Did a Boom in Money and Credit Precede East Asia's Recent Currency Crisis?

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This paper assesses the relationship between money and credit and episodes of sharp depreciation in East Asia by: (i) examining the growth rates of money and credit variables around depreciation episodes; (ii) estimating the impact of money and credit variables on the probability of a sharp depreciation episode using logit models; (iii) evaluating the signals contained in money and credit variables prior to episodes of sharp currency depreciation. Reserve money grew rapidly prior to the 1997 currency crisis in East Asia. However, signs of a money or credit boom based on other indicators were mixed. The 1997 episodes differ from East Asia's past experience in a number of ways. Rapid growth in the M2 multiplier and in the ratio of M2 to foreign reserves, positive deviations of reserve money from trend, and declines or sluggish growth *in reserve money and in foreign reserves, helped predict episodes of sharp depreciation up to mid-1996. While some of these indicators pointed to the possibility of a crisis in some of the countries prior to the 1997 episodes, they did not consistently predict the sharp depreciations that occurred.*

Two perspectives may be offered on Asia's recent currency crises. First, at the macroeconomic level, there is a widespread perception that these crises resulted from unsustainable booms in money and credit. However, in contrast to the balance of payments crises observed in Latin America in the 1980s (and modeled in the first-generation literature on balance of payments crises, Krugman 1979), it is generally recognized that expansion in money and credit in Asia did not reflect fiscal profligacy. In the years preceding the 1997 currency crises in East Asia, domestic saving rates in Asia were generally very high (30 percent of GDP or higher), and government budgets were in surplus or showed very small deficits.

Instead, a combination of external shocks and domestic factors spurred money and credit growth directed towards private sector borrowers rather than towards financing budget deficits. In most Asian economies, money and credit expansion was in part stimulated by booming economic conditions in Asia, reflecting strong domestic demand and increases in domestic asset prices and robust export markets (notably the U.S. market). In a number of cases, money and credit expansion also was stimulated by capital inflow surges in response to declining world rates of interest or an appreciating yen, which encouraged relocation of Japanese investment to the rest of Asia. Financial liberalization is also believed to have played a role, to the extent that it was associated with looser restrictions on credit by financial institutions or on short-term foreign borrowing. Finally, to the extent that there may have been a boom in money and credit, monetary authorities would necessarily have played a key role by allowing rapid money growth to proceed unimpeded or by stimulating such rapid growth through their policies.

Second, at the microeconomic level, there is the belief that the currency crisis stemmed from the inability of Asia's underdeveloped banking systems to perform an effective financial intermediation role as money and credit expanded. In recent years, credit in many Asian economies was directed to speculative and ultimately unprofitable investments, such as real estate ventures in Thailand or loss-making projects undertaken by Korean enterprises. It is apparent that the allocation of credit was not always based on considerations of profit or risk management, and there is the impression that the volume of credit itself may have been excessive. By increasing the vulnerability of the financial sector, credit misallocation made exchange rate regimes vulnerable to shocks.

The literature offers two broad reasons that misallocation of credit, and possibly excessive lending, may occur. One is that *financial intermediaries may be unable to use business criteria to allocate credit.* Loans may be directed to poorly managed firms because of government policy objectives or because well-connected borrowers cannot be refused credit. In other cases, government officials decide that a firm should receive credit even if it is poorly managed, because it operates in a strategic sector.

Another reason is that *creditors do not expect to bear the full costs of failure, because other people's money (depositors or taxpayers) is at risk.* This may result from high leverage (low capital), the inherent lack of transparency in banking, and, perhaps most important, implicit or explicit government guarantees against losses. As noted by McKinnon and Pill (1997) and Krugman (1998), this can lead to overborrowing and investment in unproductive activities.

Many of the conditions described above were present in a number of Asian economies, and the question of interest is whether these conditions were reflected in money or credit growth prior to episodes of sharp currency adjustment. In particular, we will examine the role of money and credit growth in Asia's recent currency crises by focusing on the following questions: To what extent was there a money and credit boom in East Asia in the period leading up to the recent financial crises? Were money and credit conditions unusually expansionary compared to the historical average for the region and compared to previous episodes of sharp currency depreciation?

Addressing these questions can shed light on what kind of aggregate money and credit behavior might be associated with the sharp adjustments in Asian exchange rates observed in 1997. If money and credit aggregates grew at an unusually fast rate, then attention to such indicators might help predict future episodes of sharp currency depreciation. If they did not, then policymakers should not be misled by "normal" behavior of money and credit aggregates into thinking that the exchange rate is not vulnerable to a shock.

This type of analysis may also clarify the role of expansionary monetary policy in triggering exchange rate adjustments, as well as the extent to which an institutional structure conducive to "overborrowing," along the lines suggested by McKinnon and Pill (1997) or Krugman (1998), may be associated with unusually rapid growth in aggregate money and credit prior to periods of sharp depreciation. For this purpose, we will examine the historical behavior of reserve money, M2, domestic credit, the money multiplier, the ratio of M2 to foreign reserves, and foreign reserves.

The behavior of reserve money prior to sharp depreciation episodes is of interest because it sheds light on the role of an aggregate that can be directly influenced by the central bank. The broader aggregates are of interest because of their relationship to financial intermediation. In terms of the financial sector vulnerability issues, rapid growth in M2 may raise concerns about whether changes in sentiment could lead to a sudden withdrawal of deposits. On the asset side, the correspondingly rapid growth in domestic credit may raise concerns about the ability of banks to assess loan quality and may be associated with increased risk-taking behavior, which may ultimately trigger a currency crisis.

The M2 multiplier is often seen as an indicator of the effects of financial liberalization (Calvo and Mendoza 1996). Such liberalization may lead to monetary booms reflected in increases in the multiplier that in turn lead to currency crises. Kaminsky and Reinhart (1996) observe that the financial sector had been liberalized during the five years prior to 18 of the 26 banking crises they study, and their index of financial liberalization signals 71 percent of balance of payments crises (and 67 percent of banking crises, which in turn signal balance of payments crises).

As is well known, the volume of international capital flows to emerging markets increased significantly in the 1990s. One important issue raised by the resulting closer integration with world financial markets is that holders of short-term financial sector liabilities can respond to uncertainty by quickly converting them to foreign currency. A crisis may be triggered if the demand for foreign currency exceeds the central bank's supply. Indeed, there is a widely held view that the recent currency crises in Asia were triggered by a reversal of capital inflows that exhausted central bank foreign exchange reserves. To shed light on this question we will review trends in M2 relative to the foreign exchange reserves of the central bank. A high ratio would indicate that the liquid liabilities of the banking sector exceed the foreign currency assets of the central bank. The question is whether there was a significant increase in this ratio in the period leading up to the crisis. In addition, we will examine the behavior of the foreign exchange reserves of the central bank to see if these were depleted prior to episodes of sharp currency adjustment, as might be expected if capital inflow surges were reversed. As discussed below, the behavior of foreign reserves also may facilitate interpretation of the behavior of reserve money, as it is an important component of the central bank balance sheet.

There is some evidence suggesting that rapid growth in some money or credit aggregates is associated with episodes of balance of payments crises. Moreno (1995) studies episodes of speculative pressure in Pacific Basin currency markets using nonparametric methods and finds that unusual growth in central bank domestic credit (rather than domestic credit of the entire banking sector, which is the variable used in the present study) appears to be associated

with episodes of depreciation. Studying broader samples, Frankel and Rose (1996) find that rapid growth in domestic credit (of the entire banking sector) precedes periods of currency collapse. Kaminsky and Reinhart (1996, Figure 2) find that M1 and M2/reserves grow sharply in the months before balance of payments crises.[1] Kaminsky, Lizondo, and Reinhart (1997) find that certain monetary indicators such as M2/foreign reserves, "excess" M1 balances, the M2 multiplier, and domestic credit/GDP help predict exchange rate crises. Sachs, Tornell, and Velasco (1996) find in a cross section of 20 emerging market economies that a lending boom over the period 1990–1994 increases the magnitude of a balance of payments crisis.[2] The present study extends this literature by focusing on Pacific Basin economies, whose characteristics may differ from the broader samples typically studied in the literature, and by focusing on whether money and credit variables helped predict East Asia's recent currency crisis.[3]

We cannot rule out the possibility that episodes of sharp depreciation may not be preceded by rapid growth in money and credit in East Asia. In a small open economy, the expected relationship between a change in reserve money and the exchange rate depends on the underlying source of the disturbance to reserve money. If fluctuations in reserve money reflect exogenous changes in central bank domestic credit creation, growth in reserve money may indeed lead to collapsing pegs or episodes of sharp currency depreciation (as in Krugman 1979). However, there are conditions under which even rapid growth in reserve money may be associated with a tendency for the exchange rate to *appreciate*, rather than depreciate. For example, if the economy is booming, reserve money growth may reflect efforts by the central bank to accommodate increases in money demand. Also, growth in reserve money may reflect (not fully sterilized) intervention by the central bank to stabilize the exchange rate in the face of capital inflow surges (Glick and Moreno 1995). It is quite possible that reserve money fluctuations in East Asia are dominated by these latter factors, since, as suggested earlier, East Asian central banks have not been under pressure to engage in domestic credit creation to finance fiscal deficits.

As for the broader aggregates, the conditions that may trigger sharp depreciation episodes (such as excessively risky lending that makes the financial system—and the exchange rate regime—vulnerable to shocks) need not be associated with unusually rapid growth in money and credit. Even if they are, it can be argued that a depreciation is more likely to occur after a money and credit boom linked to robust economic growth or rising asset prices has ended (in which case the costs of preserving the peg may well exceed the benefits, as in the second-generation currency crisis model of Obstfeld 1995), rather than when the boom is in full force. In this case, the relationship between broad money and credit growth and sharp depreciation episodes may be tenuous.

The paper is organized as follows. Section I discusses the data and provides an informal description of the behavior of money and credit variables prior to episodes of sharp currency depreciation, including the most recent episode. Section II pools the data and estimates logit models of the relationship between monetary variables and episodes of sharp depreciation up to 1996 and then examines whether the 1997 crises were successfully predicted. Section III assesses the extent to which monetary variables predicted episodes of sharp currency depreciation in East Asia using a "signals" method suggested by Kaminsky, Lizondo, and Reinhart (1997).

I. DEPRECIATION EPISODES AND MONETARY BEHAVIOR

Data for the end-of-period exchange rate against the U.S. dollar, M2 (money plus quasi money, lines 34 + 35), reserve money (line 14), and foreign exchange reserves (line 1d.d) were collected from the International Financial Statistics CD-ROM issued by the International Monetary Fund. The sample includes Indonesia, Korea, Malaysia, Philippines, Thailand, and Singapore. To maximize the availability of complete monthly data, the full sample period spans 1972:01–1997:10 for all countries. Part of the analysis will focus on episodes of sharp currency depreciation, which are defined as those in which the percentage change in the exchange rate exceeds the mean plus two standard

1. Kaminsky and Reinhart define an index of currency market turbulence as a weighted average of exchange rate changes and reserve changes, with weights such that the two components of the index have equal conditional volatilities.

2. Their crisis index is defined as a weighted average of the exchange rate devaluation with respect to the U.S. dollar and the percentage change in foreign exchange reserves between November 1994 and April 1995. The weights are given by the inverse of the variance of each series over the past ten years. The lending boom is the percentage change between 1990 and 1994 in the ratio of the size of the claims of the banking sector (demand deposit banks and monetary authorities) on the private sector to GDP. There is also mixed evidence on the relationship between lending booms and banking crises, which may in turn trigger balance of payments crises. Along with Gavin and Hausman (1996), Kaminsky and Reinhart (1996, Figure 3) find evidence in favor of the hypothesis that lending booms precede financial crises. However, Caprio and Klingebiel (1997) do not.

3. Moreno (1995) also focuses on Pacific Basin economies, though there are a number of differences. First, he defines episodes of speculative pressure sequentially in terms of unusual changes in the exchange rate, foreign exchange reserves and interest rates, rather than in terms of exchange rates alone. Second, his analysis relies on nonparametric methods.

deviations, where the standard deviation is computed over the full sample. To reduce the chances of capturing the continuation of the same episode, three months of data were skipped after each episode before continuing the search for the next episode. Some episodes and the data around them were dropped because they reversed large appreciations or because data were missing.[4]

Two points are worth making with regard to our choice of episodes. First, the cut-off point of two standard deviations is entirely arbitrary. According to a recent study by Frankel and Rose (1996), the results may not be very sensitive to the precise cut-off in selecting depreciation episodes.

Second, in contrast to some previous research, which includes episodes of speculative pressure in which the exchange rate did not always adjust, this paper focuses only on episodes of sharp depreciation, and does not consider the behavior of foreign exchange reserves and interest rate differentials. One reason for this sole focus is that it helps capture episodes that might be more similar to the 1997 currency crises in Asia, in which policymakers found themselves unable to resist sharp depreciation. Another reason is that this measure is not subject to the criticism of previous measures made by Frankel and Rose (1996). They argue that the lack of market-determined short-term interest rates with long histories implies that interest rate hikes as well as foreign currency reserve expenditures are less important in determining the exchange rate (over the sample) than other very difficult to measure factors, such as tightening of reserve requirements. They also argue that foreign currency reserve movements are notoriously noisy measures of exchange market intervention. (This was dramatically exemplified by the experience of Thailand in 1997, where much of the intervention that depleted foreign currency reserves occurred in the forward market and off the central bank balance sheet.) With this in mind, this paper will instead try to assess whether foreign exchange reserves contain any information that may be useful in signaling episodes of sharp currency depreciation.

How Severe Are Episodes of Depreciation?

To give a sense of the characteristics of sharp depreciation episodes in East Asia, Table 1 reports the average magnitude of depreciation during such episodes in comparison to the mean plus two standard deviation cut-off. With the exception of Thailand, the one-month adjustments in the exchange rates in East Asian economies at the onset of the latest currency crisis were not unusually large in comparison to previous episodes of sharp depreciation.

The table also reveals that, with the exception of Malaysia and Indonesia, episodes of sharp depreciation have been associated with reductions in growth in the East Asian economies in our sample. However, the magnitude of reductions in growth (or outright economic contraction) in the most recent episode of depreciation is unprecedented, with Indonesia, Thailand, and Korea among the most severely affected. This in turn reflects the interruption in credit flows in a number of economies in the region, as well as reductions in demand.

TABLE 1

Severity of Depreciation Episodes, 1972:01–1997:06

Country (number of episodes)	Exchange Rate[a]	Economic Growth[b]
	Prior Depreciation Episodes	
Malaysia (4)	1.4	2.2
Indonesia (3)	4.5	1.6
Korea (3)	3.8	–3.0
Singapore (4)	1.7	–1.8
Thailand (2)	3.2	–0.2
Philippines (3)	1.2	–4.9
Average	2.6	–1.0
	Most Recent Episode	
Malaysia (1997:07)	1.1	–13.4
Indonesia (1997:08)	1.7	–24.5
Korea (1997:10)	1.4	–13.8
Singapore (1997:08)	1.3	–7.0
Thailand (1997:07)	5.8	–13.4
Philippines (1997:07)	1.2	–6.3
Average	2.1	–13.1

[a] One-month change as a proportion of monthly mean plus two standard deviations.

[b] Change in year following episode compared to year before episode. GDP forecasts for 1998 were obtained from the Asia Pacific Consensus Forecasts, October 12, 1998.

4. The following depreciation episodes were not included because in the previous month there was a large appreciation: Malaysia, 1978:11, Philippines, 1992:09 and Singapore, 1978:11 The following depreciation episodes were not included because of insufficient data: Malaysia and Singapore, 1973:11, Philippines 1983:10, 1984:06, 1984:10 and 1986:02.

Money and Credit and Exchange Rate Depreciations

Before assessing money and credit conditions around periods of sharp exchange rate adjustment, it is useful to have some idea of benchmark values. For this purpose, Table 2 shows average 12-month growth of nominal and real reserve money (reflecting central bank outside money creation), M2 and domestic credit (reflecting inside money and credit creation by banks), and the levels and growth rates of the M2 multiplier (the ratio of M2 to reserve money) over the period 1972.01–1997.06 in East Asian economies. (The growth rates in the ratio of M2 to foreign reserves and in foreign reserves are reported later on.) Simple averages of these growth rates for the region are also reported. In this section, growth is measured over a 12-month period.

Table 2 also reports indicators of money and credit conditions for the subsample 1993:01–1997:06. This subsample was chosen more or less arbitrarily, but it roughly coincides with certain developments that may have influenced money and credit conditions including (i) an extended period of rapidly growing capital flows to emerging markets, only briefly interrupted by the Mexican peso crash of 1994; (ii) the establishment of a number of offshore banking facilities in the region, notably the Bangkok International Banking Facility in 1993; (iii) robust growth in all the emerging East Asian economies, including a notable recovery in the Philippine economy. Also, the sample ends before the collapse of the Thai baht in 1997:06, to focus on the period prior to the most recent crisis. The question of interest is whether money and credit indicators grew more rapidly in this more recent period, triggering a crisis of unprecedented severity.

Table 2 reveals that:

Over the full sample, money and credit growth was not unusually rapid in East Asia. Growth in nominal reserve money, M2, and domestic credit averaged 17, 21, and 24 percent respectively. Money and credit growth rates tended to be slower in Singapore and fastest in Indonesia and Korea.

There is no consistent evidence that growth in money and credit aggregates over the subsample 1993:01–1997:06 was more rapid than over the full sample. For example, reserve money, M2, and credit growth increased in the Philippines. In contrast, growth in these aggregates slowed in Korea, very sharply in the case of reserve money. Turning to the real version of these variables, the general disinflation in the 1990s attenuates, but does not reverse, the impression that money and credit growth did not consistently increase in this decade.

The averages thus show no consistent evidence of a money and credit boom in the 1990s.

Money Multiplier Behavior

As noted earlier, in the literature on banking and currency crises, the money multiplier is sometimes interpreted as reflecting monetary conditions following financial liberalization. The reason is that in a controlled financial environment, the money multiplier is an artifact of government policy that is determined by credit ceilings or by stringent reserve requirements.[5] In contrast, in a liberalized financial environment, we can say that the money multiplier reflects the amount of money that can generally be supported by the amount of reserves available in the interbank market. The multiplier is likely to vary with the incentives for risk management in the banking sector. The lower the incentives for risk management (due to implicit or explicit government guarantees, low capitalization, or perhaps intense competitive pressures), the higher the multiplier is likely to be. Under these conditions, a high multiplier may signal vulnerability to shocks or to adverse shifts in market expectations and may then precede episodes of speculative pressure in currency markets, as apparently occurred in Mexico before the 1994 peso crash (Calvo and Mendoza 1996).

How applicable is this interpretation to East Asia? In the 1980s (in the case of Singapore, in the 1970s), many of the East Asian economies did eliminate a number of financial sector restrictions, such as the use of aggregate credit ceilings for purposes of monetary control (for example, Indonesia and Thailand eliminated such ceilings in the first half of the 1980s). There was also a broad tendency for reserve requirements to fall in a number of these economies, although such reductions were at times reversed during periods when money growth was felt to be excessive. These developments would tend to lead to increases in the money multiplier and possibly to greater risk-taking and more vulnerable exchange rate regimes.

Nevertheless, the interpretation of multipliers along these lines poses some conceptual difficulties. A higher multiplier also can be seen as indicating a more developed financial system, with more efficient transactions or interbank settlements technology, rather than greater risk-taking. (For example, the money multiplier in the United States, at 9.7 in 1996, is much higher than the money multipliers of any of the economies in East Asia.) Indeed, one challenge that remains to be addressed is how to distinguish between these two effects to determine which is more important. We will

5. Even in the absence of such government ceilings or requirements, if interest rates are subject to controls, the multiplier is likely to reflect distortions associated with the lack of an effective price-setting mechanism.

TABLE 2

PERCENTAGE CHANGES IN SELECTED NOMINAL MONEY OR CREDIT INDICATORS
FULL SAMPLE: 1972:01–1997:06; SUBSAMPLE 1993:01–1997:06

	NOMINAL						REAL						M2 MULTIPLIER LEVEL		M2 MULTIPLIER GROWTH	
	RESERVE MONEY		M2		DOMESTIC CREDIT		RESERVE MONEY		M2		DOMESTIC CREDIT					
COUNTRY	FULL	SUB	FULL	SUB	FULL	SUB	FULL	SUB	FULL	SUB	FULL	SUB	FULL	SUB	FULL	SUB
Malaysia	16.8	25.5	17.3	20.5	20.8	20.2	11.7	20.7	12.2	16.0	15.4	15.8	4.2	4.2	0.9	–3.3
	(0.6)	(1.4)	(0.4)	(0.7)	(0.7)	(1.7)	(0.5)	(1.3)	(0.4)	(0.7)	(0.5)	(1.3)	(0.0)	(0.1)	(0.4)	(1.3)
Indonesia	23.0	25.0	29.7	23.4	30.7	21.6	9.6	15.3	15.8	13.8	16.7	12.1	4.1	7.6	6.3	–0.9
	(0.8)	(1.3)	(0.6)	(0.6)	(1.3)	(0.5)	(0.6)	(1.3)	(0.5)	(0.7)	(1.2)	(0.6)	(0.1)	(0.1)	(0.6)	(1.0)
Korea	20.3	10.2	22.7	16.6	24.2	15.9	10.0	4.9	12.0	11.1	13.0	10.4	5.1	6.0	4.3	7.9
	(1.1)	(1.9)	(0.5)	(0.4)	(0.6)	(0.5)	(1.1)	(1.8)	(0.5)	(0.4)	(0.3)	(0.5)	(0.1)	(0.1)	(0.9)	(2.2)
Philippines	15.9	11.9	20.9	24.0	27.2	57.3	3.6	3.8	8.2	15.0	13.9	45.6	3.7	4.2	5.0	11.2
	(0.7)	(0.9)	(0.4)	(0.8)	(1.9)	(7.1)	(0.7)	(0.9)	(0.5)	(0.8)	(1.8)	(6.5)	(0.0)	(0.1)	(0.7)	(1.1)
Singapore	12.7	8.2	14.2	10.2	20.5	13.9	8.4	6.0	14.2	8.0	15.6	11.6	4.5	5.9	1.7	2.0
	(0.5)	(0.5)	(0.4)	(0.4)	(1.2)	(0.7)	(0.4)	(0.5)	(0.4)	(0.4)	(1.0)	(0.7)	(0.1)	(0.0)	(0.4)	(0.6)
Thailand	14.3	17.2	19.0	15.2	20.4	22.0	7.1	11.7	11.6	9.8	12.9	16.3	6.2	8.6	4.3	–1.6
	(0.3)	(0.6)	(0.2)	(0.4)	(0.3)	(0.7)	(0.4)	(0.6)	(0.4)	(0.4)	(0.4)	(0.6)	(0.1)	(0.0)	(0.3)	(0.6)
AVERAGE	17.2	16.3	20.6	18.3	24.0	25.2	8.4	10.4	11.6	12.3	14.6	18.6	4.6	6.1	3.8	2.6

NOTE: Figures in parentheses are the standard error of the full sample or subsample mean.

not address this question, but focus at this time on whether there is evidence of unusual growth in the money multiplier in the 1990s.

Turning first to the M2 multiplier levels in Table 2, it is apparent that these were generally higher in the 1990s. It is also remarkable that the average level of Singapore's money multiplier is no higher than that of Indonesia, Korea, or Thailand, whose financial sectors are not as developed as Singapore's. As these economies were also the most severely affected by the crisis, it is tempting to conclude that high multipliers reflected some kind of excess money creation.[6] However, Table 2 also reveals that while the growth in the multiplier in the 1990s accelerated in Korea, it was negative in Indonesia and Thailand. This means that multiplier levels in these last two economies were already high years before the crisis. In particular, as we shall confirm below, with the exception of Korea, rapid growth in the multiplier was not generally a predictor of the severity of the currency crises in 1997.

To sum up the results of Table 2, with the exception of Malaysia, in East Asia in the 1990s the growth in reserve money picked up modestly or declined relative to the full sample. Changes in the growth of M2 and domestic credit in many cases declined relative to the full sample average. Also, while high levels of the M2 multiplier seemed to be associated with greater vulnerability to the 1997 currency crisis, it appears that these high multipliers could persist for years without any impact on the exchange rate. Thus, it is apparent that money and credit indicators in Asia in the 1990s provided no consistent signal of a "boom" in the most affected economies. This differs from the impression sometimes conveyed by the financial press and financial analysts.

Money and Credit Growth and Depreciation Episodes

To assess the relationship between money and credit growth and periods of sharp depreciation, we compute the one-month percentage change in the exchange rate over the full sample period (1972.01–1997.10), and then select episodes in which the depreciation in the exchange rate exceeds the mean plus two standard deviations. We then check the average 12-month percentage change in money or credit aggregates in the year before previous episodes of sharp depreciation.

Table 3 reports the results. The behavior of money and credit aggregates prior to previous episodes of depreciation may be summarized as follows. First, *reserve money grew more slowly than the full period average* in five of the six countries, and there is no consistent pattern in the behavior of M2 nor domestic credit. The impression of slower growth around episodes of depreciation is reinforced by the real measures, suggesting that inflation tends to slow prior to such episodes. Second, *historically the M2 multiplier has tended to grow faster than the full period average.*

As for the behavior of these aggregates in the year before the most recent (1997) depreciation episodes, Table 3 reveals that nominal reserve money, M2, and domestic credit grew *faster* than the full period average in some of the affected economies (Indonesia, Malaysia, and Thailand for reserve money, Malaysia and the Philippines for M2 and domestic credit) prior to the currency depreciations of 1997. For these variables, there was no evidence of unusually rapid growth in the other economies.

While the real measures modify this impression somewhat, the various money and credit series are quite volatile, making it difficult to form any definitive conclusions. Also, real reserve money growth still contracted sharply in Korea. We will bring further evidence to bear on this in later sections.

As for the money multiplier, the outcomes also are mixed. Growth in this indicator prior to the latest crisis was well above the full sample average, particularly in Korea. However, in Thailand (and also in Indonesia and Malaysia), where the most recent episode began, growth in the money multiplier was below the full-sample average in the year before July 1997.

External Vulnerability

As suggested previously, in a closed economy there is concern that rapid growth in monetary liabilities may make the banking system vulnerable to runs. In an open economy there is the additional concern that domestic depositors may attempt to switch their domestic liquid assets (such as M2) into foreign currency, which could lead to a collapse in the value of the currency. In this section we examine two indicators of such vulnerability. One is the ratio of M2 to the foreign exchange reserves of the central bank, which may indicate the extent to which a run on a currency may be triggered by perceptions that the central bank does not have the ability to convert liquid assets into hard currency. Another is the foreign exchange reserves of the central bank. As suggested earlier, this variable is of interest as a monetary indicator partly because it is an important component of reserve money. In "first generation" models of speculative attacks (Krugman 1979), foreign exchange reserves decline in the

6. Although there have been significant enhancements in transactions technologies in a number of Asian economies in the 1990s, even in more advanced economies like Korea, the preference for cash and paper transactions influences the extent to which these are replaced by an electronic system. We would therefore expect that the M2 multiplier would be lower in such an economy.

TABLE 3

Performance of Aggregates Preceding Depreciations[a]

Country (number of episodes or month)	Average Growth						
	Nominal			Real			
	Reserve Money	M2	Domestic Credit	Reserve Money	M2	Domestic Credit	M2 Multiplier
	Year before Earlier Depreciations						
Malaysia (4)	–5.1	0.7	–6.4	–5.1	0.5	–6.3	4.9
Indonesia (3)	–10.5	–8.3	0.1	–4.9	–2.9	4.8	1.9
Korea (3)	–1.0	4.1	12.0	–11.5	–7.8	–1.3	4.0
Philippines (3)	0.5	0.1	–1.2	–2.3	–2.2	–3.9	1.7
Singapore (4)	–3.3	–1.0	–6.9	–4.0	–2.0	–7.3	1.9
Thailand (2)	–3.2	2.4	1.2	–4.8	0.6	–0.4	5.2
Average	–3.8	–0.3	–0.2	–5.4	–2.3	–2.4	3.3
	Year before 1997 Depreciation						
Malaysia (1997:07)	15.5	5.4	8.8	16.6	6.8	10.2	–8.0
Indonesia (1997:08)	11.0	–2.5	–8.3	16.9	4.3	–1.2	–10.8
Korea (1997:10)	–34.3	–4.2	–2.4	–27.7	1.5	3.5	34.8
Philippines (1997:07)	–1.3	2.6	7.9	5.1	9.1	14.2	3.0
Singapore (1997:08)	–5.8	–3.3	–3.8	–3.3	–0.9	–0.9	2.2
Thailand (1997:07)	2.2	–6.8	–4.8	4.2	–4.3	–2.4	–7.7
Average	–2.1	–1.5	–0.4	2.0	2.8	3.9	2.3

[a] Average growth relative to full-sample mean.

TABLE 4

Ratio of M2 to Foreign Exchange Reserves

Country	Level		Growth	
	Full sample	Subsample	Full Sample	Subsample
Malaysia	3.3	2.9	3.7	10.1
	(0.0)	(0.1)	(1.1)	(4.2)
Indonesia	4.7	6.5	10.3	6.0
	(0.1)	(0.1)	(3.7)	(1.1)
Korea	8.3	6.5	8.5	–2.9
	(0.2)	(0.1)	(2.9)	(1.4)
Philippines	6.2	4.6	12.1	0.9
	(0.3)	(0.1)	(3.7)	(2.9)
Singapore	1.1	1.1	0.0	–2.9
	(0.0)	(0.0)	(0.4)	(4.9)
Thailand	5.7	3.9	3.0	–0.2
	(0.2)	(0.0)	(1.1)	(1.0)
Average	4.9	4.3	6.3	1.8

Notes: Figures in parentheses are the standard error of the mean for the full sample and subsample. The M2 multiplier in the U.S. in 1996 was 9.7.

period leading up to a currency crisis because central bank intervention seeks to offset domestic credit creation by the central bank. Even in the absence of such an effect, foreign exchange reserves may be depleted if investors are switching from domestic assets to foreign assets prior to a currency collapse.

Table 4 summarizes the behavior of the ratio of M2 to foreign reserves in East Asian economies over the full sample and in the 1990s (the level of foreign reserves over these long periods is not very informative so it is not discussed). Three points may be made. First, over the full sample period and also in the most recent subsample, Singapore has a remarkably low ratio of M2 to foreign currency reserves of approximately one. This might help explain why Singapore has managed to emerge from Asia's financial crisis without the severe interruptions in international credit flows experienced by other economies. Second, apart from Singapore, there is no clear pattern in the levels over the entire sample, or in the 1990s, that provides any hint of which economy might be more severely affected. For example, while Indonesia and Korea (which have been severely affected) had high ratios, the ratio for Thailand was actually lower than the ratio for the Philippines. Perhaps past a certain level, these ratios convey little information. Third, with the exception of Malaysia, growth rates of M2 over foreign exchange reserves *fall* in the 1990s, compared to the full sample. This reflects the accumulation of foreign exchange reserves as central banks sought to stabilize the exchange rate during periods of capital inflow surges.

Table 5 reveals that with the exception of Malaysia and Singapore, the growth in the ratio of M2 to foreign reserves tended to be higher than the full-sample average in the year prior to past episodes of depreciation. However, there is no discernible pattern in the behavior of the ratio in the year before the episodes of sharp currency depreciation in 1997. In contrast, the growth in foreign exchange reserves generally falls below the sample average prior to episodes of sharp depreciation in the region. The discussion below will seek to shed further light on the robustness of these findings.

TABLE 5

PERFORMANCE OF M2/FOREIGN RESERVES AND FOREIGN RESERVES PRECEDING DEPRECIATIONS[a]

COUNTRY (NUMBER OF EPISODES OR MONTH)	GROWTH IN PERCENT	
	M2/FOREIGN RESERVES	FOREIGN RESERVES
YEAR BEFORE EARLIER DEPRECIATIONS		
Malaysia (4)	–4.4	3.0
Indonesia (3)	38.2	–39.2
Korea (3)	34.6	–23.3
Philippines (3)	17.2	–12.5
Singapore (4)	–4.1	3.7
Thailand (2)	25.9	–21.1
AVERAGE	17.9	–14.9
YEAR BEFORE 1997 EPISODE		
Malaysia (1997:07)	8.9	–8.6
Indonesia (1997:08)	–14.3	–2.6
Korea (1997:10)	5.3	–33.4
Philippines (1997:07)	–25.7	13.2
Singapore (1997:08)	–0.8	–6.9
Thailand (1997:07)	5.5	–15.2
AVERAGE	–3.5	–8.9

[a] Average growth relative to full-sample mean.

II. INTERPRETING POOLED DATA: LOGIT MODELS

While the preceding discussion is suggestive, more rigorous analysis is needed to determine the relative value of money and credit indicators in predicting episodes of sharp currency depreciation. Furthermore, episodes of sharp depreciation in any given economy are relatively rare, so there are potential advantages to pooling the data from the countries in the region. Pooling increases the number of depreciation episodes analyzed to 25, compared to 2–4 for each country individually. It also may be noted that the discussion so far has focused on deviations from the *average* behavior of monetary variables during periods leading up to a depreciation. This is a relatively weak criterion, and the average may disguise important features of the data.

To take these issues into account, we use two alternative procedures. First, we estimate univariate regressions to assess whether the lagged growth in money or credit variables helps predict episodes of sharp depreciation. Second, we assess the usefulness of alternative indicators using the "signals" method suggested by Kaminsky, Lizondo, and Reinhart (1997).

To assess the predictability of episodes of sharp currency depreciation we define a variable y_{it}, which takes on the value of unity during episodes of sharp currency adjustment and 0 in other periods. We would like to estimate the probability p_{it} that y_{it} equals 1, conditional on the recent behavior of money or credit variables. As is well known, there are many disadvantages to using a linear regression

to estimate such a relationship. For this reason we estimate a logit model using STATA[7], where:

$$(1) \quad \log\left(\frac{p_{it}}{1-p_{it}}\right) = \alpha + \sum_{j=1}^{L}\beta_j \Delta M_{i,t-j}; \qquad \begin{matrix} i = 1,\ldots,N \\ t = 1,\ldots,T \end{matrix}$$

where the log of the odds ratio is on the left hand side, α is a constant and ΔM is the *one-period* percentage growth of a particular money or credit variable. In equation (1), L is the number of lags (set to 12), T is the number of time periods, and N is the number of economies ($N = 6$). In this section, the data are seasonally adjusted using the X-11 filter of RATS (the data reported elsewhere are not seasonally adjusted, except as noted). The estimation period is 1972:01–1996:06, a year before the most recent currency crises broke out in East Asia.

One limitation of the present analysis that is worth bearing in mind is that it focuses only on money or credit variables. This implies that certain effects that may be important, such as trade or competitiveness, are not explicitly taken into account.[8]

The results, reported in Table 6, reveal that the growth in money or credit variables is not very strongly related to episodes of sharp depreciation. The variables explain a rather low proportion of the behavior of the dependent variable (see the pseudo-R^2). As likelihood ratio and Wald tests convey a somewhat different impression of the predictive ability of these variables in finite samples, both test statistics are reported. (Asymptotically, the two tests should give the same results.) As can be seen, both the likelihood ratio and Wald tests indicate that M2, the money multiplier and domestic credit did not predict episodes of sharp depreciation prior to the most recent episode. Based on the Wald test, M2/Foreign Reserves and Foreign Reserves did predict episodes of sharp depreciation at the 1 percent level.

Reserve money growth is also a significant predictor of sharp depreciation episodes, however the coefficient sum is negative, so the probability of a sharp depreciation rises when reserve money *falls* (this also is the case for M2 and domestic credit, but the null hypothesis that the block of coefficients for these variables is zero cannot be rejected). Thus, if there is a boom in money and credit growth prior to sharp depreciation episodes, it is not reflected in these results. While this is in line with the results of Table 3, it contrasts with the results of some of the literature cited earlier, particularly Kaminsky, Lizondo, and Reinhart's (1997) finding that a boom in real domestic credit precedes episodes of sharp depreciation. We explore the role of domestic credit further using methods similar to theirs in a later section.[9]

We now use the model to assess the extent to which money or credit variables predicted the 1997 episodes using the (out-of-sample) predicted probabilities. For this purpose, Figures 1 to 4 illustrate the probabilities of a sharp depreciation episode from June 1996 to October 1997, predicted by the model based on the growth of reserves, the M2 multiplier, M2/Foreign Reserves, and Foreign Reserves, which were found to be significant in the logit regressions. The probabilities are shown by country. For reference purposes, the mean in-sample predicted probability is shown as a horizontal line. In most cases, the mean is in the neighborhood of 1.2 percent, with a standard deviation ranging from 1 to 2 percent. Under certain assumptions,[10] a monthly probability of a crisis of 1.2 percent implies a probability of a crisis occurring within the next 12 months of 14 percent. The maximum monthly probability in the sample ranges from a low of 14 percent for nominal domestic credit to a high of about 57 percent for foreign reserves.

Figure 1 reveals that when the growth of reserve money is the right-hand-side variable, the predicted probability is below the mean in most cases, with the striking exception of Korea, where the probability rises sharply early in 1997, and then again after June 1997. (Notice that to facilitate viewing the other graphs, the scale for the Korean graph is much higher than for the other economies.) The implied probability of a currency crisis in Korea over a 12-month

7. The model also was estimated using country-specific fixed effects, but as a Wald test suggests that the fixed effects were not significant, these were dropped. It may be noted that when N is large and T is small, fixed effects models give inconsistent estimates of the parameters (Chamberlain 1980 and Maddala 1993). However, in the present case, T is relatively large. In any case, estimation using conditional logit (which eliminates the possible inconsistency in the estimates) gives qualitatively similar results.

8. Glick and Moreno (1998) estimate probit models that also consider the effects of external competitiveness or trade in a sample that includes selected Asian and Latin American economies.

9. The results also differ from those of Sachs, Tornell, and Velasco (1996), who find that in a cross-section sample spanning 1990–1994, rapid growth in the banking sector's claims on the private sector, scaled by GDP, precedes episodes of pressure in the foreign exchange market. However, these results are difficult to compare with ours as they reflect cross-section effects over a much shorter time period.

10. If each month is an independent "trial" in which a crisis event may or may not occur, $p(M)$ denotes the monthly probability of a crisis, and $p(A)$ denotes the probability that a crisis will occur once in a 12-month period, then $p(A)$ can be calculated as follows:

$$p(A) = (1 - (1 - p(M))^{12})*100.$$

We use these figures for illustrative purposes only, as our use of lags on the right-hand-side implies that events in a given month may be correlated to events in a preceding month.

FIGURE 1

PROBABILITY OF SHARP DEPRECIATION PREDICTED BY GROWTH IN NOMINAL AND REAL RESERVES

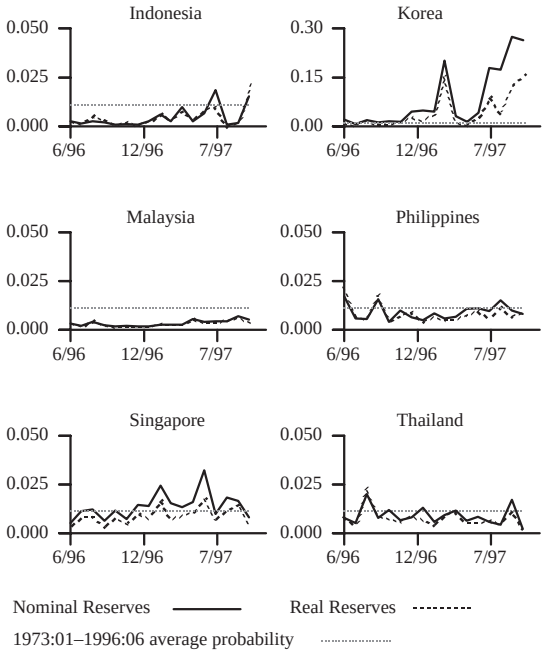


FIGURE 2

PROBABILITY OF SHARP DEPRECIATION PREDICTED BY GROWTH IN THE MONEY MULTIPLIER

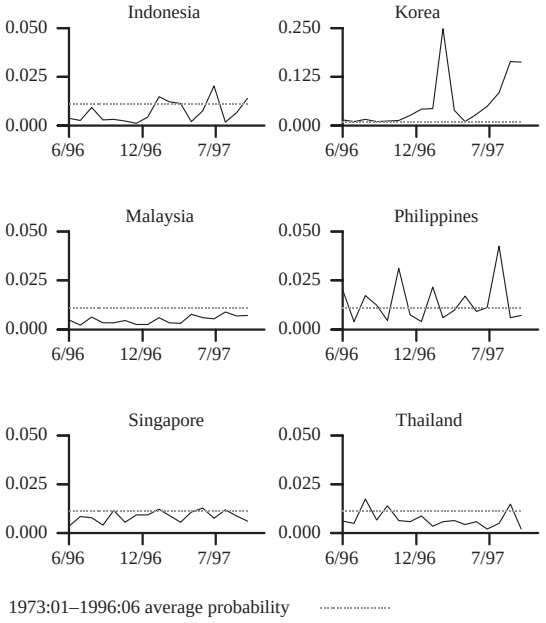


FIGURE 3

PROBABILITY OF SHARP DEPRECIATION PREDICTED BY GROWTH IN M2/FOREIGN RESERVES

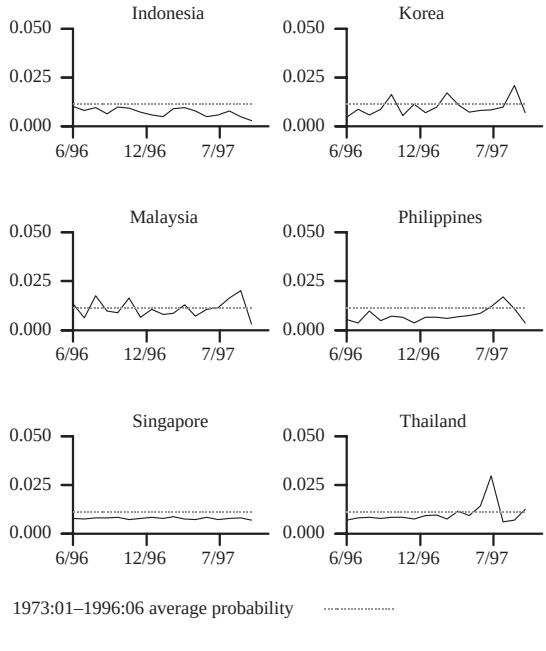
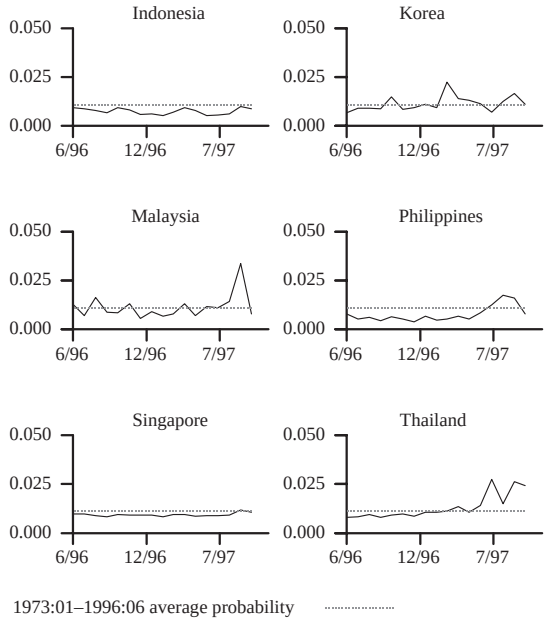


FIGURE 4

PROBABILITY OF SHARP DEPRECIATION PREDICTED BY GROWTH IN FOREIGN RESERVES



period is nearly 100 percent. It is worth recalling that these rising probabilities indicate *contractions* in reserve money growth. However, although the Wald test suggests that contractions in reserve money predict episodes of sharp depreciation in the region as a whole, this variable failed to signal a currency crisis in most East Asian economies in 1997. As suggested by Table 3, and confirmed below, this is because reserve money growth was actually quite rapid in a number of East Asian economies.

The predicted probabilities for the growth in the M2 multiplier are illustrated in Figure 2. These probabilities tend to be below the sample average, with the exceptions of Korea, where it peaks at close to 25 percent (implied probability of 98 percent over a 12-month period), and to a lesser extent the Philippines, where it peaks at around 5 percent (implied probability of 46 percent).

Figure 3 illustrates predicted probabilities for the growth in M2 over foreign reserves, and Figure 4 shows the corresponding probabilities for the growth in foreign reserves. These results are of particular interest because the Wald tests suggest that they are the best predictors of episodes of sharp currency depreciation within the sample (see Table 6). In Thailand and the Philippines, there is a distinct rise in the predicted probabilities associated with these variables before the onset of the depreciation episodes in July 1997. However, there is no similar pattern elsewhere. In Malaysia, Indonesia, Korea, and Singapore, the probabilities turn up after July 1997, although in the last three the probabilities stay close to the mean in-sample probabilities.

The 1997 episodes of currency depreciation thus differ from previous episodes, as indicators of external vulnerability did not consistently signal a crisis in East Asian countries. In part this was because some of the foreign reserve depletion in 1997 involved obligations in the forward market that occurred off the central bank balance sheet; but it perhaps also reflected the fact that the crisis unfolded very suddenly in a number of economies. This result is also of interest because it suggests that the contraction in reserve money observed in Korea was not fully explained by recorded contractions in foreign exchange reserves. Instead, the sluggishness in reserve money appears to reflect domestic conditions.

TABLE 6

LOGIT REGRESSIONS (1972:01–1996:06)

VARIABLE (LAGS 1 TO 12)	LOG LIKELIHOOD (PSEUDO-R^2)	LIKELIHOOD-RATIO/WALD TESTS ON COEFFICIENTS (p-VALUE)	SUM OF COEFFICIENTS (z STAT/p-VALUE)
Reserve Money (Nominal)	–93.2 (0.10)	20.8/24.0 (0.05/0.02)	–87.2 (–3.3/0.0)
Reserve Money (Real)	–93.8 (0.09)	19.5/24.5 (0.08/0.02)	–64.8 (–3.0/0.0)
M2 (Nominal)	–96.2 (0.07)	14.8/16.6 (0.25/0.17)	–57.2 (–1.4/0.17)
M2 (Real)	–95.5 (0.08)	16.1/18.1 (0.18/0.11)	–37.8 (–1.0/0.3)
DC (Nominal)	–100.9 (0.02)	5.1/6.4 (0.95/0.90)	–15.0 (–0.8/0.4)
DC (Real)	–100.4 (0.03)	6.1/7.7 (0.91/0.81)	–16.4 (–0.9/0.36)
Money Multiplier	–95.2 (0.08)	16.8/21.4 (0.16/0.04)	72.9 (3.0/0.00)
M2/Foreign Reserves	–93.2 (0.10)	20.7/26.9 (0.05/0.01)	20.4 (3.2/0.0)
Foreign Reserves	–93.1 (0.10)	21.0/27.5 (0.05/0.01)	–20.7 (–3.2/0.0)

III. "SIGNALS" METHOD

The preceding discussion has focused on the average growth of variables prior to episodes of depreciation and then on the predictive ability of money or credit variables based on models of discrete choice. In this section we take a slightly different approach. We identify episodes of sudden depreciation as before, with a 3-month exclusion window after each episode to avoid counting continuations of the same episode. We then assess whether money or credit behavior is "unusual" in the 24 months leading up to a sudden depreciation episode, in the sense that the value of the variable exceeds a certain threshold specific to that variable. The threshold for most variables is a certain percentile, between 80 and 99, selected to minimize the noise-to-signal ratio of that particular variable. However, in the case of reserve money and foreign exchange reserves, the threshold is a percentile within the lowest quintile, selected using the same noise-to-signal minimization criterion. In the case of reserve money, the results reported earlier (Table 3, and the odds-ratios) suggest that values from the *lower* (rather than the upper) quintile of reserve money growth may provide a better signal of impending sharp depreciation. As for foreign reserves, theory suggests that a currency crisis should be preceded by a depletion in foreign reserves.

This method defines unusual behavior more stringently than does a simple average, and it differs from our previous discussion by also focusing on how *frequently* within a certain period money or credit variables exhibited unusual behavior, and also by explicitly taking into account the number of false signals.

The use of a 24-month period prior to an episode to collect signals and a 3-month exclusion window after an episode implies that the same observation of a variable is sometimes used more than once to signal two different episodes of depreciation. This can be avoided by using the same window before and after an episode. To assess the robustness of the results, we also report (in parentheses) estimates based on a 12-month window on either side of an episode. The results are summarized in Table 7.

To assess the quality of alternative signals, and to shed additional light on our previous findings, we have included two transformations. On the top half of the table, the results for the variables in 12-month percentage changes (the same criterion used by Kaminsky, Lizondo, and Reinhart 1997) are shown. On the lower half, the performance of the residuals from a regression of the log levels on a constant, trend, and seasonal dummies are reported.[11]

One advantage of using the results from the two transformations together is that it may facilitate making fuller inferences about money or credit conditions. In particular, we can classify the results as follows:

Rapid growth and large deviations from trend in an aggregate occur prior to depreciation episodes. This case is one in which there unambiguously is a boom. The table reveals that it applies to M2/foreign reserves, where noise-to-signal ratios are below unity. (This supports the finding of the logit regressions, which suggested that the growth of the ratio of M2 to foreign reserves has some predictive ability in the sample.) Domestic credit also appears to fit in this category, but the noise-to-signal ratios are higher and do not give the impression that this indicator gives a particularly strong signal.[12]

Large deviations from trend, but no rapid growth (or slower than usual growth) occurs prior to episodes of depreciation. Taken together, these results are consistent with a scenario in which there has been a money or credit boom in the past, so that the aggregate is above its trend level, but the boom peaked within 24 or 12 months of the episodes, so growth is not unusually rapid or is even slow. This applies to reserve money (particularly real reserve money), where (positive) deviations from trend provide the best signals of an impending sharp depreciation of any of the variables reported here. For example, using a 24-month horizon, deviations from trend in real reserve money have a noise-to-signal ratio of 0.39. While they signal a depreciation episode only about 15 percent of the time, the proportion of bad signals is much lower, at 6 percent. The conditional probability of a crisis given a signal, at 52 percent, is 22 percentage points higher than the corresponding unconditional probability. At the same time, the noise-to-signal ratio for (slow or negative) growth in reserve money is 0.57.[13]

Unusual (rapid or sluggish) growth in an aggregate, but no large deviations from trend occur prior to depreciation episodes. This tends to be the case for the money multiplier and foreign reserves. It indicates that while no sustained boom may have occurred in the period leading up to episodes (or in the case of foreign reserves, the log level has not fallen far below its trend), sharp changes in growth within the forecast horizon (an increase in the case of the multiplier, a decline in the case of foreign reserves) may signal a crisis.[14]

No unusual growth or large deviations from trend occur prior to sharp depreciation episodes. We may tentatively place nominal and real M2 in this category, as noise-to-signal ratios tend to exceed unity (with the exception of growth rates with a 24-month horizon).

Signaling the 1997 Crisis

We now assess the extent to which the money or credit variables may have signaled a sharp depreciation of the currency in each of the East Asian countries in 1997. To facilitate comparison, we extend the sample to 97:10, to include the latest episodes of currency depreciation and re-estimate the signals. For example, a reduction in noise-to-signal ratios suggests that the variable predicted the 1997 crisis according to the criteria used in this section. The changes associated with the inclusion of the 1997 episode are reported in Table 8.

Inspection of Table 8 reveals that the most recent episode was generally not associated with large changes in the predictive ability of money or credit variables. In most cases, changes in noise-to-signal ratios were mixed (rising or falling depending on the horizon or transformation used),

11. The qualitative results using unadjusted data without seasonal dummies are similar.

12. Kaminsky, Lizondo, and Reinhart estimate noise-to-signal ratios for growth in the ratio of M2 to foreign reserves and growth in domestic credit/GDP (our closest comparable measure is real domestic credit) of 0.48 and 0.62 respectively. This compares to our estimates of 0.56 (0.46) and 0.77 (0.83). They do not report estimates for deviations from trend. Some experimentation reveals that the noise-to-signal ratio is much lower for deviations from trend in real domestic credit if we adopt a weaker criterion in defining an episode.

13. In sharp contrast, the noise-to-signal ratio for unusually rapid growth in reserve money (drawn from the upper rather than the lower quintile) tends to exceed unity.

14. The table reveals that the noise-to-signal ratio for growth in the money multiplier is 0.74 (0.55 at a 12-month horizon) and for sluggish growth in foreign reserves is 0.76 (0.52). This compares to 0.61 and 0.55 respectively, reported by Kaminsky, Lizondo, and Reinhart (1997).

TABLE 7

"SIGNALS" FROM MONEY OR CREDIT VARIABLES TO MID-1996[a]

VARIABLE	NOISE/ SIGNAL	% GOOD SIGNALS	% BAD SIGNALS	P(CRISIS/SIGNAL)	P(CRISIS/SIGNAL) – P(CRISIS)
			PERCENTAGE CHANGES		
Reserve Money[b] (Nominal)	0.89	12.4	11.1	31.9	2.5
	(0.44)	(18.6)	(8.2)	(22.9)	(11.3)
Reserve Money[b] (Real)	0.57	14.0	8.0	42.2	12.8
	(0.46)	(29.9)	(13.6)	(22.3)	(10.7)
M2(*) (Nominal)	0.60	14.3	8.6	41.0	11.6
	(1.54)	(13.7)	(21.1)	(7.8)	(–3.7)
M2 (Real)(*)	0.70	12.2	8.6	37.2	7.81
	(1.16)	(15.2)	(17.7)	(10.1)	(–1.5)
Domestic Credit (Nominal)	0.61	27.9	17.0	40.6	11.2
	(0.79)	(23.0)	(18.2)	(14.2)	(2.6)
Domestic Credit (Real)	0.77	14.0	10.8	35.1	5.7
	(0.83)	(11.3)	(9.4)	(13.6)	(2.0)
Money Multiplier	0.74	21.0	15.5	36.1	6.7
	(0.55)	(21.1)	(11.5)	(19.3)	(7.7)
M2/Foreign Reserves	0.56	18.2	10.2	42.6	13.2
	(0.46)	(21.1)	(9.7)	(22.1)	(10.5)
Foreign Reserves[b]	0.76	23.7	18.1	35.3	5.9
	(0.52)	(17.2)	(8.8)	(20.2)	(8.7)
			LEVELS (RESIDUALS FROM TREND)		
Reserve Money (Nominal)	0.28	19.1	5.3	59.9	30.5
	(0.61)	(21.1)	(12.9)	(17.6)	(6.0)
Reserve Money (Real)	0.39	15.5	6.0	51.6	22.2
	(0.71)	(10.8)	(7.7)	(15.5)	(3.9)
M2(*)	0.92	21.2	19.4	31.3	1.87
	(1.25)	(16.2)	(20.3)	(9.5)	(–2.1)
M2*(*) (Real)	1.04	13.4	13.8	28.7	–0.7
	(1.60)	(9.8)	(15.7)	(7.6)	(–4.0)
Domestic Credit (Nominal)	0.62	12.8	8.0	40.1	10.7
	(0.56)	(17.2)	(9.6)	(18.9)	(7.4)
Domestic Credit (Real)	0.75	12.2	9.2	35.8	6.4
	(0.81)	(22.1)	(17.8)	(13.9)	(2.4)
Money Multiplier*	1.24	11.7	14.5	25.1	–4.3
	(0.65)	(17.2)	(11.1)	(16.8)	(5.3)
M2/Foreign Reserves	0.45	16.8	7.6	48.1	18.7
	(0.48)	(23.5)	(11.2)	(21.5)	(10.0)
Foreign Reserves*(*)[b]	1.28	17.4	22.3	24.5	–4.9
	(1.00)	(21.1)	(21.0)	(11.6)	(0.0)

NOTE: Figures in parentheses summarize the quality of signals using a 12-month forecasting horizon.

[a] Values exceeding threshold in upper quintile, unless otherwise noted.

[b] Signals from lower quintile of the series.

* Variable provides no information using 24-month horizon.

(*) Variable provides no information using 12-month horizon.

TABLE 8

CHANGES IN SIGNALING PERFORMANCE WHEN 1997 EPISODES ARE INCLUDED

VARIABLE	NOISE/ SIGNAL	% GOOD SIGNALS	% BAD SIGNALS	P(CRISIS/SIGNAL)	P(CRISIS/SIGNAL) – P(CRISIS)
			PERCENTAGE CHANGES		
Reserve Money[a] (Nominal)	–0.08	–0.3	–1.2	4.8	2.2
	(–0.02)	(0.6)	(–0.1)	(6.2)	(3.0)
Reserve Money[a] (Real)	0.02	–0.5	0.0	2.3	–0.3
	(0.01)	(–6.4)	(–2.6)	(4.8)	(1.5)
M2(*) (Nominal)	0.08	–1.8	–0.1	0.0	–2.6
	(0.26)	(–2.1)	(–0.3)	(1.0)	(–2.3)
M2 (Real)(*)	0.06	–0.7	0.2	0.9	–1.7
	(–0.14)	(–0.7)	(–2.9)	(4.5)	(1.2)
Domestic Credit (Nominal)	0.04	–1.4	0.1	1.5	–1.1
	(0.09)	(–1.3)	(0.9)	(2.3)	(–0.9)
Domestic Credit (Real)	–0.01	1.5	1.1	3.0	0.4
	(–0.06)	(4.7)	(3.0)	(4.8)	(1.5)
Money Multiplier	0.0	0.1	0.2	2.8	0.2
	(0.02)	(–0.8)	(0.0)	(4.2)	(0.9)
M2/Foreign Reserves	0.07	–2.0	0.0	0.1	–2.5
	(0.13)	(–6.2)	(–0.9)	(0.6)	(–2.7)
Foreign Reserves[a]	0.07	–1.0	0.8	0.8	–1.8
	(0.18)	(–3.8)	(0.6)	(–0.3)	(–3.6)
			LEVELS (RESIDUALS FROM TREND)		
Reserve Money (Nominal)	0.01	1.4	0.6	2.2	–0.4
	(–0.12)	(–1.9)	(–3.6)	(8.8)	(5.5)
Reserve Money (Real)	–0.03	3.2	0.7	5.0	2.4
	(0.28)	(8.4)	(0.5)	(13.5)	(10.2)
M2(*)	0.03	–0.7	0.0	1.9	–0.7
	(–0.01)	(0.1)	(–0.1)	(2.9)	(–0.4)
M2*(*) (Real)	–0.10	1.8	0.4	4.6	2.0
	(–0.60)	(2.2)	(–3.7)	(7.2)	(4.0)
Domestic Credit (Nominal)	0.00	0.4	0.2	3.0	0.4
	(0.01)	(–1.6)	(–0.8)	(4.6)	(1.3)
Domestic Credit (Real)	–0.01	0.8	0.5	3.1	0.4
	(–0.01)	(–2.9)	(–2.5)	(4.0)	(0.8)
Money Multiplier*	–0.02	0.3	0.1	2.8	0.2
	(0.02)	(–0.5)	(0.1)	(3.8)	(0.5)
M2/Foreign Reserves	0.06	–2.2	–0.1	0.0	–2.6
	(0.16)	(–6.1)	(–0.2)	(0.0)	(–3.3)
Foreign Reserves*(*)[a]	0.17	–2.3	–0.2	–0.1	–2.7
	(0.33)	(–5.5)	(–0.3)	(–0.0)	(–3.3)

NOTE: Figures in parentheses summarize the quality of signals using a 12-month forecasting horizon.

[a] Signals from lower quintile of the series.

* Variable provides no information using 24-month horizon.

(*) Variable provides no information using 12-month horizon.

TABLE 9

PERCENTAGE OF "GOOD" SIGNALS IN 24 MONTHS (12 MONTHS) PRIOR TO 1997 DEPRECIATIONS

VARIABLE	MALAYSIA	INDONESIA	KOREA	SINGAPORE	THAILAND	PHILIPPINES
			PERCENTAGE CHANGES			
Reserve Money[a] (Nominal)	0.0 (0.0)	0.0 (0.0)	50.0 (91.7)	29.2 (33.3)	0.0 (0.0)	4.2 (0.0)
Reserve Money[a] (Real)	0.0 (0.0)	0.0 (0.0)	50.0 (91.7)	25.0 (41.7)	0.0 (0.0)	0.0 (0.0)
M2(*) (Nominal)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	16.7 (0.0)
M2(*) (Real)	20.8 (41.7)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	33.3 (66.7)
Domestic Credit (Nominal)	37.5 (58.3)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	16.7 (0.0)	66.7 (50.0)
Domestic Credit (Real)	37.5 (58.3)	0.0 (0.0)	8.3 (16.7)	0.0 (0.0)	8.3 (0.0)	37.5 (58.3)
Money Multiplier	0.0 (0.0)	8.3 (0.0)	62.5 (91.7)	4.2 (8.3)	0.0 (0.0)	29.2 (8.3)
M2/Foreign Reserves	41.7 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	8.3 (16.7)	0.0 (0.0)
Foreign Reserves[a]	37.5 (0.0)	0.0 (0.0)	16.7 (0.0)	20.8 (0.0)	20.8 (16.7)	0.0 (0.0)
			LEVELS (RESIDUALS FROM TREND)			
Reserve Money (Nominal)	83.3 (100.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	83.3 (100.0)	0.0 (0.0)
Reserve Money (Real)	91.7 (100.0)	58.3 (91.7)	0.0 (0.0)	0.0 (0.0)	41.7 (66.7)	0.0 (0.0)
M2(*)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	87.5 (100.0)
M2*(*) (Real)	37.5 (75.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	75.0 (100.0)
Domestic Credit (Nominal)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	66.7 (100.0)
Domestic Credit (Real)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	37.5 (33.3)	70.8 (100.0)
Money Multiplier*	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	66.7 (91.7)
M2/Foreign Reserves	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Foreign Reserves*(*)[a]	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
YEAR AND MONTH OF EPISODE	1997:07	1997:08	1997:10	1997:08	1997:07	1997:07

NOTE: Figures in parentheses summarize the quality of signals using a 12-month forecasting horizon.

[a] Signals from lower quintile of the series.

* Variable provides no information using 24-month horizon.

(*) Variable provides no information using 12-month horizon.

or were relatively small, so that even when they fell, noise-to-signal ratios remained close to unity or higher. However, there is a distinct fall in the noise-to-signal ratio of deviations from trend in reserve money (particularly real) at a 12-month horizon. The noise-to-signal ratio increased in a number of cases, notably for the growth in M2, M2/Foreign Reserves, and Foreign Reserves. Thus, these variables had little success in predicting the 1997 episodes of currency depreciation in East Asia. This supports our earlier results suggesting that the 1997 episodes differed from the past experience of the region.

To gain further perspective on the 1997 episodes, we compute the percentage of good signals in the 24 months and the 12 months prior to the sharp depreciations in 1997. The data are therefore roughly comparable to the second column of Table 7, except that they now refer to one episode per country. The results are reported in Table 9.

We focus first on real reserve money and M2/foreign reserves, which have relatively low noise-to-signal ratios. First, it is apparent that positive deviations in trend in reserve money signaled depreciation in Malaysia, Indonesia, and Thailand. In line with this, reserve money growth was also unusually rapid in these economies prior to the 1997 episodes of sharp depreciation. Reserve money growth was sluggish or negative only in Korea, and to a lesser extent in Singapore. Rapid growth in reserve money thus distinguishes the 1997 episodes from previous episodes of sharp depreciation in Asia, which may indicate that policymakers were attempting to offset contractionary influences more vigorously before the 1997 crisis. As for M2/foreign reserves, this variable generally also failed to predict the 1997 episodes of depreciation.

Among the remaining variables, predictive performance was similarly uneven. A boom in M2 (nominal and real) and in domestic credit signaled impending depreciation in the Philippines and to a lesser extent in Malaysia, but was not apparent in the other economies. Rapid growth in the money multiplier strongly signaled impending depreciation in Korea, and to a lesser extent in the Philippines.

IV. CONCLUSION

This paper has used a variety of methods to assess the empirical relationship between money and credit and episodes of sharp depreciation in East Asia. We find that the answer to the question posed in the title depends on the measure used. There is some evidence of unusually high reserve money prior to the 1997 currency crisis in East Asia. However, signs of a money or credit boom based on other indicators were unevenly spread throughout the region.

These results are of interest because they contrast with those of a number of studies based on larger samples that have identified an empirical relationship between rapid money or domestic credit growth and currency crises in emerging markets.

Indeed, the analysis suggests that money or credit booms have not generally preceded episodes of currency depreciation in the region. Logit regressions estimated over a 1972–1996 sample that excludes the 1997 crisis period suggest that rapid nominal or real growth in broad money or domestic credit do not help predict episodes of sharp depreciation in East Asia.

The 1997 crisis differs from East Asia's own past experience in a number of ways. Our empirical analysis indicates that rapid growth in the M2 multiplier and in the ratio of M2 to foreign reserves, positive deviations of reserve money from trend, and *declines* in reserve money and in foreign reserves, helped predict episodes of sharp depreciation in episodes up to mid-1996. While some of the indicators signaled the possibility of sharp depreciation episodes in 1997 in some of the countries, they did not do so in a consistent manner.

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APPENDIX: DESCRIPTION OF "SIGNALING" METHODOLOGY

Signal. An indicator is said to issue a signal whenever it departs from its mean beyond a given threshold level.

Signaling horizon. 24 months or 12 months.

Good signal. A signal followed by a crisis within the signaling horizon.

Bad signal, or *noise.* A signal not followed by a crisis within signaling horizon.

Threshold levels. Defined by searching over the upper or lower quintile of the distribution of observations of the indicator. The "optimal" set of thresholds is given by the percentiles that minimize the noise-to-signal ratio or the ratio of bad signals to good signals.

	CRISIS (WITHIN SIGNAL HORIZON)	NO CRISIS (WITHIN SIGNAL HORIZON)
SIGNAL WAS ISSUED	A	B
NO SIGNAL WAS ISSUED	C	D

A — Number of months in which indicator issued good signal

B — Number of months in which the indicator issued a bad signal or noise

C — Number of months in which the indicator issued no signal but a crisis occurred

D — Number of months in which indicator issued no signal and a crisis did not occur

A perfect indicator is one in which $A > 0$, $B = 0$, $C = 0$, $D > 0$.

Percentage of crises correctly called. Number of crises for which the indicator issued at least one signal in the previous 24 months (expressed as a percentage of the total number of crises for which data on the indicator are available).

Good signals. Number of good signals divided by total number of months prior to crises episodes or $A/(A + C)$, 100% requires that good signals be issued every month during the 24 months prior to the crisis.

Bad signals. Number of bad signals divided by total number of months leading to non-crisis episodes, $B/(B + D)$.

"Adjusted" noise-to-signal ratio. Divide bad signals by good signals, [B/(B + D)]/[A/(A + C)] In sufficiently large samples, a series with no intrinsic predictive power would yield an adjusted noise-to-signal ratio equal to unity.

Unconditional probability of a crisis. (The number of crises signaled + the number of crises not signaled)/Total number of observations in the data or (A + C)/(A + B + C + D). Note that this probability rises as the pre-crisis horizon widens relative to the post-crisis window. If the pre-crisis horizon is sufficiently wide, it will be 100%.

Crisis conditional on a signal from the indicator. The number of times crises were signaled correctly divided by the total number of times crises were signaled. A/(A+B). Note that this probability may be high if the pre-crisis horizon is sufficiently wider than the post-crisis window.