Stock Prices as a Leading Indicator of the East Asian Financial Crisis

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Abstract: Using a basic currency crisis model, we assess the effectiveness of stock prices as a leading indicator of the East Asian currency crisis in 1997 and 1998. Stock prices are incorporated into a basic monetary model, through the wealth effect postulated by Friedman (1988). In addition to the domestic stock price, we also incorporate the stock prices of Hong Kong, China and Japan to determine their ability to predict the crisis. Using monthly data, the results indicate that the domestic stock price is a significant leading indicator, however the main stock prices indicator of the crisis is the Hong Kong stock price. In addition the US price level is also a highly significant predictor of the crisis. Causality tests suggest evidence of bi-causality between the stock markets and foreign exchange markets.

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I Introduction

The aim of this paper is to primarily determine whether the domestic stock market can be used as a leading indicator during a regional currency crisis, as in East Asia during 1997 and 1998. Further we investigate whether the major stock markets within East Asia had any effect on the currencies suffering the crisis and can also be used as an early warning system. A particular feature of the East Asian crisis was the almost simultaneous decline in asset prices and currencies, as international investors moved their capital out of the respective domestic markets. This resulted in a subsequent depreciation of the exchange rate as the domestic currency was sold. However the degree of severity of the crisis varied across East Asia, as did the extent of the decline in the domestic stock markets.

To date most models for predicting currency crises have concentrated on leading indicators from either the banking sector or the current account (e.g., Kaminsky *et* al., 1998, Kwack, 2001). When stock prices have been included, it has been limited to only domestic stock prices. In this paper we suggest a simple monetary based model, in which stock prices can be incorporated as a leading indicator of currency crises. We also investigate whether foreign stock prices are a significant leading indicator, based on three theories concerning the origins of the South East Asian currency crisis.

When investigating the relationship between stock prices and exchange rates, the main concern is usually over the direction of causality between these variables. There are theoretical reasons for causality to run in both directions, as suggested by Bahmani-Oskooee and Sohrabian (1992) and Granger *et al* (2000). The empirical

evidence is equally ambiguous, although Granger *et al* (2000) finds evidence of causality running from stock markets to exchange rates during a currency crisis, but their study uses daily data rather than monthly data. In this study we too assume causality is from stock prices to exchange rates.

Following the introduction, we assess the interrelationship between stock prices and exchange rates during a currency crisis. We then derive a simple model of currency crises, in which stock markets are incorporated through the demand for money function. The next section describes the data and assesses the results from the empirical models. Finally we give our conclusions and suggest some implications for future policies.

II Currency Crises and Stock Prices

The main attempt to incorporate the domestic stock market into empirically based currency crisis models has been Kaminsky and Reinhart (1996) and Kaminsky *et al* (1998). These models incorporate a number of real, financial and political variables in purely empirical models, to identify which are significant and also the length of the signalling horizon. They use the "signals" approach, which in general involves a one step ahead probability of a devaluation, in the context of a multivariate probit or logit type model. The domestic stock markets are generally found to be a significant leading indicator of currency crises, over a number of different currency crises in the recent past. In the study by Kaminsky *et al*. (1998), stock prices are found to be the fourth best predictor of currency crises.

There has been a certain amount of debate in the literature as to the direction of causality between stock prices and exchange rates. Granger *et al*. (2000) show that causality runs from domestic stock prices to exchange rates. They offer some theoretical support for a bi-directional relationship between the stock market and foreign exchange market, but only over the short run. They argue that a change in exchange rates would change the market value of all firms that trade internationally. This would depend on whether the firms are net importers or exporters, such that if in aggregate most firms were net exporters, a devaluation would have a beneficial affect on those firms profitability and therefore stock market value. This causal relationship is termed the traditional approach, although it does not specify the sign of the effect.

In contrast to this approach, both Bahmani-Oskooee and Sohrabian (1992) and Granger *et al*. (2000) stress the importance of the portfolio approach to analysing the relationship between stock prices and exchange rates. This suggests that a rise in stock prices, increases the domestic wealth of investors, facilitating a rise in the demand for money. Following the consequent rise in interest rates, capital is attracted into the domestic economy appreciating the domestic currency. This approach assumes there is a negative relationship between stock prices and exchange rates, with causality running from the stock market to the foreign exchange market. Wu (2001) provides evidence of the negative relationship between equities and exchange rates in South East Asia. This explanation is the most relevant to this relationship during a currency crisis. We have conducted a set of Granger causality tests between domestic stock prices and exchange rates, as with other studies, there is evidence of bicausality between the stock market and foreign exchange markets. When causality

runs from stock prices to the exchange rate, there is a negative relationship, which suggests the portfolio approach is most important in South East Asia.

Apart from the US stock market, we have investigated whether the crisis could have originated from any of the main neighbouring stock markets, in Japan, Hong Kong and China. Although the crisis began in Thailand in 1997, others have suggested the crisis began earlier than this, with both China/ Hong Kong and Japan being suggested as contenders. Fernald *et al* (1999) have suggested that the rise in China's economic strength during the 1990's added to the crisis. They focused on the 1994 devaluation and subsequent strong export performance as the cause of the troubles, as China captured export markets, which had previously been dominated by the Association of Southeast Asian Nations (ASEAN) countries. This facilitated current account problems, reduced company profitability and culminated in the general financial demise of the area. It has also been argued that a further source of the crisis could have been Hong Kong, which in 1997 was officially returned to China from the UK. Initially this had a positive effect on Hong Kong's share prices, but as the date for the handover approached, so concern about investment in Hong Kong increased.

Some argue that another source of the crisis was Japan. Following rapid rises in the stock market during the 1980's, the early and mid 1990's saw a reversal of this trend, with some sharp falls. At the same time the Japanese economy experienced an era of stagnant growth and lack of demand. This facilitated a decline in demand for ASEAN imports and a fall in investment flows to these countries. The financial crisis in Japan culminated in the failure of Yamaichi corporation in 1997, the fourth largest financial institution. This in turn caused another large fall in the Japanese stock market.

If either Japan or China/ Hong Kong were the instigators of this crisis, then a measure of their financial troubles could be a useful leading indicator for the currency crises in East Asia. To determine if this is the case, we have incorporated the stock market indices of China, Hong Kong and Japan into the basic monetary based model, along with the domestic stock market index.

III Model

The following model is based on the Krugman (1979) model of currency crisis, with stock market effects incorporated through the money demand specification. As with Edin and Vredin (1993), this is only used as a basis for the empirical investigation and as with the leading indicator literature in general, other leading indicators are also incorporated into the empirical tests, without specific theoretic modeling. The stock market is included in the money demand function[2] for three reasons, as suggested by Friedman (1988). It primarily acts as a wealth effect, as a rise in stock prices increases nominal wealth. Additionally a rise in stock prices reflects a rise in expected returns from risky assets. To offset this rise in risk, agents switch away from long-term bonds to safer monetary assets. Thirdly a rise in stock prices implies a rise in financial transactions and thus transactional demand for money. These imply a positive relationship between money and stock prices. There could also be a negative relationship through a substitution effect. As stock prices rise, agents substitute the

[2] The stock market could have been related to other macroeconomic variables, such as consumption, output and investment. However given the monetary basis of most currency crisis models, we have incorporated it into the money demand function.

more attractive equities for money. However as with Friedman (1988) we assume the positive effect dominates.

As with the conventional monetary model, we assume purchasing power parity (PPP) and uncovered interest parity (UIP) [3]hold;

$$e_t = p_t - p_t^* \tag{1}$$

Where, e is the exchange rate, p are domestic prices and p^* are foreign prices.

$$E(\frac{de}{dt}) = i_t - i_t^* \tag{2}$$

Where i are domestic interest rates and $i^*$are foreign rates. Money demand takes the following form:

$$m_t - p_t = \phi y_t - \lambda i_t + \chi s_t \tag{3}$$

Where m *is* domestic money balances, y is domestic income and s is a domestic stock market index. We have assumed that the domestic money supply is purely accommodating. By rearranging the above equations, we get:

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[3] As with currency crisis models in general based on the monetary model, we have assumed PPP and UIP, although empirical studies question whether the former holds due to trade impediments and transport costs and the latter due to the presence of a risk premium.

$$e_t = m_t + \lambda i_t^* + p_t^* - \phi y - \chi s_t + \frac{\lambda de}{dt} \quad (4)$$

To test for the effects of stock prices on the exchange rate, we have chosen a standard empirical model, based on equation[4] (4). This suggests the crisis is a function of:

$$cc = f(\Delta m, \Delta y, \Delta i^*, \Delta p^*, \Delta ds, \Delta rer, \Delta res, \Delta xs) \quad (5)$$

Where *cc* is the rate of change in the exchange rate for the month when the exchange rate is in a crisis condition,Δ *m* is the domestic money supply (M1), *y* is output, *i** is the US interest rate, *p** is the US price level, *ds* is the domestic stock market index, Δ*rer* is the change in the real exchange rate, *res* are foreign currency reserves and *xs* are the relevant foreign stock market indexes (All variables are in logs and in change form). As with Edin and Vredin (1993) we have also included the real exchange rate, rather than the nominal exchange rate and added foreign exchange reserves. The relevant foreign stock market indexes are the US, Japan, Hong Kong and China. The US stock market is included because the East Asian currencies are pegged to the dollar, the Japanese markets have traditionally had a strong effect on the region as a whole. China has recently undergone important political changes which have affected

[4] An alternative approach would have been to include a variety of other relevant variables relating to the banking sector, current account and political factors, as in Kaminsky *et al.* (1998). However in order to provide a theoretical basis for the empirical tests, the emphasis is on variables relating to the Friedman based monetary model. In addition it would not be possiblt to incorporate all the potential leading indicators into the model, so we have concentrated on the stock market area.

their financial markets and Hong Kong has been transferred from UK to Chinese control.

In addition to the main leading indicator tests, we have also included some Granger Causality tests, between the exchange rates and domestic stock prices. In addition we have included some causality tests between the exchange rates and foreign stock price variables. The basic tests is:

$$\begin{aligned} \Delta e_{it} &= \alpha_0 + \alpha_1 \Delta e_{it-1} + \alpha_2 \Delta s_{it-1} + u_t \\ \Delta s_{it} &= \beta_0 + \beta_1 \Delta s_{it-1} + \beta_2 \Delta e_{it-1} + v_t \end{aligned} \tag{6}$$

Where *e* is the exchange rate, *s* is the stock price variable and *u* and *v* are error terms. As with Blomstrom *et al.* (1996) we have included country dummy variables and use the t-statistic on the lagged explanatory variable to determine if there is evidence of causality.

IV Data and Results

The countries included in the investigation are those that experienced the worst problems during the crisis. This includes Thailand, Malaysia, South Korea, Indonesia and the Philippines. The data is all monthly, running from January 1996 to December 1999, so including months where a crisis was evident as well as months in which the exchange rate was relatively stable. The exchange rate is expressed as the domestic currency in terms of the US dollar, the foreign explanatory variables are the respective US variables. This reflects the fact that the relevant currencies were

initially all in effect pegged to the US dollar. The data on prices, foreign exchange reserves, money supply and interest rates are taken from *International Financial Statistics* and *Datastream.*.

The stock market data consists of the total return expressed in index form as supplied by *Datastream*. This incorporates both the capital gain and dividend[5] payment. In addition to the standard currency crisis variables and the domestic stock market indices, we have also added stock market variables from the surrounding countries. This includes Hong Kong, China and Japan, where the origins of the crisis are believed to have began, as well as the US stock market variable.

The causality tests are reported in Table 1, where there is evidence of bi-causality between the exchange rate and domestic stock prices, as found in Kwack (2000). In addition there is evidence that the stock prices in China and particularly Japan cause the East Asian exchange rates.

[5] Friedman suggests using a stock market index such as the main market index in his 1988 paper. However other studies have suggested using the return on equities and the dividend yield as an alternative measure of the stock market. By using the *Datastream* index of stock prices, it includes the capital gain, whilst the dividend yield is incorporated into the index in the form of a further capital gain.

A binomial probit[6] is used to estimate the various models, where we define a crisis as a depreciation of the currency in any month greater than 2%. This roughly equates with the definition of a currency crisis given by Frankel and Rose (1996), which is a depreciation of the exchange rate greater than 25% in any given year[7] so the dependent variable is the change in the exchange rate. Other values were also estimated, but made little difference to the results. The model has been estimated using both fixed and random effects, however in all tests there are no significant differences between the results, so only the fixed effects are reported.

The first model to be estimated is the basic model, in which the variables are lagged once, incorporating only domestic stock prices. The result is presented in Table 2 and suggests the domestic stock prices and US prices are significant leading indicators, although other domestic variables are insignificant[8] Other lag lengths were also

[6] The use of the probit econometric technique in the currency crisis literature is widespread but has a number of associated weaknesses. It tends to lead to a limited definition of a currency crisis and does not take into account the complicated and individual nature of a crisis. Other studies have used the endogenous switching type of model (Edin and Vredin, 1993). However this type of model was not suitable for the East Asian financial crisis, as following the devaluations the financial regime changed, with the exchange rate floating and capital controls reinstated.

[7] We could have used various different definitions of a currency crisis, by incorporating movements in reserves and interest rates into a crisis variable. As we are concentrating specifically on the exchange rate and stock price relationship, we used only the exchange rate in our crisis variable. Radelet and Sachs (1998) use a similar technique to that used here, however they define the crisis as being a sharp shift from a capital inflow to outflow.

[8] As with other studies of the East Asian financial crisis, the domestic variables are not significant leading indicators of the crisis. However we assume that they are significant out of the crisis.

added, but were not significant as financial markets tend to adjust relatively quickly. The second model incorporates US stock prices, which are not significant, suggesting although the US real economy affected the crisis, the US stock prices are not a good leading indicator. In models 3 and 4, reserves and the Thailand stock price are included in the basic model. As with other studies reserves are not significant although the Thailand stock price is significant at the 10% level of significance This is not surprising as the crisis began with the collapse of the Thailand stock market..

Only US prices and domestic stock prices are significant leading indicators of the currency crisis. The domestic variables are not important predictors of the crisis, including the change in the real exchange rate, which as in Radelet and Sachs (1998) is insignificant. This result tends to support the contention of many observers who suggest there were very few domestic indicators of the impending crisis in these economies (e.g., Furman and Stiglitz (1998), Radelet and Sachs (1998)).

The further inclusion of the Japanese, Chinese and Hong Kong stock prices individually into the model, also shows these are significant, except the Japanese stock market, which supports the theory that the origins of the currency crisis was not the relatively small domestic stock markets, but the more powerful stock markets of some of the neighbouring economies, particularly Hong Kong. All three stock markets are negatively signed, again suggesting that the falls in the respective markets precipitated the currency crisis. The probability of predicting an outcome correctly is reasonably high at about 70%[9] in each case.

[9] However this is an in-sample forecast. Using an out-of-sample forecast, as is usually the case with policy makers, is likely to lead to a smaller probability of correctly predicting a crisis.

The final set of tests involves all three neighbouring stock markets included in the model. Only the Hong Kong market is significant of the three main East Asian markets. This provides possible evidence that the source of the instability within the ASEAN countries was Hong Kong's financial markets. The instability in these markets was caused primarily by the change in ownership of Hong Kong in 1997, when China took over administrative control from the UK. However Hong Kong did not suffer from a currency crisis itself, this may be due to the larger size and greater development of its financial markets as suggested by Radelet and Sachs (1998) or due to the authorities using their reserves to purchase equities, thus preventing a collapse on the Hang Seng.

V Conclusion

This paper provides evidence of the domestic stock market being a significant leading indicator of the recent East Asian currency crisis, unlike other domestic variables. Although the most significant leading indicator of the crisis was US prices. The effectiveness of the domestic stock prices is less powerful as a leading indicator than the stock prices of the main economies in East Asia, particularly that of Hong Kong.

The results in general support the evidence from other similar studies on the East Asian crisis, as there is little evidence that the domestic fundamentals could have been used to predict the crisis. However it could have been possible to predict the crisis with reasonable accuracy, based on the main neighbouring foreign stock markets, particularly the Hong Kong stock market. This implies that volatility in the

Hong Kong economy and financial markets, possibly as a result of the change in ownership of Hong Kong in 1997, may have triggered the crisis. This supports the various contagion theories, although it does not explain why some financial markets survived the crisis better than others.

Finally, although this model could act as an important early warning system, it has a number of limitations. These mainly relate to the individual nature of most crises, where different institutional and political factors affect the crises in different ways. However the intervention in the Hong Kong stock market by the authorities during the crisis, may have saved Hong Kong from a similar fate to its neighbours and provides the possibility of a mechanism for preventing such crises from occurring in the future. This could form part of an area for future research, as could the use of daily rather than monthly data as such data becomes more available.

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Table 1. Causality tests between Stock prices and Exchange rates.

	Δe	Δds

Δe(-1)		0.182 (1.916)**
Δds(-1)	-0.087 (1.674)**	
ΔHKS(-1)	-0.074 (1.159)	
ΔUSS(-1)	0.070 (0.499)	
ΔCHS(-1)	-0.076 (1.683)**	
ΔJPS(-1)	-0.209 (1.927)**	

Notes: T-statistics are in parentheses. E and ds are the domestic exchange rate and stock price respectively. HKS, USS, CHS and JPS and Hong Kong, US, China and Japan's stock prices respectively. ** indicates significance at the 10% level of significance. Only lagged explanatory variable included.

Table 2. Probit Models using panel data from Thailand, Malaysia, South Korea, Philippines and Indonesia

Variable	1	2	3	4
ΔM (-1)	-1.157	-1.136	-1.095	-1.131
	(1.709)	(1.681)	(1.596)	(1.442)
ΔDS (-1)	-0.620*	-0.585*	-0.572*	-0.320
	(2.363)	(2.186)	(2.170)	(0.847)
ΔUSP (-1)	-107.181*	-1.3.874*	-102.311*	-110.289*
	(11.195)	(9.488)	(9.916)	(10.234)
ΔUSS (-1)		-0.393		
		(0.615)		
USi (-1)	0.064	0.073	0.007	0.057
	(0.308)	(0.351)	(0.032)	(0.240)
ΔY (-1)	-0.608	-0.629	-0.708	-0.636
	(1.312)	(1.363)	(1.514)	(1.253)
ΔRER (-1)	0.283	0.281	0.206	0.090
	(0.807)	(0.807)	(0.577)	(0.232)
ΔRES (-1)			-0.796	
			(1.453)	
ΔTHS(-1)				-0.471
				(1.651)
L-L	-122.031	-121.841	-120.956	-97.229
Probability	70%	71%	73%	68%

Notes: t-statistics are in parentheses. Probability is the probability of a predicted outcome occurring from the 115 possible outcomes, acting as a pseudo-R^2. M is the money supply, DS is the domestic stock price, USP, Usi and USS are US prices, interest rates and stock prices respectively. Y is output and THS are Thailand's stock prices, RER is the real exchange rate and RES are reserves. L-L is the restricted log likelihood A * indicates significance at the 5% level.

Table 3. Probit Models using panel data from Thailand, Malaysia, South Korea, Philippines and Indonesia, including foreign stock prices.

Variable	1	2	3	4
ΔM (-1)	-1.061	-1.129	-1.116	-1.071
	(1.596)	(1.665)	(1.655)	(1.609)
ΔDS (-1)	-0.445	-0.500	-0.594	-0.476
	(1.668)	(1.860)	(2.265)	(1.747)
ΔUSP (-1)	-107.643*	-109.676*	-106.075*	-116.063*
	(12.306)	(11.680)	(11.008)	(10.558)
ΔUSS (-1)				1.069*
				(1.224)
USi (-1)	0.041	0.082	0.110	0.064
	(0.188)	(0.391)	(0.519)	(0.278)
ΔY (-1)	-0.573	-0.535	-0.683	-0.578
	(1.266)	(1.150)	(1.450)	(1.234)
ΔRER (-1)	0.040	0.175	0.253	-0.035
	(0.114)	(0.500)	(0.718)	(0.097)
ΔJPS (-1)			-0.602*	-0.512
			(1.093)	(0.820)
ΔCHS (-1)		-0.493*		-0.047
		(2.292)		(0.164)
ΔHKS (-1)	-0.974*			-1.141*
	(3.072)			(2.234)
L-L	-117.412	-119.494	-121.431	-116.428
Prob	72%	72%	71%	73%

Notes: See Table 1 and 2.