as the inclusion of short-term external debt, which was inspired by events in 1997. Goldfjan and

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Valdes (1998) shows a close relation between nominal and real exchange rates and a real overvaluation is invariably corrected through nominal devaluation rather than inflation differentials. Berg and Pattillo (1999) improve their approach to predict the Asian crisis (out of sample), and found mixed results. They also compare the ranking of severity of currency crises in 1997 with the ranking of vulnerability according to predicted probabilities of crisis. Kraay (2003) investigates the existence of such non-linear effects of monetary policy and employs a large cross-section of speculative attacks and several episode-specific fundamentals, but fails to find any significant effect. The explanation of the Asian currency crisis stresses the link between future deficits and current movements in the exchange rate. This link is also stressed by Corsetti and Mackowiak (2006), Daniel (2001), and Dupor (2000), who use the fiscal theory of the price level to argue that prices and exchange rates jump in response to news about future deficits. Sometimes the pre-crisis behavior of a variable is compared to its behavior during "tranquil" or non-crises periods for the same group of countries.[1] In other instances, the control group is composed of countries where no crisis occurred. Parametric and nonparametric tests are used to assess whether there are systematic differences between the pre-crisis episodes and the control group. These tests can be useful in narrowing the list of potential indicators, as not all the variables included in the analysis ended up showing "abnormal" behavior in advance of crises. The papers include individual country studies and multi-country panel studies.[2] Some of these papers also have attempted to shed light on the variables that determine the size of the devaluation.[3] In a related spirit, Sachs et al. (1996) seek to identify those macroeconomic variables that can help explain, which countries were vulnerable to "contagion effects" following the Mexican crisis in December 1994. The results from this group of studies also help to narrow the list of useful indicators, as not all the variables included turned out to be statistically significant in the logit (or probit) estimation exercises typically undertaken.

In this study, we compare the effect of Binary Regression Quantiles with the Probit Regression model and Logit Regression model. The Quantile regression as introduced by Koenker and Bassett (1978) seeks to extend these ideas to the estimation of conditional quantile functions—models, in which quantiles of the conditional distribution of the response variable are expressed as functions of observed covariates. The method implemented in currency crisis calculation in this study is “Binary Regression Quantiles”. The foundation of the research and the way to forecast is simply according to Kordas (2006). From an estimation viewpoint, binary regression quantiles and their linear combinations can provide more efficient estimations than any individual quantile estimate. In rare event cases, quantiles above or below the median will most likely be more efficient, while in balanced samples, combinations of regression quantiles will improve the relative (to the median estimate) efficiency of the point estimate. The Ordinary Least Square is the most common way to regression analysis, but in the classic linear regression, the change of dependent variable comes from the independent variable, averagely. It neglects the marginal change of the dependent variable according to different scale and distribution.

The global financial crisis, brewing for a while, began to show its effects in the middle of 2007 to 2009. Across the globe, stock markets have fallen, large financial institutions have collapsed or been bought out. It is evident that there is a need to develop a warning system that helps to monitor whether a country may be slipping into a potential crisis. The objective of this study determines the extent to which probit model, logit method and binary quantile regression can detect financial crises and enhance our capacity to identify future trouble spots among emerging market countries. To achieve this goal (this study analyzes and extends the leading indicators) we acceded to the Financial derivatives and Direct investment abroad and expect that those variables may be the leading indicators of global financial crises.

To study the nature of crises, we construct a chronology of events in the banking and external sectors and draw inference about the possible causal patterns among banking, balance-of-payments problems and financial liberalization. We also examine the behavior of macroeconomic indicators that have been stressed in the theoretical literature during the period crisis. Our aim is to gauge whether the crises share a common macroeconomic background. This study also allows us to assess the fragility of economies during the time of the financial crises and sheds light on the extent to which the crises were predictable.

The remainder of this study is organized as follows: A description of the data and methodology adopted for this study is provided in Section 2. Section 3 shows the presentation of our empirical results. Finally, the conclusions drawn from this study are presented in Section 4.

DATA AND METHODOLOGY

Data

The purpose of this study is to establish the leading indicators based on the probability of occurrence of currency crises. Initially, we choose seventeen countries, of both developed and emerging market economies, used in Kaminsky et al. (1998) studies. Our sample countries include Australia, Bolivia, Brazil, Chile, Colombia, Iceland, Indonesia, Jordan, Malaysia, Mexico, Peru, Philippines, Sri Lanka, Thailand, Turkey, Uruguay and Venezuela.

[1] For example, Eichengreen, Rose, and Wyplosz (1995), and Frankel and Rose (1996).

[2] Individual countries are discussed in Cumby and Wijnbergen (1989) and Eichengreen *et al.* (1995).

[3] For instance, Bilson (1978).

Table 1. Expected Sign of Leading Indicators.

	Indicator	Expected sign
Macroeconomic indicators	Inflation	+
	GDP growth rate	
	Stock price index	
	Real interest rate	
Current account indicators	Import growth rate	+
	Terms of trade changes	
	Export/GDP	
	Foreign portfolio investment/GDP	+
	Direct investment abroad	+
	Financial derivatives	+
Financial account indicators	Bank deposits	

Note: The variable is positive correlation with currency crisis, represent sign + , negative sign .

The monthly data[4] span the period from 1970 to 2008. Our empirical data were obtained from International Financial Statistics database of International Monetary Fund, World Development Indicators database of World Bank, AREMOS database, and Datastream database. Since we need to decide a crisis window to make the indicators have the abilities to foretell crises, Kaminsky et al. (1998) theoretical literature on currency crises was considered. 105 variables were collected, the selected 15 indicators were obtained and verified several times. An effective warning system should consider a broad variety of indicators; currency crises seem to be usually preceded by multiple economic and sometimes, political problems. The evidence reviewed here, points to the presence of both domestic and external imbalances, which span both the real side of the economy and the domestic financial sector. We classify our 15 indicators into three categories: Macroeconomic indicators, current account indicators and financial account indicators. The followings are the indicators of each category:

1. Macroeconomic indicators: Inflation, GDP growth rate, stock price and real interest rate.
2. Current account indicators: Imports growth rate, terms of trade changes (export price/import price), export/GDP, foreign portfolio investment/GDP, direct investment abroad and financial derivatives.
3. Financial account indicators: Bank deposits, domestic credit/GDP, foreign gross liabilities/GDP, M2/foreign exchange reserves and short term external debts/gross external debts.

Note that the variable positively correlate with currency crisis, and is represented with sign "+", and when negative with sign " ".

As shown in Table 1, we used Edison (2000) to provide more information on the indicators used in the basic framework and in the expanded model. The first column shows the category headings and the second column provides the name of the variable. The third column reports whether high (upper) or low (lower) values of each variable would signal that the economy is vulnerable to a currency crisis or not. It is an expected sign of the leading Indicators, in which the repression change relationship about variable and currency crisis. As the low stock price becomes the leading indicator of recession, the real exchange rate is overvalued when nominal exchange rate depreciates, and the probability of currency crisis increase. Import growth rate and weak external sector will lower competitiveness and lead to devaluation. In order to eliminate seasonal effects, we followed the method of Kaminsky et al. (1998) and define all indicators on a given month to be the percentage change in the level of the variable with respect to its level which was a year earlier except that of real exchange rate, interest rates, and excess M2 balance. Terms of trade changes, when export price index dived import price index smaller than 1, the domestic export power recession, may result to currency crisis. Stock price index and low stock price are leading indicator of economic recession. Domestic credit/GDP, loose fiscal policy from central bank and credit expands may also result to currency crisis.

[4] See Kaminsky and Reinhart (1996), monthly real GDP was interpolated from annual data.

The definition of a crisis

Following the research made by Sachs et al. (1996), and Kaminsky and Reinhart (1999), we identify crises by looking at an index of exchange market pressure (EMP) defined as a weighted average of percentage changes in the nominal exchange rate and (the negative of) percentage changes in international reserves. Since the volatilities of reserves and exchange rates are different, the weights are chosen so as to prevent any one of the series from dominating the index by dividing the standard deviation of its change rate. Therefore, the exchange market pressure index is as follows:

$$EMP_t = \frac{\Delta e_t}{\sigma_e} - \frac{\Delta R_t}{\sigma_R} \quad (1)$$

where e_t and R_t denote the national currency per foreign currency (U.S. dollars) and the international reserves at the time t ,

Table 2. Currency crisis of emerging country.

Emerging country	Currency crisis			
Argentina	1982	1987	1989	
Bolivia	1986	1989	1991	1997
Brazil	1982	1992	1994	1998
Chile	1982	1983		
Colombia	1972	1974		
India	1992	1993	2001	
Indonesia	1997	1998		
Jordan	1978	1983	1993	
Malaysia	1994	1996	1997	
Mexico	1981	1987	1989	1994
Peru	1990			
Philippines	1981	1984	1997	
Sri Lanka	1983	1992		
Thailand	1980	1997		
Turkey	1992	1994		
Uruguay	1978	1982	2001	
Venezuela	1987	1989		

Note: Table shows number of observations.

respectively. σ_e and σ_R are the standard deviations. From equation (1), we know that both deprecation of the exchange rate and (or) decline in the international reserves raise the EMP.

The intuition behind the construction of the index is that when a currency is under a speculative attack, the monetary authorities can respond to the attack by devaluing the currency, running down international reserves or raising the interest rates. The advantage of the weighted index is that it associates crises with both successful and unsuccessful speculative attacks. A successful attack will cause the depreciation of foreign exchange rate, and the reserves will loss if the authorities try to defend the attacks. In practice, a crisis is identified whenever the EMP exceeds certain threshold value. A crisis is defined as an event, in which the EMP is more than n standard deviations above the mean:

$$Crisis = \begin{cases} 1 & if \quad EMP_t > \mu_{EMP} + n \cdot \sigma_{EMP} \\ 0 & otherwise \end{cases} \tag{2}$$

A crisis is defined as an event, in which the EMP is more than 1.5 standard deviations. From equation (1), we know that both deprecation of the exchange rate and decline in the international reserves raise the EMP.

Table 2 provides the variables of the currency crisis periods identified. The Figure 1 show the currency crisis of each countries painted by EMP index. To give a sense of how these financial pressure indices works, it displays the financial pressure index (solid line), in which the horizontal (dashed) line is the threshold. When the pressure index exceeds this value, it indicates a crisis. In the case of Mexico, four episodes are identified: 1981, 1987, 1989 and 1994. These episodes are consistent with the dates when Mexican currency crises are generally understood to have taken place. Table 2 shows the number of observations.

Note that solid line represents the exchange rate pressure variable, calculated as the weighted average of percent changes in the exchange rate and percent changes in foreign reserves. The dashed line is the threshold above which the exchange rate pressure indicates a crisis, calculated as the mean of the pressure variable plus 1.5 times the standard deviation (Figure 2).

Binary quantiles regression model

Binary quantiles regression and quantiles regression are quite different. The explained variable of quantiles regression is continuous; the explained variable of binary regression quanitles is of two types of discrete quality variable. The threshold of EMP index is used to determine currency crisis occurrences in this paper. We use the extension of Horowitz's (1992) smoothed maximum score estimator of the binary choice model to quantiles other than the median. Maximum score estimation, developed and studied by Manski (1975, 1985), is equivalent to quantile regression applied to the binary choice model. Consider the model:

$$Y^* = X'\beta + U \tag{2}$$

$$Y = 1\{Y^* \geq 0\} \tag{3}$$

where Y^* is a scalar latent continuous variable, Y is an observable binary indicator, X is a k × 1 vector of explanatory variables, β is a k × 1 vector of parameters, and U is a scalar random disturbance. The quantile regression latent linear specification of Koenker and Bassett (1978) is given by:

$$Q_{Y^*}(\tau \mid X) \equiv F_{Y^*}^{-1}(\tau \mid X) = X'\beta_\tau \qquad \tau \in (0,1) \tag{4}$$

where Q(э) and F(э) are the conditional quantile and distribution functions of the latent continuous variable Y^*, respectively. The real can not be obtained by way of observation, the function uses monotonic transformation that is equal to variation character, which is another observed variable of crisis indicator $Y = 1(Y^* > 0)$, obtain follow:

$$Q_{Y}(\tau \mid X) = 1\{X'\beta_\tau \geq 0\} \tag{5}$$

Manski (1985) used maximum score estimation to develop 10 model, we can use minimum below function to estimate parameter:

$$b_{n\tau}^* = \arg\min_{\{b:\,|b|=1\}} \sum_{i=1}^{n} \rho_\tau(Y_i - 1\{X_i'b \geq 0\}) \tag{6}$$

The $\rho_\tau(\lambda) \equiv [\tau - 1\{\lambda < 0\}]\lambda$ is a check function developed by

Konder and Bassett (1978), and then Manki (1985) proved the consistence of result through Maximum Score Estimation and Binary regression quantiles model.

EMPIRICAL RESULTS

We select 17 countries in the emerging market and 15 explain variable. We neglect the marginal change of the

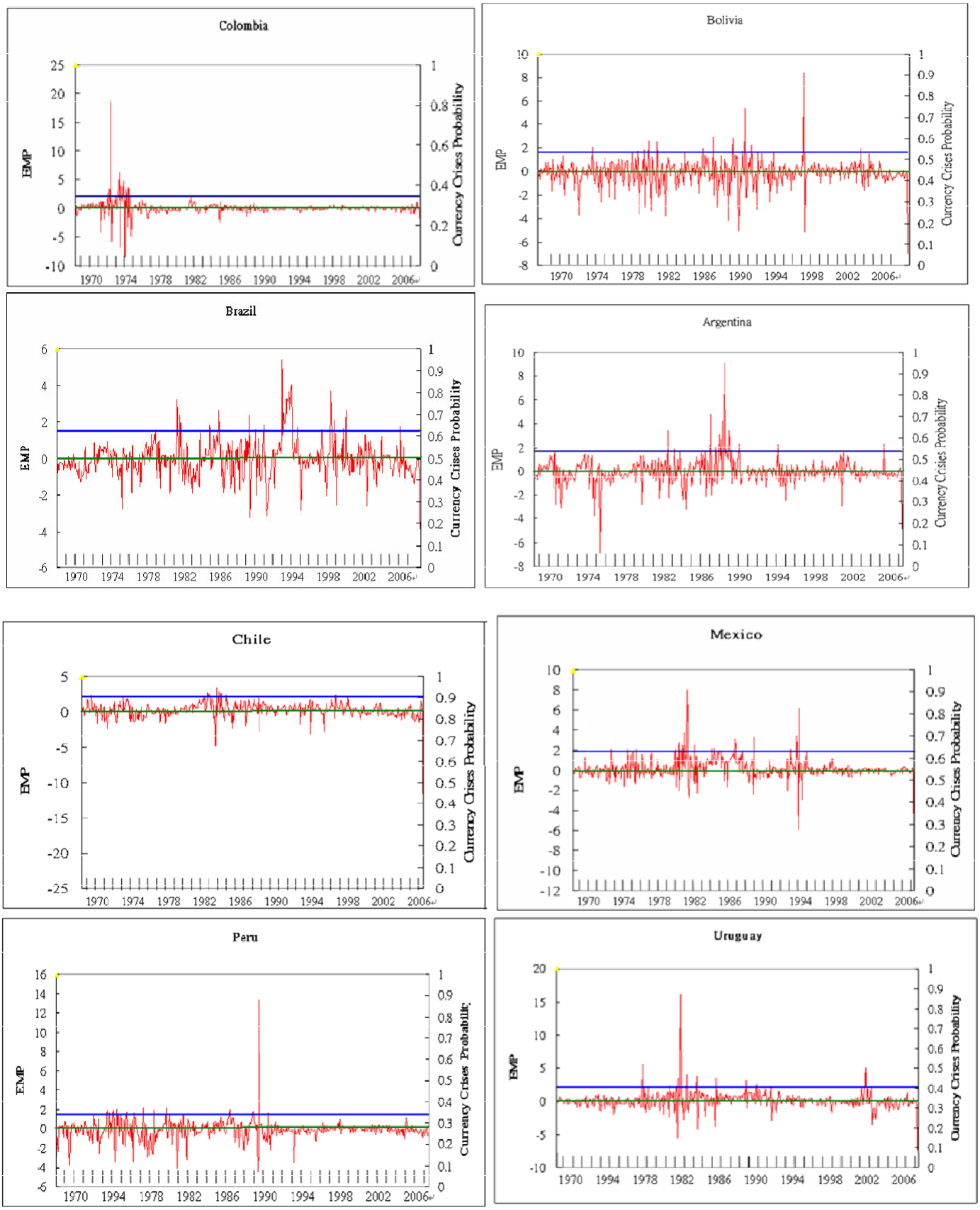

Figure 1. Identification of currency Crises: Exchange rate pressure index and crisis threshold.

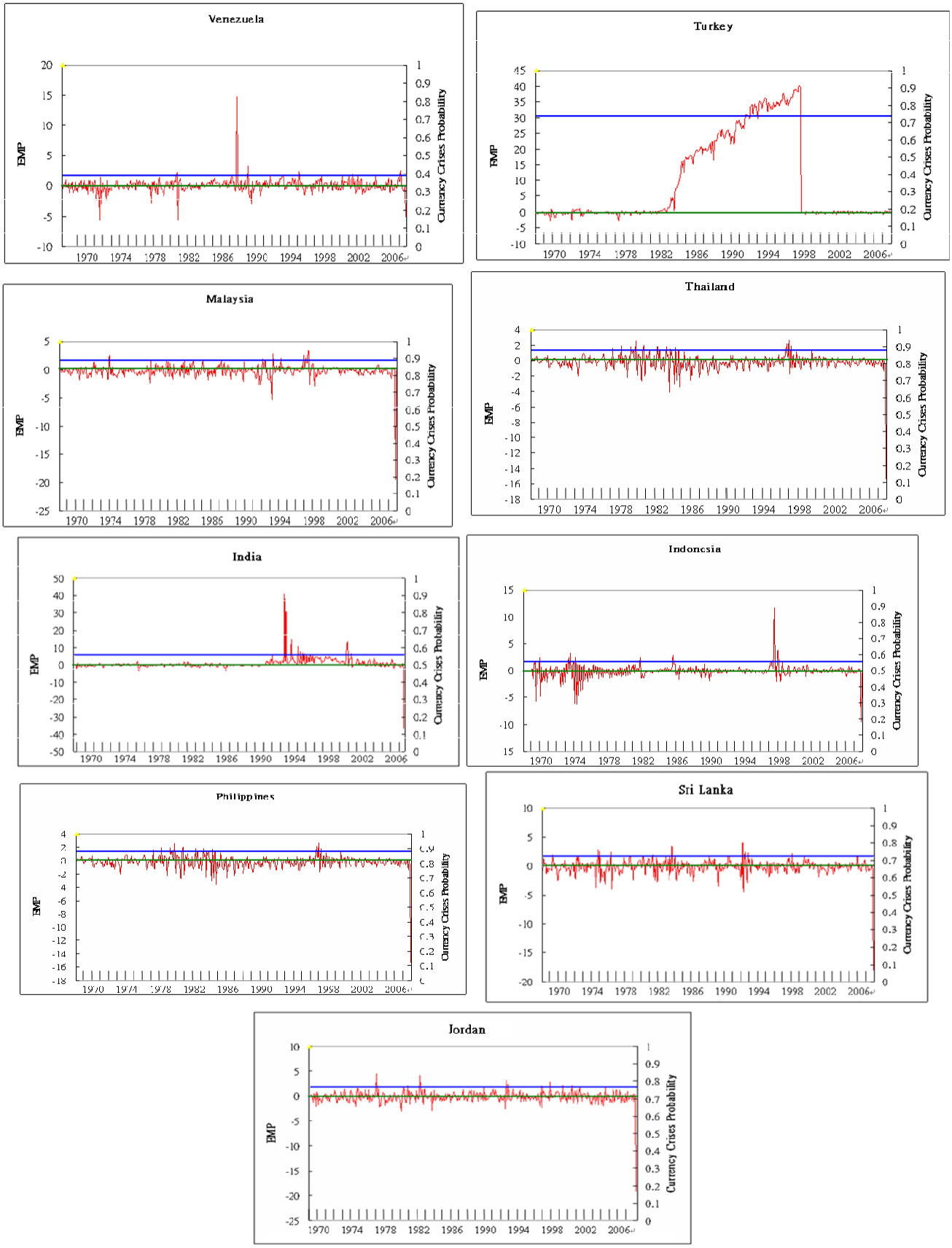

Figure 1. Contd.

Table 3. Empirical result of probit model.

	Coefficient (Std. error)	P- value		Coefficient (Std. error)	P- value
Inflation	0.001 (0.000)	0.043**	GDP growth rate	-0.070 (0.023)	0.000***
Stock price index	-5.93E-05 (1.48E-05)	0.000***	Real interest rate	0.132(0.086)	0.123
Import growth rate	0.001 (0.000)	0.001***	Terms of trade changes	0.004 (0.002)	0.054*
Export /GDP	-0.093 (0.022)	0.000***	Foreign portfolio investment/GDP	0.094 (0.599)	0.208
Direct investment abroad	0.001 (0.000)	0.035**	Financial derivatives	0.003 (0.001)	0.013**
Bank deposits	5.07E-05 (4.46E-05)	0.255	Domestic credit / GDP	-0.024 (0.004)	0.000***
Foreign gross liabilities/GDP	0.010 (0.231)	0.403	M2/foreign exchange reserves	0.001 (0.016)	0.426
Short term external debts/ gross debts	0.002(0.013)	0.346			

Note: ***, **, * indicated at least significant at 1%, 5% and 10% level, respectively.

dependent variable according to different scale and distribution and compare the binary quantiles regression to the logit and probit regression. The results of the three kinds of regression models are thus explained.

Empirical results of probit model

In the Table 3, the Inflation, GDP growth rate, stock price index, import growth rate, Terms of trade changes, export/GDP, direct investment abroad, financial derivatives and domestic credit/GDP are statistically significant at 10% level. The coefficient of Domestic credit/GDP is negative, and it means that credit contraction will result to currency crisis. An increase in short-term debt, in inflation or in M2/foreign exchange reserves (the value of the score) will, thus, increase the probability of a crisis. An overvalued currency or a high rate of inflation increases the probability of a crisis, as well as the occurrence of crises in the same region. Other indicators are also absent. Domestic inflation, an overvalued real exchange rate and reserve losses do not only have a direct effect on the crisis indicator, but they also have an impact through the probability of entering the volatile regime. For the probability of a crisis, this indirect effect dominates the direct effect.

Other variables that have a significant impact on the probability are the terms of trade change; consequently, a crisis may be triggered by solvency problems (high import/export ratio or an overvalued currency) as well as liquidity-related problems. Regarding liquidity, the M2/foreign exchange reserves is economically and statistically more important than the short term debt/reserves ratio. This result might explain why the influence of the M2/foreign exchange reserves is absent in Bussière and Mulder (1999), as they only investigated the depth of a crisis. The main reason is probably that the timing of currency depreciations, or reserve losses, is not easily predictable, otherwise market participants could make arbitrage profits. The influence of uncertainty is much more important (Table 3).

Note: ***, **, * indicated at least significant at 1, 5 and 10% level, respectively.

Empirical results of logit model

In the Table 4, the Inflation, GDP growth rate, Stock price index, Import growth rate, Terms of trade changes, Export/GDP, Direct investment abroad, Financial derivatives and Domestic credit/GDP are statistically significant at 1, 5 and 10% level, respectively. Lower reserves seem to raise the odds of crises. Loose monetary policy (higher M2), sharp depreciation and low exports tends to increase the probability of currency crisis. Adequate monetary policy and sufficient foreign reserves can decrease the probability of currency crisis (Table 4).

Note: ***, **, * indicated at least significant at 1%, 5% and 10% level, respectively.

Binary regression quantiles

There are 15 explained variables in the index of exchange market pressure. The model allots 0.1, 0.2, 0.3 quantile...until 0.9 quantile. In Table 5, the Inflation rate in all quantiles is not significant. The Stock price index in 0.5 and 0.6 quintiles' are significant. The Import growth rate in all quintiles is not significant. The Export/GDP in 0.6 and 0.7 quatnile are significant. The Direct investment abroad in all quantiles is not significant. The Bank deposits in 0.4, 0.5 and 0.8 quatniles are significant. The Foreign gross liabilities/GDP in 0.5 quatnile is significant. The Short term external debts/gross debts in 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9 quatniles are significant. The GDP growth rate in 0.1, 0.2, 0.4, 0.8 and 0.9 quatniles are significant. The Real interest rate in 0.4, 0.7 and 0.8 quantiles are significant. The Terms of trade changes in 0.1, 0.2 and 0.7 quatniles are significant. The Foreign portfolio investment/GDP in 0.3 quatnile is significant. The Financial derivatives in 0.4 and 0.5 quatniles are significant. The Domestic credit/GDP in all quatniles are not significant. The

M2/foreign exchange reserves in all quatniles are not significant.

According to Table 5, the coefficient of determination of quantile is equal to 0.9 and is higher than other quantiles model that possess more robust explain power. The ratio short-term debt/gross debt is higher than other variable that has six significant in the quatniles analyze. Recent internal guidelines for IMF staff recommended the monitoring of the ratio short- term debt/reserves, which has some similarity with the ratio short-term debt/total debt appearing in our Asian score. The sign of the openness indicator means that a more open economy is more likely to experience a currency crisis. This result confirms the findings of Berg and Pattillo (1998).

Note: ***, **, * indicated at least significant at 1, 5 and 10% level, respectively. Standard deviation is in parentheses.

Performance of respective indicators

Using Reille and Forster (2008) to achieve this goal, this study analyzes and extends the leading indicators to the financial derivatives and direct investment abroad variable. We expect that two variables could be the leading indicators of global financial crises. Following the Figure 2, we do not input the Financial derivatives and Direct investment abroad variable, the area under ROC curve of probit model is 0.6623, area of logit model is 0.6847, and the area of Binary Regression Quantile model is 0.6453, we found out that the area under ROC curve of logit model is most biggest in three method, and that the predictive ability of logit model is the best.
Note:

1. The area under ROC curve of probit model is 0.6623.
2. The area of logit model is 0.6847.
3. The area of Binary Regression Quantile model is 0.6453.

We input the Financial derivatives and Direct investment abroad data, following the Figure 3, the area under ROC curve of probit model is 0.7219, area of logit model is 0.7438, and the area of Binary Regression Quantile model is 0.5518. In average, the probit model and logit method is better than Binary Regression Quantile. The results of Binary Regression Quantile have greater differences. In this study, the financial derivatives and the direct investment abroad are useful for predicting currency crises in recent years by using the probit model and logit method.

Note: 1. The area under ROC curve of probit model is 0.7219
2. The area of logit model is 0.7438
3. The area of Binary Regression Quantile model is 0.5518

Following Figures 2 and 3, it is shown that the area under ROC curve of logit model is the biggest in the three methods, and that the predictive ability of the logit model is the best. We still found out that the input in the Financial derivatives and the Direct investment abroad data,that is, the area under ROC curve of Binary Regression Quantile model is lower than the input in the two variables. This allowed us to further reduce this set and to exclude possible indicators that discriminate in a non-linear way, meaning that there are several intersections between the two groups' deciles distributions. The variables will cause the dissimilar effect in different quantiles that could influence the expected result. Indicators have proven to be particularly useful in anticipating crises. The models from the leading indicators can be used to signal an increase in country's risk and potential currency crises in real time.

Conclusions

This study demonstrates that the leading indicators of currency crises could be informative tools for signaling future currency crises in real time. We combine the probit model, the logit model, and binary regression quantile to construct a set of composite indicators for different groups to predict currency crises. The conclusions regarding the

Table 4. Binary quantiles regression.

Quantiles	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	-2.481	-2.489	3.264	-1.412	-7.985*	1.924	-3.903	0.623	-6.270**
	(3.485)	(4.344)	(4.329)	(3.063)	(4.368)	(4.051)	(4.466)	(4.267)	(3.101)
Inflation rate	-0.025	-0.023	0.024	0.038	-0.594	0.181	0.263	0.240	-0.298
	(1.923)	(0.821)	(1.333)	(2.375)	(0.808)	(0.531)	(0.904)	(1.951)	(1.637)
Stock price index	0.365	0.3636	-1.583	-1.461	-7.854*	-7.618*	1.877	-1.857	3.646
	(15.869)	(10706)	(1.258)	(1.525)	(4.330)	(4.319)	(3.225)	(3.968)	(3.687)
Import growth rate	0.244	0.243	-2.044	-2.015	4.862	0.320	1.998	-0.697	2.286
	(4.136)	(3.156)	(3.536)	(3.462)	(5.451)	(4.384)	(3.364)	(3.319)	(4.281)
Export /GDP	-6.194	-6.195	-2.514	3.488	2.871	-8.023**	-9.714**	1.494	0.165
	(4.450)	(4.747)	(3.752)	(3.973)	(4.959)	(3.624)	(4.379)	(4.743)	(3.750)
Direct investment abroad	0.223	0.223	0.155	-0.055	1.387	-0.194	-0.272	0.981	1.0599
	(1.267)	(1.219)	(0.340)	(1.486)	(1.495)	(0.417)	(1.744)	(2.756)	(2.834)
Bank deposits	-3.595	-3.591	-3.468	-8.407**	-8.686**	-0.135	-0.174	-6.264*	-0.159
	(2.798)	(3.407)	(3.288)	(3.740)	(3.782)	(1.753)	(2.289)	(3.507)	(0.616)
Foreign gross liabilities/GDP	-4.443	-4.441	-2.925	1.552	-9.606*	3.387	0.166	-4.125	-6.261
	(3.762)	(4.337)	(3.874)	(4.240)	(5.664)	(4.996)	(3.532)	(4.096)	(4.288)
Short term external debts/gross debts	-3.045	-3.046	-3.288	-9.933**	-6.387**	-6.731**	-7.953**	-9.690**	-7.111*
	(4.344)	(3.951)	(3.125)	(4.108)	(3.456)	(2.205)	(4.041)	(4.417)	(4.304)
GDP growth rate	-6.588*	-6.585*	1.166	-9.427**	-6.698*	2.590	1.531	-8.912*	-7.655**
	(3.901)	(3.998)	(5.349)	(3.524)	(4.477)	(3.843)	(5.036)	(5.078)	(3.587)
Real interest rate	4.631	4.634	-3.652	-7.172*	4.311	-2.881	-7.713**	-9.995**	-2.561
	(4.974)	(4.409)	(3.471)	(3.885)	(4.601)	(3.628)	(3.051)	(4.904)	(4.059)
Terms of trade changes	-8.014**	-8.017*	-2.082	1.832	-4.578	-1.167	-6.474*	-4.331	4.733
	(3.356)	(4.401)	(3.906)	(4.098)	(3.337)	(3.233)	(3.806)	(3.823)	(4.419)
Foreign portfolio investment/GDP	-4.610	-4.614	-8.226**	-2.415	-3.492	-5.358	0.848	2.117	3.289
	(3.579)	(3.482)	(4.163)	(3.421)	(3.821)	(4.239)	(3.624)	(3.546)	(4.244)
Financial derivatives	-3.657	-3.661	-4.151	-8.912**	-9.165**	-4.254	0.547	3.188	2.945
	(5.247)	(3.428)	(3.305)	(4.531)	(4.309)	(17.153)	(0.573)	(2.909)	(6.333)
Domestic credit / GDP	-4.663	-4.662	-0.453	3.871	3.517	0.619	0.902	3.768	0.605
	(3.272)	(3.295)	(2.022)	(3.625)	(4.010)	(1.051)	(1.195)	(2.368)	(3.270)
M2/foreign exchange reserves	-7.192	-7.191	-5.742	1.373	-4.313	-4.027	-7.174	-3.175	-3.982
	(4.916)	(4.892)	(4.347)	(4.304)	(3.737)	(2.511)	(4.674)	(4.628)	(4.646)

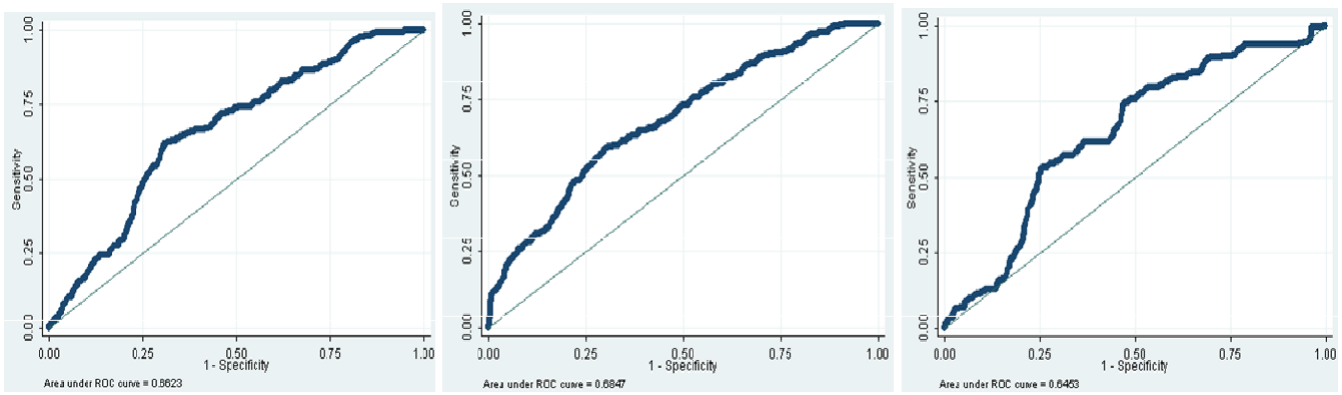

Figure 2. Without the Financial derivatives and direct investment abroad variables.

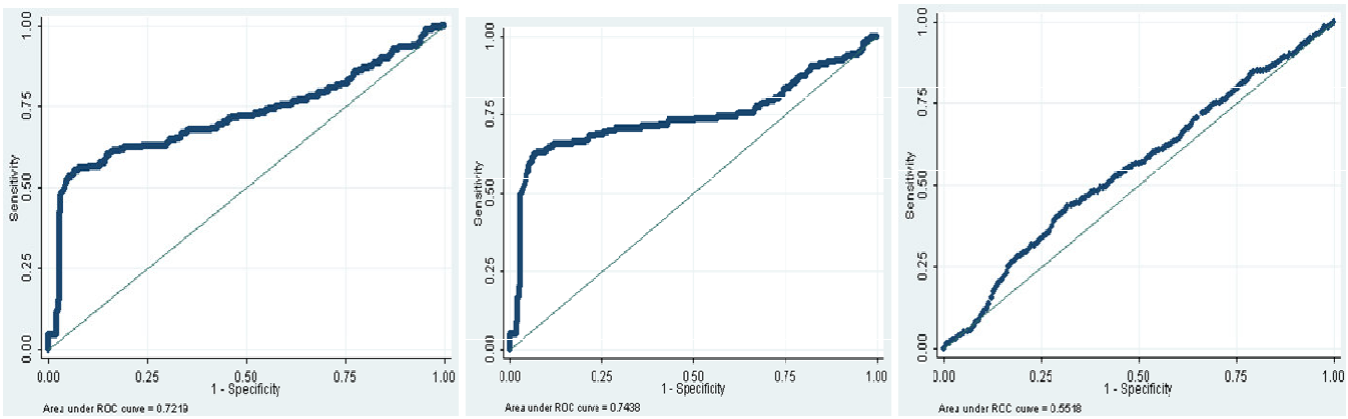

Figure 3. Input the financial derivatives and direct investment abroad variables.

remaining indicators examined in this study are necessarily tentative, in part because of the limited number of studies that formally tested their statistical significance in a variety of circumstances. According to ROC method, we discover that the logit model is better than other model in forecast power. In this study, we inputed the ROC method in the financial derivatives and the direct investment abroad (these two variables) and discover that all the models are better. The finance derivatives and direct investment abroad are useful for predicting currency crises. Indirectness can be found if global financial tsunami is in close relation with these two parameters and if it allows preemptive counter policy measurement by the central bank.

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