EAST ASIAN FINANCIAL CRISIS REVISITED: AN ECONOMETRIC ANALYSIS (1981-2001)

FERIDUN, Mete*

Abstract

This article seeks to find out which macroeconomic variables played a role in the East Asian financial crisis of 1997 using a linear probability model built for Malaysia, Indonesia, Thailand, Singapore, and Philippines. Results indicate that foreign direct investment, money stock, growth of exports, current account balance, and real interest rates seem to have played a role in the crisis in most countries, whereas the significance of domestic credit, inflation, and short-term debt relative to reserves appears to be rather weak as explanatory factors for the occurrence of the crisis.

JEL Classification: F31;F32;F41;F47

Keywords: financial crises; linear probability models; East Asian crisis

1. Introduction

Before the financial crisis that took place in mid-1997, East Asia was the largest growing region in the world, and a few countries including Indonesia, Singapore, Thailand, Philippines, Malaysia were regarded as the world's most promising countries with their double-digit economic growth rates, prudent fiscal policies, and high rates of private savings.

The currency crisis, which began in Bangkok in mid-1997 rapidly spread to the rest of the region resulting in both currency and financial system crises. Foreign investors and lenders quickly pulled out capital from the region that had become dependent on capital inflows over the decades preceding the crisis. Due to the importance of the East Asian region in the world economy, the crisis had an

* Mete Feridun, Faculty of Economics and Administrative Sciences, Cyprus International University, Nicosia, Cyprus. E-mail: mete.feridun@lycos.com

enormous impact on a global scale adversely affecting the financial markets all around the world. Local countries that suffered most from the crisis were Thailand, Indonesia, Singapore, Malaysia and the Philippines. In these countries, the crisis started from the currency crisis, and was followed by financial and economic crises[1] that resulted in plunges in the stock markets in the East Asian countries from mid-1997 to mid-1998. This has lead to severe financial sector difficulties, prolonged deterioration in economic activity, and increased unemployment during the years following the crisis.

It has been widely argued that financial liberalization, private sector expenditure and financing decisions, government involvement in the private sector, and lack of transparency in corporate sector, and fiscal and economic profligacy played a role in the East Asian financial crisis which was not possible to predict due to the fact that it originated from the private sector rather than the public sector and involved no public deficit or debt build-up (Bustelo *et al* 1999),

2. Literature Review

In Feridun(2004) literature on financial crises is categorized into three mainstream models, namely first-generation models, second-generation models, and third-generation models.

There have been numerous studies in the literature on the determinants of financial crises**.** Empirical literature on financial crises can be categorized into two separate groups. The first group consists of studies based on a model known as "Signals Approach" which involves observing the behavior of a number of indicators as they issue signals when they exceed certain threshold values. The second approach is based on a logit or probit model and uses lagged values of early warning indicators as well as a dummy variable to predict crises.

Signals approach was developed by Kaminsky *et al*. (1998) and consists of a bilateral model where a set of high frequency economic

[1] In addition to economic crisis, political crisis erupted in Indonesia

variables during a specified period is compared, one at a time, with a crisis index so that when one of these variables deviates from its normal level beyond a specific threshold value prior to a crisis, it issues binary signals for a possible currency crisis. The signals approach uses information from crisis and non-crisis times and takes the timing of crises explicitly into account. This method makes it possible to evaluate the predictive powers of individual indicators facilitating the establishment of indicator rankings. Therefore, it is well suited for finding vulnerabilities in an economy as it immediately reveals the variable that causes the weakness. This enables policy makers to develop prompt policy responses in order to prevent crises. These models work well with small samples and impose no restriction on the number of explanatory variables. Despite these advantages, in signals approach, information from each indicator is treated in an inefficient way since all are transformed into dummies. This implies that signals are equally strong regardless of whether an indicator just passes the threshold or exceeds it by a wide margin. This approach is bivariate, in that each indicator is analyzed, and optimal thresholds calculated, separately. Due to this nature of the approach, correlations among the explanatory variables are not taken into account, which can affect the optimal thresholds in a negative way when constructing a composite leading indicator. In addition, these models do not allow the application of some standard statistical evaluation methods, such as the significance tests, as they are nonparametric.

Probit and logit models, pioneered by Frankel and Rose (1996), uses limited dependent variable models known as probit or logit regressions to identify the causes of crises. In these models, the currency crisis indicator is also modeled as a zero-one variable, as in the signal approach. However, the explanatory variables do not take the form of a dummy variable, but enter the model in a linear fashion. This approach defines a crisis indicator equal to one or zero depending on whether a currency crisis does or does not occur within the specified time period. Frankel and Rose (1996) attempted to find out how international debt structure and external factors affected the probability of currency crises. They used a number of external, internal and foreign macroeconomic variables in a multivariate probit

model specified for 105 developing countries, covering annual data from 1971 to 1992. They defined a crisis as at least 25% depreciation of the nominal exchange rate that also exceeds the previous year's depreciation level by at least 10% and constructed a dummy crisis variable according to that rule. Results of their model indicate that the overall explanatory power of the model is quite low with a pseudo R^2 measure of around 20% for all specifications. According to the same results, current account and budget deficits are insignificant as well as most of debt composition variables, except for foreign direct investment. A fall in this variable by one percent of the debt is associated with a 3% increase in the probability of a crash. Results of their model suggest that the probability of a crisis increases when output growth and reserves are low, and domestic credit growth, external debt and foreign interest rates are high. They also found out that the probability of a crash is higher during recessions and when the ratio of foreign direct investment to total debt is low.

3. Background of the East Asian Economy

In this section, we will provide information about economic background of the East Asian countries prior to the crisis. Before the crisis in 1997, ASEAN-5 countries had strong conventional macroeconomic fundamentals such as high savings, net capital inflows, investment, and GDP growth rates. They also had moderate inflation, ample foreign exchange reserves, fiscal surpluses, low public debts and low unemployment. As a result, no one had the reason to be apprehensive of an upcoming crisis in 1997.

However, as pointed out by Bustelo *et al* (1999), East Asian countries had a number of common weaknesses. To begin with, financial liberalization, in terms of inadequate governmental regulation and prudential supervision, allowed domestic firms to borrow recklessly both domestically and abroad. It also increased fragilities in the domestic financial sector through excessive risk-taking, high domestic and foreign exposure, inadequate bank sheets, maturity and currency mismatch between borrowing and lending, and short-term external debt.

Financial liberalization reduced the quality of risk-assessment as low capital adequacy limits and high legal lending limits contributed to bank overlending. In particular, foreign borrowing in short-term funds denominated in foreign currencies contributed to an excessive bank lending on a long-term basis in domestic currency.

As a result, balance sheets in banks and other financial institutions featured a growing maturity and currency mismatch between liabilities and assets. In the case of bank borrowing, obtaining capital from abroad at low interest rates on a short-term basis to lend in the domestic market at high interest rates on a long-term basis was profitable and therefore contributed, besides to the maturity mismatch between liabilities and assets, to a substantial short-term foreign debt. In the case of bank lending, due to increased competition in the domestic market, most banks tended to direct their loans to the stock market and to commercial and residential property market contributing to growth of an asset bubble in those sectors (Bustelo *et al*, 1999).

East Asian manufacturing firms had an easy access to credit. As a result, they were highly leveraged. Both borrowing respective to investment and debt respective to equity were abnormally high. Moreover, debt-to-equity ratios in the corporate sector rose in the two years preceding the crisis in Malaysia, the Philippines and Thailand.

Both banks and firms were also excessively indebted in foreign short-term liabilities, while the change in foreign exchange reserves was not matching the latter. Furthermore, short-term foreign debt as a proportion of international reserves increased noticeably in Thailand and Malaysia 1994 and 1997.

In addition, financial liberalization contributed to substantial net capital inflows most of which were short-term bank loans or portfolio investments. High net capital inflows provoked the real appreciation of currency due also to differentials in inflation rates and to the US dollar rise, which led to significant slowdown in exports and, subsequently, to an increase in current account deficits.

4. Data and Methodology

For our study, we used a data set[2] of yearly observations that covers the period between 1981 and 2001. We selected our explanatory variables on the basis of previous empirical literature and financial crisis theories. Our study incorporates a total of eight macroeconomic variables[3] as indicated in Tables 1.1 and 1.2. We transformed the data sets into log returns in order to achieve mean-reverting relationships, and to make econometric testing procedures valid.

A monetary policy indicator that is used frequently in the literature and we included in this study is domestic credit as a percentage of GDP. This explanatory variable is used as an indicator of the banking sector as well as indicator of capital structure, indebtedness and riskiness of firms. As Kaminsky and Reinhart (1998) point out, very high growth rates of domestic credit may serve as a simple indicator of the fragility of the banking system and the higher the domestic credit, the more dependent is the real economic activity on the health of the banking system, and the worse the effects of a crisis on the economy.

Another explanatory variable used quite frequently in the literature is the level of exports growth. Jotzo (1999) points out that declining volume of exports can be considered as an indication of loss of competitiveness of a country, possibly caused by an overvalued domestic currency. In our study, annual growth rate of exports of goods and services based on constant local currency was used as an indicator of the current account of the countries along with current account balance, which is the sum of net exports of goods, services, net income, and net current transfers.

[2] All data are obtained from World Bank's 2003 World Development Indicators CD

[3] A limitation of our study is that our model is based solely on quantitative variables and takes no account of any qualitative variables.

Table 1. Explanatory variables CAB, DOC, EXPO and FDI

Variable	Symbol& expected sign	Explanation[4]
Current account balance	CAB-	Current account balance is the sum of net exports of goods, services, net income, and net current transfers. Data are in current U.S. dollars.
Domestic credit/GDP	DOC+	Domestic credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable that establish a claim for repayment.
Growth of exports	EXPO-	Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They exclude labor and property income as well as transfer payments. Annual growth rate of exports of goods and services is based on constant local currencies. Aggregates are based on constant 1995 U.S. dollars.
Foreign direct investment/GDP	FDI+	Foreign direct investment is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows in the reporting economy.

[4] Explanations are taken from World Bank's 2004 World Development Indicators CD

Table 1.2. Explanatory variables INF, M2,SDR and RIR

Variable	Symbol& expected sign	Explanation[5]
Inflation (CPI)	INF+	Inflation is measured by the consumer price index and reflects the annual percentage change in the cost of goods and services.
Money stock (M2)/Gross international reserves	M2+	Money stock (M2) comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than those of the central government. Gross international reserves comprise holdings of monetary gold, special drawing rights, and the reserves of IMF members held by the IMF.
Short-term debt/reserves	SDR+	Short-term debt includes all debt having an original maturity of one year or less and interest in arrears on long-term debt. Reserves comprise holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities. Data are in current U.S. dollars.
Real interest rate	RIR+	Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator.

[5] Explanations are taken from World Bank's 2004 World Development Indicators CD

An important indicator used as a capital account indicator in our study is the money stock (M2) to gross international reserves ratio. As Eichengreen *et al.* (1995) point out, M2 is a measure of liquidity, and its growth indicates excess liquidity, which may invoke speculative attacks on the currency thus leading to a currency crisis. This suggestion is also supported by Dowling and Zhuang (2000) who affirm that rapid growth in credit induced by excessive monetary expansion have historically been associated with currency and banking crises in many countries. We also used foreign direct investment as a percentage of GDP. This indicator shows net inflows in the reporting economy. It is a well-known fact that East Asian countries had been for quite a long time on net capital inflows over the decade preceding the crisis. Therefore, we decided to include this variable in our study.

Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator. We included this variable following the prior empirical studies. High domestic real interest rates is known to reflect distress and problems in the finance sector (Zhuang and Dowling 2000). We also employ short-term debt/reserves ratio as a measure the vulnerability of the economy to speculative attacks As Ghosh (2000) points out, a large percentage of short-term debt in the context of insufficient foreign exchange reserve does make the economy vulnerable to speculative attacks. Lastly, in order to measure the effect of inflation on the financial crises, we use consumer price index (CPI).

In this study, we aim at finding out whether the aforesaid variables played a role in the East Asian crisis of 1997 or not, using a linear probability model[6]. In a linear probability model, the dependent variable y is a dichotomous variable taking the value 1 or 0 depending on whether a currency crisis, does or does not occur. If the

[6] A drawback of this method is that the number of crises in the underlying sample is very small in comparison with the number of tranquil periods. As a result, the statistical properties of the limited dependent regression may be poor.

crisis takes place, the dependent variable takes the value of 1. Otherwise, it remains 0.

$$? = \begin{cases} 1 \text{ if the crisis takes place} \\ 0 \text{ otherwise} \end{cases} \quad (1)$$

The dependent variable is then regressed on the explanatory variables based on the form:

$$?_i = a_i + ß_i x_i + e_i \quad (2)$$

The literature on predicting currency crises has used the term crisis synonymously with speculative attacks or extreme pressure on the exchange rate. As a result, crisis indices have often been based on identifying sharp changes either in the exchange rate alone, as done by Frankel and Rose (1996), or in the weighted averages of exchange rates and reserves as done by Kaminsky, Lizondo, and Reinhart (1998). Essentially, classifying each sample period as being in crisis or not depends on whether or not an index of vulnerability exceeds an arbitrarily chosen country specific threshold. In this study, we use the *exchange market pressure index*[7] of Komulainen and Lukkarila (2003) whose crisis index includes exchange rate depreciation and loss of reserves, which are weighted equally. The index accurately captures the actual crisis that took place in 1997 in all countries. However, in order to improve the statistical properties of our model, we use a 3-year window[8], i.e. we consider that the crisis episode spans a time period of 3 years following the year in which the crisis emerged. Descriptive statistics, for each country, are given in Tables 2.1 to 2.5.

[7] The exchange market pressure index takes the form: EMP = ?e – (se/sr)*?r where ?e denotes the change in exchange rate and ?r in international reserves, se and sr denote the standard deviation of exchange rate alteration and reserves, respectively. We determine the values of the EMP index more than two standard deviations above the mean as a crisis as suggested by Komulainen and Lukkarila (2003).

[8] This practice, from the statistical point of view, strongly increases the number of ones in the sample thereby improving the statistical properties of our regressions.

Table 2.1. Statistics of Indonesia

	INF	EXPO	FDI	M2	SDR	RIR	CAB	DOC
Mean	0.26	57.56	-93.70	38.99	20.29	12.27	2.13	-39.94
Maximum	1.00	756.42	59.46	425.67	42.85	57.64	19.75	97.94
Minimum	0.00	-81.84	-745.75	-117.21	6.49	3.72	-44.90	-399.50
Std. Dev.	0.45	204.24	228.65	116.48	11.30	13.06	17.37	112.53

Table 2.2. Statistics of Malaysia

	FDI	DOC	EXPO	RIR	SDR	CAB	INF	M2
Mean	35.40	540.45	-38.17	-15.52	6.85	6.30	4.28	-0.63
Maximum	781.56	11121.0	192.14	367.56	20.39	10.00	17.85	6.14
Minimum	-91.11	-164.03	-303.95	-202.70	-27.95	-7.36	-7.59	-16.81
Std. Dev.	178.05	2428.0	107.23	117.77	11.43	4.49	6.26	5.12

Table 2.3. Statistics of Philippines

	RIR	CAB	M2	FDI	DOC	EXPO	INF	SDR
Mean	353.81	10.42	1.05	7.30	-500.79	14.32	20.45	-1.56
Maximum	8017.7	23.50	12.88	336.68	123.57	124.42	112.59	46.63
Minimum	-388.62	-12.96	-18.41	-464.89	-8783.9	-62.33	-54.89	-31.10
Std. Dev.	1759.63	10.38	7.75	144.16	1927.8	51.77	50.34	15.14

Table 2.4. Statistics of Singapore

	RIR	DOC	EXPO	FDI	M2	CAB	INF	SDR
Mean	79.02	7.01	38.76	1.89	13.25	4.38	3.53	31.68
Maximum	121.00	11.00	71.10	8.62	27.00	7.81	6.80	57.50
Minimum	40.30	-6.69	29.70	0.03	-4.30	1.77	2.00	19.80
Std. Dev.	25.79	4.32	10.36	2.58	7.47	2.11	1.36	9.90

Table 2.5. Statistics of Thailand

	EXPO	DOC	M2	FDI	RIR	CAB	SDR	INF
Maximum	34.48	18.66	15.43	274.67	394.25	3.04	94.58	13.29
Mean	14.98	4.72	5.44	26.21	21.78	2.03	-39.44	6.04
Minimum	-7.46	-17.72	-1.43	-54.37	-96.12	0.90	-388.44	-10.51
Std. Dev.	11.76	9.97	4.97	78.18	102.75	0.70	111.45	5.08

In Singaporean data set, DOC and SDR are correlated with most of the remaining variables, so we do not include them in our model. In Malaysian data set, DOC is correlated with most variables, so we remove this variable. For the same reason, we disregard INF in the Thai model. In Indonesia, CAB and DOC are correlated with most of the remaining variables, so we eliminate these variables, and we do the same for SDR in Philippines for the same reason. Disregarding these variables does not mean that we consider that they are not relevant but we do that in order to avoid excessive multicollinearity. SDR is a variable very much correlated with another explanatory variables as it may be seen in the correlation matrix of Table 3. SDR shows high positive correlation with CAB, DOC and INF in Malaysia and Philippines, with DOC and M2 in Singapore, and with INF in Indonesia and Thailand. The highest negative correlations are shown with CAB and DOC in Indonesia.

Table 3. Correlation Matrix of SDR

	Id	My	Ph	Sg	Th
CAB	-0.94	0.60	0.79	0.03	0.05
DOC	-0.98	0.77	0.70	0.61	-0.28
EXPO	-028	0.07	0.38	-0.45	-0.27
FDI	-0.26	-0.33	-0.07	0.36	-0.14
INF	0.45	0.50	0.42	-0.78	0.69
M2	-0.12	0.12	-0.05	0.62	-0.50
RIR	0.21	0.21	-0.64	0.32	0.35

Before we build our regression models, we need to appraise the expected signs of the coefficients of the variables. For individual variables, a positive coefficient means that an increase in this explanatory variable will cause an increase in dependent variable, that is, dummy dependent variable gets close to 1, which indicates a crisis. A negative coefficient, on the other hand, would mean that an increase in this variable would cause a decrease in the dummy dependent variable. Next, we run regressions for each country based on the linear probability model. Table 4 gives the results of the regressions.

Table 4. Regressions

Country	Indicator	Coefficient	S.E.	Expected Sign	Found Sign
Singapore	RIR	0.016924	0.003833***	+	+
	INF	-0.007592	0.013743	+	-
	EXPO	-0.044002	0.015313**	-	-
	FDI	0.100576	0.050588*	+	+
	M2	-0.01041	0.008244	+	-
	CAB	-0.091323	0.030529***	-	-
Malaysia	FDI	0.001123	0.000639	+	+
	M2	0.000126	3.01E-05***	+	+
	EXPO	-0.005455	0.001840***	-	-
	RIR	-0.001851	0.000870*	+	-
	SDR	-0.021709	0.015975	+	-
	CAB	0.146401	0.062320**	-	+
	INF	-0.001087	0.001939	+	-
Thailand	EXPO	0.034695	0.010081***	-	+
	DOC	-0.052679	0.012421***	+	-
	M2	0.043243	0.011080***	+	+
	FDI	0.001037	0.000602	+	+
	RIR	0.001163	0.000453**	+	+
	CAB	-0.212867	0.070734**	-	-
	SDR	0.000588	0.000455	+	+
Indonesia	INF	0.000925	0.001262	+	+
	EXPO	-0.000438	0.000235*	-	-
	FDI	0.001614	0.000880*	+	+
	M2	0.020413	0.005962***	+	+
	SDR	0.000404	0.018419	+	+
Philippines	RIR	0.000159	3.16E-05***	+	+
	CAB	-0.031309	0.010324***	-	-
	M2	0.024910	0.007214***	+	+
	FDI	0.000752	0.000537	+	+
	DOC	6.59E-05	2.99E-05**	+	+
	EXPO	-0.006004	0.005836	-	-
	INF	0.007065	0.005811	+	+

*, **, *** Significant, respectively,at the 10%, 5% and 1% level.

As Table 4 indicates, foreign direct investment is significant in all countries with correct signs. Real interest rates is significant in all countries, except Indonesia, with a wrong sign in Malaysia whereas export growth is significant in all countries with correct signs except in Thailand where it has a positive sign. Domestic credit is significant only in Philippines, and Thailand, and its sign is not in line with our expectations in Thailand. M2 is significant in all countries with correct signs except in Singapore while current account balance is significant in all countries except in Indonesia. It has correct signs in all cases except in Malaysia. Short-term debt, on the other hand, is significant only in Thailand and Indonesia with correct signs. Inflation is significant in Malaysia, Indonesia and Philippines with correct signs except in Malaysia where it has a negative sign.

Table 5 summarizes the results of the regressions.

Table 5. Correctness Statistics

Variable	Significance/country	Correct signs/Significance
DOC	2/2	1/2
EXPO	5/5	4/5
M2	4/5	4/4
FDI	5/5	5/5
INF	3/4	2/3
CAB	4/4	3/4
SDR	2/3	2/2
RIR	4/5	2/4

5. Conclusions

This study aimed at identifying the macroeconomic variables that played a role in the East Asian financial crisis of 1997 using a set of yearly indicators from 1981 – 2001. It estimated separate linear probability models for Singapore, Malaysia, Indonesia, Philippines, and Thailand. Several noteworthy conclusions emerged from the study. First, increasing foreign direct investment relative to GDP apparently accounts for the financial crisis in all of the five countries.

This result is not surprising considering the fact that East Asian countries had become dependent on net capital inflows over the decade preceding the financial crisis of 1997. Second, decreasing growth of exports played a role in the crisis in all countries except in Thailand where increasing growth of exports caused the crisis. This result is in line with the findings of the prior research in the financial crisis literature which suggests that the loss of competitiveness of a country is likely to result in financial crisis. Similarly, deteriorating current account balance is significant in all countries except in Indonesia. It has correct signs in all cases except in Malaysia. Third, real interest rates is a significant factor in the financial crisis in all countries except Indonesia reflecting distress in the finance sector before the crisis. However, decreasing real interest rates seem to account for the crisis in Singapore and Malaysia, which is an interesting and novel result.

In addition, domestic credit relative to GDP played a role in the crisis in Philippines and Thailand only, but the effect is not in line with our expectations in Thailand where decreasing domestic credit seems to play a role in the crisis in this country. This result is rather unexpected as high domestic credit relative to GDP is usually considered as an indicator of the fragility of the banking system and we expected to see this variable playing a significant role in most of the East Asian countries. It is possible that credit crunch might have limited the amount of investment that was needed to get the economy moving with the normal speed. Increased inflation, on the other hand, played a role only in Indonesia and Philippines, which is an expected outcome. Besides, increasing M2 relative to gross international reserves played a role in the financial crisis in all countries except in Singapore where decreasing M2 caused the crisis. This result is in line with our expectation as the growth of this variable indicates excess liquidity, which may invoke speculative attacks on the domestic currency. Similarly, increasing short-term debt relative to reserves played a role in the financial crisis only in Thailand and Indonesia indicating increasing vulnerability of the economy in these two countries to speculative attacks. In conclusion, the results of our study emphasize the need for careful monitoring of three key variables, namely M2 relative to gross international

reserves, growth of exports, and foreign direct investment relative to GDP.

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