Reserve Adequacy in Asia Revisited:
New Benchmarks Based on the Size and Composition of Capital Flows

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Abstract

There has been considerable debate about the rationale behind the reserve hoarding by Asia, with wide ranging explanations having been offered for this behavior. In view of the ferocity and suddenness of the Asian crisis of 1997-98, the precautionary motive no doubt looms large in the decision to build up reserves to unprecedently high levels. This paper deals more narrowly with the issues of additive coverage ratios that some of the central banks are using and presents new benchmarks for judging reserve adequacy based on the behavior of different types of capital flows during currency crises. Alternative measures of the "size" of recent crises and their implications for levels of reserve adequacy for a number of Asian countries today are also considered.

Key words: *capital flows, currency crises, external debt, imports, liquidity, reserves*

JEL Classification: *F31, F33, F41*

1. Introduction and Overview

Among the key imbalances and tensions that plague the global macroeconomy are the burgeoning US current account deficit and the rapid stockpiling of international reserves by Asia. The Asian reserves (which stood at well over US$ 2,000 billion as of early 2004) have in turn been partly financing the US current account gap (hovering at close to 6 percent of GDP). While Japan and China together account for about half of Asia's reserve holdings, South Korea, Taiwan, Hong Kong, India and Singapore each also hold over US$ 100 billion of reserves (Figure 1).

There has been considerable debate about the rationale behind the reserve hoarding by Asia, with wide ranging explanations having been offered for this behavior[1]. Some have argued that the reserve growth in Asia is a by-product of a desire by regional central banks to smooth exchange rate movements. While concerns about "excessive" volatility of trade and foreign direct investment (FDI) may be well founded (see Calvo and Reinhart, 2002, Rajan, 2002 and references cited within), smoothing behavior by central banks should, over time, have no net impact on reserves. The fact that reserves are being continuously built up suggests that foreign exchange intervention is largely

[1] Of course, part of the rise in reserves in recent years is directly attributable to the depreciation of the US dollar, leading to valuation gains of that part of reserves denominated in euros, yen, etc. We do not explore the important issue of appropriate currency composition of reserves here (see Eichengreen and Mathieson, 2000).

asymmetric, i.e. sale of domestic currency during periods of upward pressure, but limited intervention on the downside[2]. A more plausible argument behind Asia's reserve accumulation is that it stems from a deep-rooted mercantilist desire by regional central banks to maintain undervalued exchange rates and bolster domestic employment[3]. Despite the generalized weakness of the US dollar, Figure 2 reveals that the real effective exchange rates (REERs) of a number of Asian countries have largely remained stable or, in some cases, slightly depreciated since 2000[4].

In contrast to these exchange rate motives, others argue that reserves are being accumulated by Asia as a buffer against future financial crises or shocks (for instance,

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[2] A more sophisticated line of reasoning is that high reserves help to reduce exchange rate volatility via a signaling effect (i.e. signal of creditworthiness). There is some evidence of the validity of this thesis (Hviding *et al.*, 2004). We return to this theme in the concluding section.

[3] Mercantilism may also have an important political dimension. As the former Chairman of the President Bush's National Economic Council, Lawrence Lindsay, recently noted about China:
The objective of mercantilism is fundamentally not economic in nature as we understand that term. It is political. It is designed to enhance the power of the state…The Chinese state not only has the same vested interest in mercantilism as Louis XIV, it also has the same interest as exporters generally as elements of the state, particularly the army, own some of the leading exporting firms…So, the maintenance of a fixed exchange rate also symbolizes an inherent political fact about China: economic policies are made in the interests of the state and the elements that make it up, not in the interests of the economy or the population more generally. We should view this as a fundamental weakness -- or immaturity -- in Chinese political and economic development (Lindsay, 2003, pp.9-11).

[4] This further suggests that other regions like Europe and Latin America have undergone significant real appreciations.

see Aizenman and Marion, 2004). While it is generally appreciated that stockpiling reserves cannot act as a substitute for appropriate domestic policy reforms, this insurance or precautionary motive is consistent with modern second generation (escape clause-based) currency crises models *a la* Obstfeld (1994, 1996). These models emphasize the possibility of multiple equilibria in a world of substantial capital mobility where a country's underlying payments position is neither "quite strong" nor "hopelessly weak", i.e. where it is in a vulnerable zone. In such circumstances a country's level of reserves may not only influence its ability to finance speculative runs on its currency but can also has a bearing on their probability of occurring[5]. Such large levels of "own liquidity" may be particularly necessary in the absence of the development of strong quasi lender of last resort capabilities by the IMF and limited progress in monetary cooperation at the regional level[6].

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[5] Sachs, Tornell, and Velasco (1996) assume and purport to find empirical support for the proposition that high reserves ratios can fully offset weak fundamentals. However, Willett *et al.* (2004b) question the robustness of the Sachs-Tornell-Velasco conclusion that high reserves can offset weak fundamentals and point out that it is at odds with the standard crisis models. With fundamentals in the vulnerable zone, high reserves could have a powerful effect in protecting against crises. But with weak fundamentals, first generation crisis models imply that reserve levels should only influence the timing of crises, not whether they occur. This also suggests that reserve needs should be related to the state of fundamentals in a non-linear manner.

[6] While the ASEAN plus Three (China, Japan and Korea) economies have established the Chiang-Mai initiative (CMI), it remains a series of bilateral and uncoordinated swap arrangements. While there has been some discussion about regionalizing the CMI (Montiel,

Broadly, we can think of the insurance precautionary demand for reserves as arising from three types of considerations: (a) the ability to finance underlying payments imbalances; (b) the ability to provide liquidity in the face of runs on the currency; and (c) the preventive function of reducing the probability of runs on the currency[7]. All of these considerations will in turn be influenced by external and internal shocks, the degree of exchange rate flexibility, the ability and willingness of governments to make domestic policy adjustments, and the magnitudes of currency pressure that can be quickly brought to bear. Of course, while there is always the possibility of domestic currency holders running for the exits ("internal drain"), a country's exposure to currency runs is also heavily influenced by the extent of foreign capital in the country, particularly liquid capital such as portfolio investments and short term bank loans ("external drain").

What does this imply for central bankers keen on operational guidelines in reserve management? There is already a broad understanding that in a world of

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2004), no significant steps have been taken in that direction. There is also some discussion about -- but no action regarding -- the possibility of pooling part of the region's international reserves as a means of safeguarding against financial crisis (Bird and Rajan, 2002, Rajan, 2003, 2004 and Rajan and Siregar, 2004). On the IMF's currently very limited role as a quasi lender of last resort see the analysis and references in Willett (2004).

[7] For a useful recent treatment emphasizing the similarity of the insurance demand to a put option, see Lee (2004).

substantial capital mobility traditional measures of reserve adequacy in terms of month's worth of imports is of limited value. The capital account nature of crises has led some of the more sophisticated governments and central banks to develop rules of thumb for reserve adequacy based on different types of international liabilities[8].

In this paper we deal more narrowly with the issues of sensible values for such coverage ratios, and also the likely sufficiency of focusing only on additive coverage ratios. We focus particularly concepts of reserve adequacy in countries that may be subject to overly optimistic bubbles of capital flows, which subsequently burst. While extremely difficult to capture in formal optimizing crises models, many observers have suggested that such behavior has characterized a number of recent currency crises, including Asia in 1997-98 (for example, see Willett *et al.*, 2004b). We suspect that this is a major reason why foreign financial capital may be more prone to exit than domestic capital for countries where domestically generated capital flight has not been a major problem.

The remainder of this paper is organized as follows. Section 2 offers a brief overview of the inadequacies of current coverage ratios in light of the capital account nature of crises that have afflicted Asia and other emerging economies since the mid

[8] The Bank of Korea (BOK) and the Reserve Bank of India (RBI) are examples. For details on reserve management in India, Korea and other selected countries, see IMF (2001).

1990s. While crises due to bank panics are well known, portfolio investment is another form of highly mobile capital that needs to be taken into account. Section 3 discusses new benchmarks for judging reserve adequacy based on the behavior of different types of capital flows during currency crises. We also present analyses of the ratios of reversals for different types of capital flows during the Asian crisis to investigate whether there is a case for holding different levels of "reserve backing" against different types of capital flows. Alternative measures of the "size" of recent crises and their implications for levels of reserve adequacy for a number of Asian countries today are also considered. Section 4 offers a summary and a few concluding remarks on reserve and exchange rate policies in Asia.

2. Capital Account Crises and Limitations of Existing Reserve Adequacy Measures

For the post war period, the reserves-to-imports ratio became the standard way of quantifying reserve adequacy. In other words, imports were thought to be the most appropriate scale variable. The broad rule-of-thumb for reserve adequacy was that reserves should be sufficient to pay for about three to four months of imports[9]. The reserves-to-imports criterion was appropriate when international capital flows were

[9] The IMF has regularly presented data about reserve levels in this way in its *World Economic Outlook*

highly limited. However, as the emerging economies have liberalized short term capital movements during 1990s, most of the countries have become far more exposed to the risk of sudden stops or outright capital reversals. As the IMF (2001) has noted:

> As international capital flows increased relative to the size of national economies, so too did the disruption threatened by their reversal. The need to maintain investor confidence can serve as a useful discipline, magnifying the rewards for good policies and the penalties for bad ones. But in recent years flows have become much more volatile than changes in the economic prospects of individual countries could explain or reasonably justify. Economies have thus become increasingly vulnerable to crises of confidence, akin to runs on banks. Investors on occasion overreact to economic developments, responding late and excessively (p.2).

But what are the specific connections between the various forms of mobile capital and crises?

2.1 Bank Flows, Crises and Reserves-to-Short Term Debt Ratio

Conceptually, the crisis-inducing nature of bank loans is straight forward, being based on an open economy version of the bank panic model *a la* Diamond-Dybvig (1983)[10]. Following some negative shock, depositors, concerned about the safety of their savings, attempt to withdraw *en masse* (which occurs given the "first-come-first-served" rule of deposit withdrawals), while creditors become unwilling to rollover

[10] For recent formalizations, see Chang and Velasco (1998, 1999) and Goldfajn and Valdes (1997).

short-term loans. This sudden termination of bank finance forces the abandonment of potentially solvent investment projects, leading to a sudden and sharp economic collapse[11].

Empirically, the extent of short term indebtedness has been found to be a key indicator of (il)liquidity and a robust predictor of currency crises (for instance, see Bussière and Mulder, 1999, 2003, Dadush *et al.*, 2000, Rodrik and Velasco, 1999, Willett *et al.*, 2004b, and World Bank, 1999). In recognition of this, Pablo Guidotti, former Deputy Minister of Finance of Argentina and Alan Greenspan, Chairman of Fed proposed that countries hold reserves at least equivalent to short term debt cover (i.e. all debt that actually falls due over the year) (Bird and Rajan, 2003, Greenspan, 1999 and De Beaufort Wijnholds and Kapteyn, 2001). This implies, at a minimum, that usable international reserves should exceed scheduled external amortization for one year.[12] Table 1 makes apparent that even if one considers a benchmark of reserve adequacy based on the sum of the three months import and all short term external debt, most of

[11] A reasonable question some times asked is, if short term debt is potentially hazardous and must be "insured against" (by holding reserves), why not restrict this form of capital flows in the first instance? In a somewhat contrarian view, Jeanne (2000) argues that short-term debt contracts may play a socially advantageous function in reducing agency problems.

[12] Ideally we need to incorporate longer-term debt that comes due within the year. Unfortunately we do not have data on this.

the Asian economies held excess reserves (except the Philippines and Hong Kong)[13].

Bussière and Mulder (1999, 2003) find empirical support for the Greenspan-Guidotti rule and offer a simple rule-of-thumb based on the results of empirical tests: the reserve target should be set at the level of short term debt, and should be augmented by 5 percent for each one per cent of current account deficit and by 1 percent for each per cent of overvalued exchange rate. While this is a notable modification, even the modified debt based measure of reserve adequacy has some significant limitations.

First, while the reserves-to-short term external debt gives an indication of the vulnerability to an "external drain", it fails to take into account internal drain associated with capital flight by residents. The latter may be best captured by measures of broad money supply (M2). Specifically, the reserves-to-M2 ratio captures the extent to which liabilities of the banking system are backed by international reserves; a low and declining ratio is among the leading indicators of a currency crisis (for instance, see Berg and Pattillo, 1998 and Kaminsky and Reinhart, 1999).[14]

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[13] Furthermore as Lee (2004) argues, optimal balancing of expected costs and benefits implies that self insurance generally should be less than full.

[14] De Beaufort Wijinholds and Kapteyn (2001) proposed a new criterion of reserve adequacy for the emerging market economy which incorporates both short term external debt and a measure of the scope for capital flight (part of M2) modified by a "probability factor" captured by a country risk index.

Secondly, the reserves-to-short term external debt ratio does not account for other liabilities that may be highly mobile and easily reversible. For instance, while reversals of bank loans dominated the capital account dynamics during the Asian crisis (see for instance, Rajan and Siregar, 2002 and Willett *et al.*, 2004a), reversals in portfolio flows were important in Mexico and other countries.

2.2 Portfolio Flows, and Foreigners' Stock Holdings

One rule of thumb that has been suggested is to hold additional reserves equal to thirty percent of foreigner holdings in the stock market. Table 2a illustrates the implications of a coverage rule of three months imports plus all short-term debt plus thirty percent of foreign stock market holding would imply for prudent reserve levels for Korea. These calculations suggest that by 2001 Korea had rebuilt reserves to adequate levels despite the large increases in foreign investment in the Korean stock market[15].

Furthermore, the thirty percent rule of thumb for reserve against foreign stock market investment appears too conservative in light of the actual outflows in Korea's

[15] Aizeman *et al.* (2004) presents evidence of a structural break in Korea's demand for international reserves after the crisis. Trade openness losses its significance after the crisis, while short-term foreign debt becomes significant and foreign shareholdings become more significant.

portfolio investment during the crisis. Table 2b provides quarter-by-quarter data on the value of foreign holdings in the Korean stock market and recorded portfolio equity capital flows for 1996 through 1998. The dollar value of foreign stock market holdings declined drastically, from almost $18 billion in early 1996, to barely over $5 billion in the fourth quarter 1997. However, almost the entire decline was due to the fall in the stock market and the depreciation of the won. The capital flow data show only small outflows in the fourth quarter 1997 and second and third quarter 1998. The combined total of these three outflow quarters was less than $2 billion and was more than offset by the $2.6 billion inflow in the first quarter of 1998. The maximum net outflow after the crisis started that is captured in quarterly statistics is $1.4 billion or less than 10 percent of the pre-crisis value of foreign holdings. Thus, holding reserves against 30 percent of foreigner holdings in the stock market may be excessive.

From the stand point of financing crises outflows, the hundred percent reserve backing for short term foreign debt is likely to substantially overstate prudent levels of reserves. As we show in the following sections, during the Asian Crisis the total sizes of capital outflows from all categories were considerably less than the level of short-term debt alone[16].

[16] No doubt the internationally coordinated negotiations between Korea and the major international banks led to a greater roll over of loans than would otherwise have taken place.

In focusing on how much capital could potentially leave a country, there is a tendency to frame the analysis in ways that encourage implicit worst case analysis. More useful we believe is to look at the data on the magnitudes of capital outflows that have occurred. Of course there are substantial problems with the available data on capital flows, and there is no reason to expect that a future crisis will exactly duplicate a previous one. Still we think that by looking at a number of previous crises we can help officials begin to get a better handle on ballpark ranges for prudent but not excessive levels of reserve holdings. In the present paper we only focus on the set of Asian crisis countries to illustrate our suggested approach.

3. Capital Account Crises and New Benchmarks of Reserve Adequacy

3.1 Issues in Measuring Capital Account Crises

Vulnerability to capital account crises should not be judged by standard measures of the variance of different types of capital flows. Such measures confound the variability of rates of inflow with the size of capital flows reversals which is much more important from the perspective of financial crises. Some studies have used rather

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But the ratio of total outflows to short-term debt was also less than one for the other four Asian crisis countries in our sample as well.

sophisticated econometric methodologies to study the variability of different types of capital flows[17]. However, since the data sample was dominated by periods of capital inflows, the results had little predictive power with respect to the magnitude of different types of capital outflows during the Asian crises. For instance, the greater variability of portfolio investment during the inflow period was not matched by more severe capital flow reversals during the crisis period. Rather, the outflows from the banking sector in Asia in 1997-98 were far greater, both in absolute terms and as a percentage of previous inflows (see Willett *et al.*, 2004a).

It is also for the foregoing reason that simple coverage ratios (be they trade based, debt based or money based) are inadequate as they fail to reflect the dynamics of currency crises. In light of this, it has become common-place to suggest that, in addition to coverage ratios, reserve management in an uncertain environment needs to adopt the liquidity-at-risk (LAR) methodology, i.e. calculating the probabilities of different size losses of reserves over a wide range of possible outcomes for pertinent financial variables (De Beaufort Wijnholds and Kapteyn, 2001 and Greenspan, 1999)[18].

While consideration of a standard that is stochastic is a clear advancement, two

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[17] For instance, see Chuhan *et al.* (1996), Claessens *et al.* (1995), Gabriele *et al.* (2000) and Sarno and Taylor (1997).

[18] This is a variant of the VAR (value-at-risk) methodology. See also Garcia and Soto (2004) for an application of predicted crises probabilities on reserve adequacy measures.

caveats should be flagged. First, different types of shocks can give rise to different patterns among capital flows so that -- as the investment-brokers routinely warn -- past performance is not a guarantee of future returns[19]. Second, LAR type statistical exercises typically use data over much too short time periods to yield much confidence that they capture most of the range of possible developments. In recognition of this, it is often recommended that LAR methodologies be complemented by stress testing, that is, by imagining various types of shocks and simulating these effects. This is similar to efforts by military planners to calculate what it would take to be able to engage effectively in a specific set of actions.

We believe that developments during recent crises can offer useful information for these purposes. We illustrate how these experiences can be used for stress testing or scenario analysis to help countries determine what levels of reserves would be sufficient to protect themselves from crisis of the order of magnitude of recent ones.

3.2 New Benchmarks of Reserve Coverage Based on Capital Outflows During Previous Crises

In measuring the size of capital account crises and their implications for the size of prudent precautionary reserves, two simple benchmarks come to mind.

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[19] This was made apparent in the financial world with the Long Term Capital Management (LTCM) saga (see Edward, 1999 for details).

The first measure is the size of actual outflows during the crisis. This would be appropriate where the rest of the balance of payments had been in approximate balance so that previous capital flows had their counterpart primarily in changes in reserves.

The second measure is the change in the size of net flows from their previous levels (see Radelet and Sachs, 1998 and Rodrik and Velasco, 1999)[20]. This would be appropriate where, prior to the crisis, the other components of the balance of payments account, especially the current account, had adjusted fully to the net capital flows, yielding approximate overall payments balance. In a situation where previous capital inflows were large, a sizeable fall in inflows could cause a problem. For example if net inflows fall from 5 to 1 percent of GDP while the current account deficit remains at 5 percent of GDP, there would be a financing or adjustment problem of 4 percent of GDP. Thus, a capital account crisis does not necessarily require a sudden stop or outright reversal; there may be cases -- as above -- where a substantial slowdown in capital inflows could have serious deleterious effects.

Of course, the two simple measures just described represent the two extremes of zero and full adjustment to previous capital flows. Often the actual situation will be one of partial adjustment. As a rough gauge of the degree of adjustment we could

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[20] Because of year-to-year fluctuations, the average of several previous years is used as the benchmark).

compare the average change in reserves to the average net capital flows over the preceding few years. We also need to keep in mind that while the most dramatic of recent crises have usually been preceded by large net capital inflows, it need not always be the case. Crises have often been preceded by substantial periods of capital flight and reserve losses.

Some caveats are in order. Our calculations make no attempt to adjust for the additional levels of reserves that may have been needed to avoid "excessive" increases in interest rates and depreciations of currencies during the crises. The problem is that there is little agreement about either the degree to which movements were excessive or the relevant elasticities that would tell us how much intervention would have been needed to avoid these excessive movements. Despite the protestations of some economists (e.g. Furman and Stiglitz, 1998), we are not convinced that there was a great deal of excessive increase in interest rates during the Asian crises since we do not believe that destabilizing speculation was the major cause of the crises (see Willett *et al.*, 2004b). Likewise, we believe that even though some of the crisis country currencies were not obviously overvalued before the crises, substantial depreciations were required given the recognition of the previously hidden financial sector problems. That said, we also believe that there was substantial over shooting of many currencies. Thus, in our

judgment, countries should have engaged in greater amounts of sterilized intervention if they had had adequate reserves available.

On the other hand, our computations also take no account of the potential availability of borrowing from the IMF and other governments. Our calculations make the heroic assumptions that these two factors roughly offset each other[21]. Likewise, there is no reason to suppose that a future crisis will be just like a past crisis. Given the high degree of current uncertainty about appropriate reserve levels in our new world of substantial capital mobility, we believe that these calculations provide useful benchmark from which adjustments can be made. For example, it is quite possible that crises in other countries may be a better predictor for a particular country than its own previous crises. Thus national authorities should be interested in looking at the sizes of numerous crisis episodes and their ratios to M2, GDP, STD and various types of previous capital inflows. Issues of "scaling up" measures to account for growth in M2 and GDP and capital account variables will be discussed below.

3.3 Application of the New Benchmarks to Asia: Some Simple Illustrations

We note that there is no one good way to accurately measure changes in capital

[21] Readers who might have specific views on such issues may scale up or down our estimates accordingly.

flows[22]. Data for many types of capital flows are not highly reliable, and it is believed that a nontrivial portion of changes in capital flows show up in the errors and omissions category.

Tables 3 and 4 report data on various combination of capital outflows for the five Asian countries most directly and adversely impacted by the 1997-1998 crisis, viz. Indonesia, Korea, Malaysia, the Philippines and Thailand[23,24].

We would like to call attention to two particularly interesting aspects of the data. First, looking at changes in reserves alone over a crisis often does not give a good indication of the magnitudes of financial crises; indeed, it sometimes even fails to indicate a crisis. This is at least in part because published figures on gross reserves often have only a very loose relationship with net reserves. For example, in the prelude to the Thai crisis the central bank sold huge amounts of dollars forward to protect the spot

[22] Furthermore the IMF keeps updating its data so that numbers for a particular year can vary across subsequent publications. For example the FAC balance in Korea in 1997 is shown as US$1.9 billion in Balance of Payments Statistics of IMF (June 2002). If one uses an updated IFS database, the same observation becomes US$ 9.1 billions.

[23] From Tables 2 to 14, FDI denotes foreign direct investment; “other loans” refer to private bank and other sector loans; FAC denotes the balance of financial account and “errors” is the sum of net errors and omissions. All data are from the IMF-IFS cd-rom.

[24] The size of capital outflows differs substantially when we use the last six quarters of 1997-98 versus the annual observations from 1997-98. The main reason is that most of these countries were receiving huge capital inflows prior to the crises. Thus the size of outflows is understated when annual data is used.

market making its available reserve levels far less that stated reserves. Second, despite the emphasis often put on portfolio investment as a major source of instability, portfolio funds were not the largest category of outflows for any of these crisis countries. While in aggregate “Other Loans”, which is primarily bank loans, was the largest category of outflows, the pattern across categories varies from country to country.

We should also note that while the usual stability of FDI during a crisis is a commonly highlighted fact, the way in which data is collected overstates the stability of FDI. While brick and mortar do not flee a country, there are usually substantial amounts of financial working capital that accompany FDI, and these may show substantial movements during crisis periods. Much of such activity is not typically captured in the FDI statistics (for instance, see Rajan. 2004 and references cited within). Still we believe that it is reasonable to assume that FDI is usually the most stable broad category of international investment.

When we are considering the levels of reserves that should be held against various types of international liability, we should be interested not only in the absolute magnitudes of outflows but also their relationship to previous inflows. Table 5 provides the ratios of the outflows in Table 2 to their cumulative inflows over the preceding five years. This offers a rough measure of reversibility. Note that a positive number indicates

that there was no net outflow between 1997 and 1998.

In order to be prudent when considering the likely size of reserves needed to finance shifts in capital flows during a future crises, we wish to develop plausible upper bound estimates of the sizes of outflows during the recent crises. To aid in this exercise we report several different combinations of capital flows and their ratios to M2 (Table 6). Since the crises lasted into 1998 we use the 6-quarter flows for 1997 and 1998. The capital flows-to-M2 ratio is used as an initial yardstick to allow comparisons across countries in the severity of crises and to scale up the expected magnitudes of future crises. We concede that there is no unambiguously best scale variable for this purpose. So while M2 is frequently used, we will also check the sensitivity of our results to the use of GDP and levels of short-term foreign debt (STD) (Tables 7 and 8).

Based on the various combinations, the maximum sizes of outflows as a proportion to M2 are presented in Table 9. These range from a low of 5 percent for Malaysia to a high of about 20 percent for Thailand and Korea.

For reasons noted previously, such figures may understate the degree of dislocation generated by capital account crises if countries have adjusted to substantial capital inflows. Therefore, in Tables 10 and 11 we present data for the differences between flows during the crisis periods and their previous averages (over five years). In

a similar vein to Table 9, Table 12 gives the maximum measures of capital outflows and reversals for each country. In Table 13 we present the ratios of these outflows and reversals to three benchmarks: M2, GDP, and short-term foreign debt.

In Table 14 we scale up the outflow figures to 2002 and 2003 values based on the size of M2 (which grew more than GDP for all five countries) and by the change in short-term debt for 2002 (the last year for which data is currently available). The last column shows the actual reserve levels for end 2002 and end 2003. These calculations suggest that all five countries have already built up more than adequate reserve levels to handle a repeat of the actual capital outflows that occurred during the 1997-98 crises scaled up to 2003 values. Scale ups of reversals are not calculated since Korea was the only country in out sample that had resumed net financial inflows by 2003. The stock market inflows for Korea were analyzed in section 2.2.

4. Concluding Remarks

Asia has been rapidly accumulating international reserves since the crisis of 1997-98. In view of the ferocity and suddenness of the Asian crisis of 1997-98, the precautionary or insurance motive no doubt looms large in the decisions of the various

Asian economies to build up reserves to unprecedently high levels[25]. The need to hold reserves as a financial safeguard, has been nicely outlined by Fischer (2001):

> Reserves matter because they are a key determinant of a country's ability to avoid economic and financial crisis…The availability of capital flows to offset current account shocks should, on the face of it, reduce the amount of reserves a country needs. But access to private capital is often uncertain, and inflows are subject to rapid reversals, as we have seen all too often in recent years. We have also seen in the recent crises that countries that had big reserves by and large did better in withstanding contagion than those with smaller reserves.. (pp.1-3).

Many previous studies have concluded that Asia is holding reserves far in excess of what is justifiable based on conventionally used yardsticks of reserve coverage or reserve demand (for example, see Edison, 2003 and Lee, 2004). However, the typical response by policy makers to suggestions that they are holding "excessively high" reserves has been that these studies have failed to sufficiently incorporate the possibility of sudden and sharp changes in the capital account (slowdowns, stops or outright reversals).

Taking this criticism seriously, we have proposed new benchmarks of reserve cover that attempt to capture the changing profile of capital flows by taking into account the extent of changes in the flows of short term external debt, portfolio investment and

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[25] Admittedly motives behind reserve accumulation may vary within a country over time and between Asian countries. For instance, see Dean and Rajan (2004) for a discussion of the motivations behind reserve build-up in China specifically.

other mobile capital. While the empirics we have provided are fairly preliminary and meant to be illustrative, application of the benchmarks to selected Asian countries leads us to conclude that all five countries investigated held excessive reserves by 2003.

We should emphasize that our analysis focuses on the reserve levels needed to offset capital outflows during a crisis. Substantial levels of reserves may also play an important role of avoiding a crisis when fundamentals are in an intermediate zone. The available empirical research is inefficient to suggest that this is a real possibility, but such studies have typically been based on rather limited samples. While available estimates can be plugged into elaborate models giving trade offs between fundamentals and prior financial flows and reserve levels needed to prevent crises, there is little reason to believe that current estimates are sufficiently robust to carry the weight of such analysis. Thus, for example, while Sachs *et al.* (1996) and Willett *et al.* (2004b) both find that reserve levels have a significant influence on the likelihood of currency crises, the trade offs with fundamentals implied by their estimates are starkly different. This is an area where we need a great deal more research.

Given the absence of any one right way to calculate optimal reserve levels, it is difficult to distinguish clearly between precautionary and mercantilist motives for reserve accumulation. Market smoothing motives may motivate extended periods of

reserve accumulation or decumulation if one believes that private markets are subject to long bouts of excessive optimism or pessimism or protracted bandwagon dynamics. Indeed, in a world of uncertainty, it seems likely that the various motives will often reinforce one another.

Our crude calculations of the reserve levels needed to finance capital outflows of the severity of the 1997–98 Asian crises suggest that reserve levels are more than adequate for most Asian countries. We plan further refinements of our calculations in the near future, examining more crises episodes and focusing especially on the degree to which various types and magnitude of capital inflows may increase a country's vulnerability to future capital outflows, and considering interactions among different categories and interrelationships with other economic variables incorporated in the demand for reserves literature[26]. Still there is little likelihood that our estimates of reserve adequacy will be raised substantially[27].

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[26] Traditional models of the demand for reserves assumed that the probabilities and magnitudes of reserve drains were independent. While the rapid accumulation of international reserves by Asia has led to a resurgence of interest in empirical studies of the demand for international reserves after a gap of two decades (for instance, see Aizenman, 2003, 2004, Edison, 2003 and Flood and Marion, 2001), the best these studies can do is to identify whether a country is out of step with average behavior.

[27] Because of the conservative methodology adopted in this paper, it is much more likely that our future "best guess" estimates will be lower.

Given the high costs of reserve holdings (Bird and Rajan, 2003 and Rajan and Siregar, 2004), Asia should clearly be concerned about their reserves holdings above "adequate" levels, or at least the costs of continuing to amass even more reserves. It does not appear, however, that cost considerations will be a compelling factor in influencing a change in the behavior of Asian governments, particularly as it would effectively imply that the regional currencies would be allowed to float upward relative to the dollar and the euro[28].

We are sympathetic to the argument put forward by Wolf (2004) that a large portion of the recent official Asian reserves accumulation was because these countries "wished to avoid a collapse of the dollar." He suggests that part of this may be due to concerns that resulting current account deficits could make them vulnerable to speculative attacks and financial crises, but also important are concerns that appreciation of their currencies could generate "additional deflationary pressure" and undermine "their export competitiveness".

While these motives are understandable, the result is a huge collective external imbalance, which makes future crises more rather than less likely. We have a classic collective action problem since the perceived adverse effects of currency appreciations will be greater if the appreciation occurs in isolation. On the other hand, the benefits of

[28] Clearly, neither will the issues of sharing of global macroeconomic adjustments.

reduced imported inflationary pressures and the reduction of excessive reserve holdings will be little impaired in the face of a coordinated Asian appreciation against all major currencies, particularly the US dollar. We are under no illusion that such formal or informal coordination of Asian appreciations would be easy to bring about politically, but we have little doubt that this is a much more important issue on which to focus current attention than discussions of possible future monetary union.

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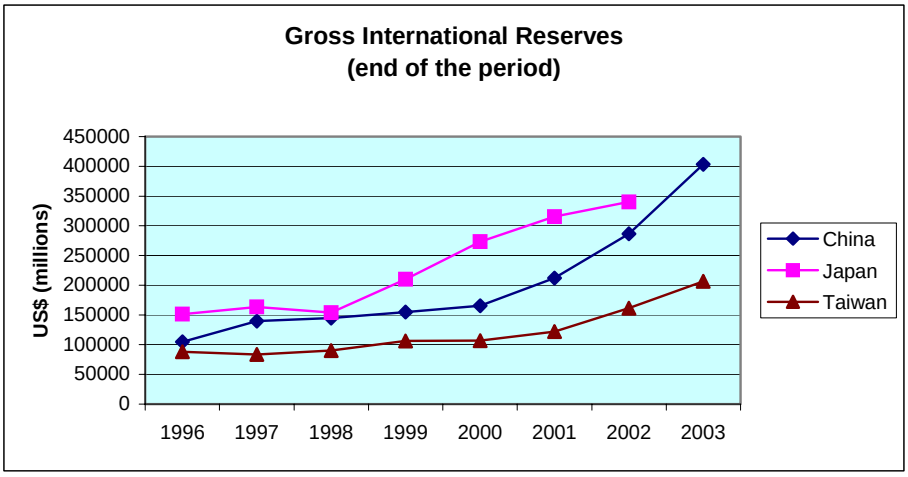
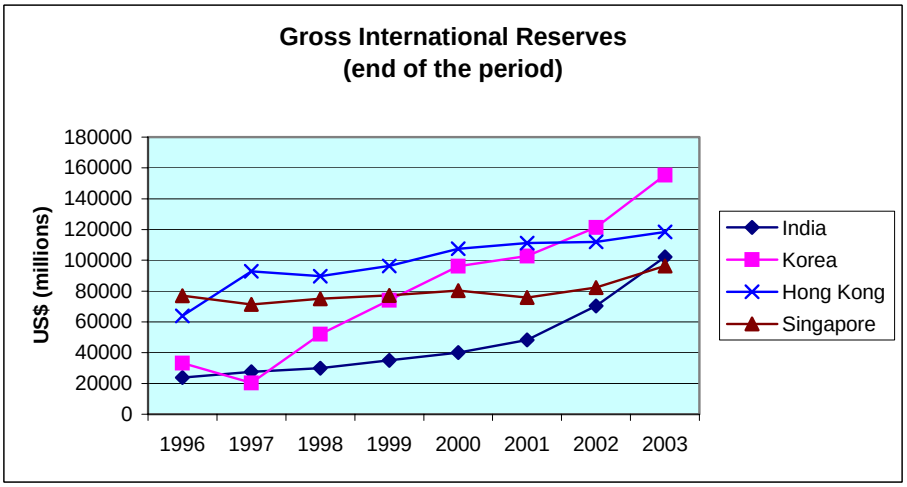
Figure 1


Gross International Reserves
(end of the period)
US$ (millions)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
1996
1997
1998
1999
2000
2001
2002
2003
China
Japan
Taiwan


Gross International Reserves
(end of the period)
US$ (millions)
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
1996
1997
1998
1999
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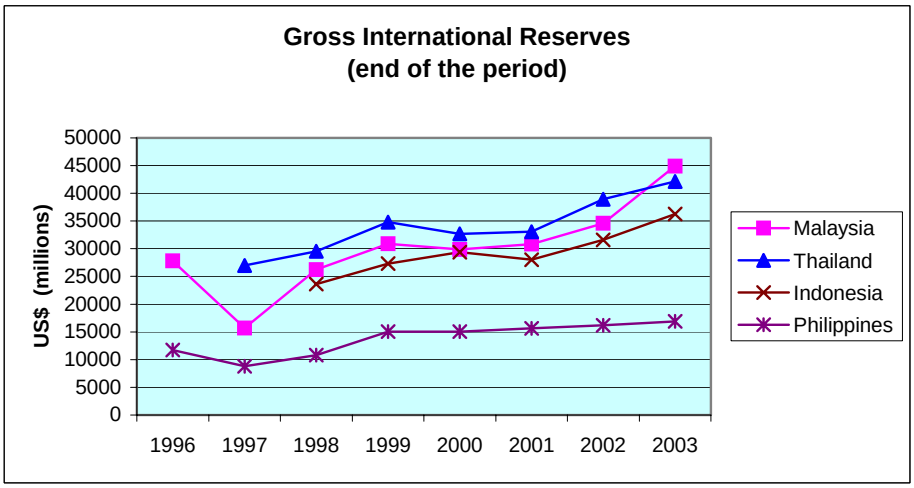
2003
India
Korea
Hong Kong
Singapore


Gross International Reserves
(end of the period)
US$ (millions)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1996
1997
1998
1999
2000
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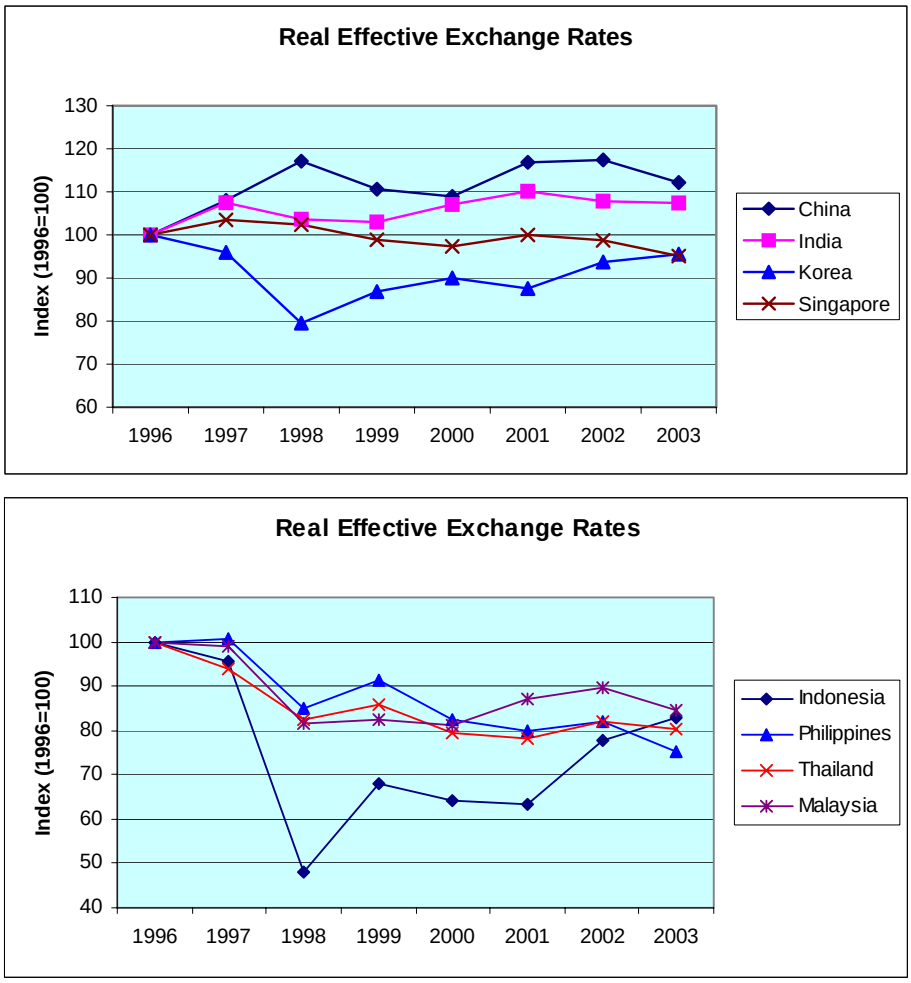
2003
Malaysia
Thailand
Indonesia
Philippines

Figure 2



Note: Decline implies real depreciation

Sources for Figures 1 and 2: ADB-ARIC (http://aric.adb.org/index.asp)

Table 1: Reserve Adequacy in Asia, 2003

(US$ millions)

	Foreign Reserves (A)	**Monthly Import (3 months) (B)**	**Short Term Debt (C)**	**(B)+(C)**	**A-(B+C)**
Korea	**155,284**	**44,696**	**56,249**	**100,945**	**54,339**
Japan	**663,289**	**103,249**	**-**	**103,249**	**560,040**
China	**408,151**	**103,266**	**40,187**	**143,453**	**264,698**
Malaysia	**44,515**	**20,487**	**11,897**	**32,384**	**12,131**
Philippines	**13,457**	**9,628**	**11,111**	**20,739**	**-7,282**
Indonesia	**34,962**	**10,421**	**15,706**	**26,127**	**8,835**
Thailand	**41,077**	**19,821**	**11,553**	**31,374**	**9,703**
Singapore	**95,746**	**32,699**	**60,707**	**93,406**	**2,340**
Hong Kong	**118,360**	**57,974**	**72,091**	**130,065**	**-11,705**

Source: BIS/IMF/OECD/World Bank Statistics for External Debt

Table 2a: Reserve Adequacy in Korea : Stress Test

(Unit: Millions of U.S Dollars)

	Foreign Reserve (A)	Monthly Import (3 months) (B)	Short-term External debt (C)	Foreigner's Stock Investment (D)	(B)+(C)+(D*0.3) (E)	(A) - (E)
1993	**20,228**	**20,950**	**32,153**	**13,671**	**57,204**	**-36,976**
1994	**25,639**	**25,587**	**44,090**	**19,528**	**75,535**	**-49,896**
1995	**32,678**	**33,780**	**60,199**	**21,586**	**100,455**	**-67,777**
1996	**34,037**	**37,585**	**74,756**	**18,031**	**117,750**	**-83,713**
1997	**20,368**	**36,154**	**64,984**	**7,319**	**103,334**	**-82,966**
1998	**51,975**	**23,320**	**41,726**	**21,223**	**71,413**	**-19,438**
1999	**73,987**	**29,931**	**44,728**	**66,867**	**94,719**	**-20.732**
2000	**96,131**	**40,120**	**42,653**	**44,898**	**96,242**	**-111**
2001	**102,753**	**35,275**	**42,668**	**70,657**	**99,140**	**3,613**
2002	**121,345**	**38,032**	**46,939**	**77,608**	**108,253**	**13,092**
2003	**155,284**	**44,696**	**56,249**	**119,515**	**136,800**	**18,485**

Sources : IMF, IFS, Bank of Korea and Korea Financial Supervisory Service.

Table 2b: Foreigner's Portfolio (Stock) Investment in Korea

Period	Foreigners' Portfolio Investment (Bn Won)	Stock Price	Exchange Rate	Foreigners' Portfolio Inverstment (Bn US $)	Portfolio Equity Flows (Bn US $)
1996.I	140,748	857.4	782.7	17.98	0.92
1996.II	145,799	867.7	810.6	17.99	2.80
1996.III	142,807	783.4	821.2	17.39	1.25
1996.IV	122,686	690.6	844.2	14.53	1.64
1997.I	127,952	656.7	897.1	14.26	0.84
1997.II	160,613	765.2	888.1	18.09	2.45
1997.III	141,986	676.5	914.8	15.52	1.00
1997.IV	87,347	390.3	1,695	5.15	-1.44
1998. I	159,929	523	1,383	11.56	2.62
1998.II	105,627	313.3	1,373	7.69	-0.01
1998.III	109,557	312.2	1391	7.88	-0.17
1998.IV	225,302	524.7	1204	18.71	1.38

Table 3: Net Capital Flows during Crises Period*

(US$ billions)

	FAC	Errors	Portfolio	FDI	Other Loans	Changes Of Reserves
Indonesia	**-16.33**	**-0.99**	**-6.62**	**0.69**	**-14.53**	**4.46**
Korea	**-28.52**	**-11.38**	**4.78**	**-0.2**	**-40.76**	**17.94**
Malaysia**	**-0.4**	**2.9**	**7.3**	**0**	**-7.5**	**-1.45**
Philippines	**1.28**	**-2.27**	**-2.02**	**2.46**	**1.09**	**-0.8**
Thailand	**-27.47**	**-3.94**	**3.15**	**9.42**	**-35.17**	**-8.91**

* Crises period is defined as the last two quarter of 1997 and all quarters of 1998 (except for Malaysia). All capital flow data is from IMF's International Financial Statistics.

(1) FAC is estimated by the sum of Financial account,n.i.e

(2) Errors is the sum of Net errors and omissions

(3) Portfolio is the sum of (Portfolio asset- portfolio liability, n.i.e) : Portfolio = (Equity securities + Debt securities)

(4) FDI is the sum of (Direct investment abroad - Direct Investment in Domestic, n.i.e)

(5) Other Loans is the sum of (Other Investment Asset - Other Investment Liabilities, n.i.e) : Other Loan = (Private Bank + Other Sector Loans)

** No quarterly data is available for Malaysia. Therefore, 1997-1998 is taken as the crises period for Malaysia and capital flows are calculated from annual data.

Table 4: Net Capital Flows during Crises Period

(US$ billions)

	FAC+Errors	FAC+Errors -FDI	Errors + Other Loans	Errors + Other Loans+ Portfolio
Indonesia	**-17.32**	**-18.01**	**-15.52**	**-22.15**
Korea	**-39.90**	**-39.70**	**-52.14**	**-47.36**
Malaysia	**2.50**	**2.50**	**-4.60**	**2.70**
Philippines	**-1.00**	**-3.46**	**-1.18**	**-3.21**
Thailand	**-31.42**	**-40.84**	**-39.12**	**-35.96**

Table 5: Ratios of Crises to Pre-crises Net Capital Flows*

	FAC	Errors	Portfolio	FDI	Other Loans
Indonesia	**-64.92%**	**27.31%**	**-120.64%**	**9.16%**	**-161.49%**
Korea	**-93.26%**	**461.20%**	**18.71%**	**5.86%**	**-245.25%**
Malaysia	**-1.42%**	**60.54%**	**-204.79%**	**0.00%**	**-265.06%**
Philippines	**7.79%**	**-1287.30%**	**-638.49%**	**71.20%**	**24.32%**
Thailand	**-52.11%**	**-251.76%**	**36.04%**	**110.05%**	**-106.79%**

* Pre-crises net capital flows are defined as the cumulative net capital flows from 1992-1996.

Table 6: Ratios of Net Capital Flows to M2 (1996) during Crises Period

	FAC+Errors	FAC+Errors-FDI	Errors+Other Loans	Errors+Portfolio +Other Loans
Indonesia	**-14.71%**	**-15.29%**	**-13.18%**	**-18.81%**
Korea	**-18.89%**	**-18.80%**	**-24.69%**	**-22.42%**
Malaysia	**2.70%**	**2.70%**	**-4.96%**	**2.91%**
Philippines	**-2.15%**	**-7.44%**	**-2.54%**	**-6.90%**
Thailand	**-21.59%**	**-28.07%**	**-26.88%**	**-24.71%**

Table 7: Ratios of Net Capital Flows to GDP (1996) during Crises Period

	FAC+Errors	FAC+Errors-FDI	Errors+Other Loans	Errors+Portfolio +Other Loans
Indonesia	**-7.75%**	**-8.06%**	**-6.94%**	**-9.91%**
Korea	**-7.51%**	**-7.47%**	**-9.81%**	**-8.91%**
Malaysia	**2.49%**	**2.49%**	**-4.58%**	**2.69%**
Philippines	**-1.21%**	**-4.19%**	**-1.43%**	**-3.89%**
Thailand	**-17.45%**	**-22.68%**	**-21.73%**	**-19.97%**

Table 8: Ratios of Net Capital Flows to STED (1996) during Crises Period*

	FAC+Errors	FAC+Errors-FDI	Errors+Other Loans	Errors+Portfolio +Other Loans
Indonesia	**-46.09%**	**-47.93%**	**-41.30%**	**-58.95%**
Korea	**-59.93%**	**-59.63%**	**-78.31%**	**-71.13%**
Malaysia	**22.59%**	**22.59%**	**-41.56%**	**24.39%**
Philippines	**-12.55%**	**-43.42%**	**-14.81%**	**-40.28%**
Thailand	**-65.85%**	**-85.59%**	**-81.99%**	**-75.36%**

* STED is Short-term debt.

Table 9: Maximum Sizes of Net Capital Outflows as Percentage of M2

	Ratios	Scaling Factor	Types of Capital Outflows
Indonesia	**-18.81%**	**M2**	**Errors+Other Loans+Portfolio**
Korea	**-24.69%**	**M2**	**Errors+Other Loans**
Malaysia	**-4.96%**	**M2**	**Errors + Other Loans**
Philippines	**-7.44%**	**M2**	**FAC+Errors-FDI**
Thailand	**-28.07%**	**M2**	**FAC+Errors-FDI**

Table 10: Net Capital Flow Reversals during Crises Period

(US$ billions)

	FAC	Errors	Portfolio	FDI	Other Loans	Changes of Reserves*
Indonesia	**-21.36**	**-0.27**	**-7.72**	**-0.81**	**-16.33**	**4.46**
Korea	**-34.63**	**-10.89**	**-0.33**	**0.48**	**-44.08**	**17.94**
Malaysia	**-6.05**	**1.94**	**8.01**	**-4.17**	**-8.07**	**-1.45**
Philippines	**-2.00**	**-2.31**	**-2.09**	**1.77**	**0.19**	**-0.80**
Thailand	**-38.02**	**-4.26**	**1.40**	**7.71**	**-41.76**	**-8.91**

Table 11: Net Capital Flow Reversals during Crises Period

(US$ billions)

	FAC+Errors	FAC+Errors-FDI	Errors+Other Loans	Errors+Other Loans+Portfolio
Indonesia	**-21.62**	**-20.81**	**-16.60**	**-24.32**
Korea	**-45.52**	**-46.01**	**-54.97**	**-55.30**
Malaysia	**-4.11**	**0.07**	**-6.12**	**1.89**
Philippines	**-4.31**	**-6.08**	**-2.12**	**-4.20**
Thailand	**-42.27**	**-49.98**	**-46.02**	**-44.61**

Table 12: Maximum Sizes of Net Capital Outflows and Reversals

(US $ billions)

	Capital Outflows		Capital Reversals	
Indonesia	**-22.15**	**Err+OL+Port**	**-24.32**	**Err+OL+Port**
Korea	**-52.14**	**Err+OL**	**-55.30**	**Err+OL+Port**
Malaysia	**-4.60**	**Err+OL**	**-6.12**	**Err+OL**
Philippines	**-3.46**	**FAC+Err-FDI**	**-6.08**	**FAC+Err-FDI**
Thailand	**-40.84**	**FAC+Err-FDI**	**-49.98**	**FAC+Err-FDI**

Table 13: Ratios of the Greatest Capital Outflows and Reversals to M2, GDP and Short Term Foreign Debt

	Ratio of Capital Outflow (CO) to Three Scales			Ratio of Capital Reversal (CR) to Three Scales		
	ratio of CO to M2	**ratio of CO to GDP**	**ratio of CO to STD**	**ratio of CR to M2**	**ratio of CR to GDP**	**ratio of CR to STD**
Indonesia	**-18.81%**	**-9.91%**	**-58.95%**	**-20.65%**	**-10.88%**	**-64.72%**
Korea	**-24.69%**	**-9.81%**	**-78.31%**	**-26.18%**	**-10.41%**	**-83.06%**
Malaysia	**-4.96%**	**-4.58%**	**-41.56%**	**-6.61%**	**-6.10%**	**-55.29%**
Philippines	**-7.44%**	**-4.19%**	**-43.42%**	**-13.07%**	**-7.36%**	**-76.29%**
Thailand	**-28.07%**	**-22.68%**	**-85.59%**	**-34.35%**	**-27.76%**	**-104.75%**

Table 14: Scaled-up Figures of Capital Outflows in Year 2002 and Year 2003

(US $ billions)

	2002				2003		
	Scaled by M2	Scaled by GDP	Scaled by STD	Actual Reserve Holdings	Scaled by M2	Scaled by STD	Actual Reserve Holdings
Indonesia	**-18.58**	**-17.85**	**-13.74**	**30.97**	**-21.21**	**-20.92**	**34.96**
Korea	**-107.99**	**-56.60**	**-36.51**	**121.35**	**-114.58**	**-59.35**	**155.28**
Malaysia	**-4.81**	**-4.35**	**-3.48**	**34.22**	**-5.26**	**-4.73**	**44.52**
Philippines	**-3.31**	**-3.17**	**-2.41**	**13.14**	**-3.28**	**-3.29**	**13.46**
Thailand	**-35.05**	**-28.56**	**-10.20**	**38.05**	**-40.71**	**-34.03**	**41.08**