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Currency Boards, Credibility, and Macroeconomic Behavior

Luis A. Rivera Batiz and Amadou N. R. Sy

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Prepared by Luis A. Rivera Batiz and Amadou N. R. Sy[1]

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Abstract

Currency boards operate differently from standard pegs. The former exhibit greater currency stability and lower transaction costs, inflation, and nominal interest rates, but are limited in their use of devaluation. We extend Drazen and Masson's (1994) signaling model to consider the choice between currency board arrangements and standard pegs. The model shows that currency boards' effectiveness hinges on their credibility properties and that they can improve welfare even with high unemployment persistence. By reducing expected inflation and the negative employment effect arising from expected but unrealized inflation, currency boards can produce less unemployment than peg regimes that abstain from devaluation.

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Author's E-Mail Address: Luisr@iadb.org, Asy@imf.org

[1]Inter American Development Bank, McGill University, and Universitat Pompeu Fabra; and Research Department, IMF respectively. We are grateful to Paul Masson, Maria-Ángels Oliva, Don Mathieson, Peter Tran, and to seminar participants at the IMF for comments.

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I. Introduction

The currency crisis of 1997-98 hit East Asian fixed exchange rate regimes with a vengeance and had contagion effects in other regions of the world. There were large losses of currency values and financial crises in Indonesia, Korea, Malaysia, Thailand, and the Philippines. Taiwan Province of China and Singapore were not strongly affected, but there was a 15 percent loss in the value of their currencies between the beginning of the crisis in July 1997 and April 1998. In contrast, the Hong Kong currency board was able to withstand the speculative attacks and the Hong Kong dollar was not devalued. The regional crisis raised once again the issue of fixed exchange rate regimes' vulnerability to speculative attacks and macroeconomic instability. Questions remain as to how to prevent these financial crises, and how to deal with them once they take place.

Currency board arrangements have been often proposed to both prevent instability and reestablish currency credibility during a currency crisis. This policy option follows from the relatively good recent experience with currency boards. The ability of currency boards to face financial crises successfully, have recently led to their adoption in Argentina (March 1991), Estonia (June 1992), Lithuania (April 1994), and Bulgaria (July 1997). In all of these cases, the currency board was chosen as part of a structural adjustment program in economies in disarray.

The countries that adopted currency boards in the nineties were able to adjust to low inflation levels as rapidly, or more rapidly and lastingly, than other countries in similar situations. None of them devalued or was forced to exit the currency board. Inflation and interest rates generally converged toward the anchor currency levels. This macroeconomic performance stands out in contrast with the currency crises, numerous forced devaluations, and high interest rates experienced in similar economies with standard peg regimes. The main exceptions to convergence concerns the increase in interest rates during the 1997-98 Estonian banking crisis, and the short-lived interest rate increases during the 1997-1998 speculative attacks against the Hong Kong currency board.

In the East Asian case, the currency board arrangement in Hong Kong SAR, established in October 1983, and the only one in the region, was able to survive the Asian crisis without a devaluation. Like other economies in the region, Hong Kong SAR felt the contagion effects associated with the crisis, was subject to strong speculative pressures, experienced a sharp stock market fall, and entered into recession. Yet, the economy did not face a major currency crisis and did not devalue its currency.

In Argentina, growth was re-ignited while inflation went down from four-digit levels to almost zero in the two years following the inception of its currency board. The downside was an increase in unemployment to 18 percent. Due to an inflexible labor market, major economic restructuring, and the effects of the Asian crisis, unemployment showed resistance to go down and remained at 14 percent in 1998. Higher interest rates associated with the 1998 Russian default and losses of competitiveness due to the depreciation of the Brazilian real helped push the Argentinian economy once again into recession. The Estonian currency board was able to generate economic growth and reduce inflation from three-digit levels before the introduction of the board, to 10 percent in 1997. The 1997 boom led to a banking crisis but there was a rapid recovery. Bulgaria established a currency board in July 1997, following a successful stabilization program begun in early 1997 based on the prospective introduction of a currency board. The Bulgarian currency board led to drastic reduction of inflation, which dropped from three and four-digit levels in 1996 and 1997 to near-zero in 1998. The 10 and 6 percent GDP contractions of 1996 and 1997 were put to an end, although there was no recovery in 1998.

The currency and inflation stabilizing properties of currency boards must be gauged in the context of medium- and long-term economic performance. Recent empirical work has examined the behavior of currency boards in a comparative perspective. Ghosh, Gulde, and Wolf [1998] report that currency boards tend to have lower average inflation and as good growth performance as other peg rate regimes. Kwan and Lui [1996] perform a simulation analysis of a currency board versus a flexible exchange rate regime, finding that the currency board both reduces output growth volatility and inflation. In a broad analysis of the experience of current currency boards, Baliño, Enoch, Ize, Santiprabhob and, Stella [1997] conclude that currency boards are attractive to countries seeking to reduce inflation, or that wish to achieve the benefits of belonging to a broader currency area. They argue that currency boards call for a strong emphasis on fiscal adjustment and labor market flexibility.

Table 1 summarizes the key results of Gulde, Keller, and Kähkönen [1999]. This study examines the average performance of currency boards, other pegs, and floating rates during 1975-1996. On average, currency boards had lower inflation, faster GDP growth, lower M2 growth, and lower government deficits than both other peg regimes and floating rates. Using a de facto rather than de jure classification of exchange rate regimes, the sample covers all members of the International Monetary Fund for which there is annual data available, including the currency boards experiences of Argentina, Antigua and Barbuda, Djibouti, Dominica, Estonia, Grenada, Hong Kong SAR, St. Lucia, St. Vincent and the Grenadines, and Lithuania.

Why do currency boards show greater exchange rate stability and seem to produce better inflation performance, and no worse growth performance, than other types of fixed exchange rate regimes? Can we identify specific conditions under which a currency board is likely to perform better than other pegged regimes? Does a currency board really lend credibility to policymakers? Surprisingly, there are no existing models of currency boards that could be used to specify their macroeconomic behavior and credibility properties relative to other types of pegged rate regimes.

This paper presents a comparative review of recent evidence on currency boards. The evidence on Hong Kong SAR and Argentina shows that currency boards have lower currency market spreads, lower inflation and greater short-term interest rate stability than comparable peg or floating rate regimes. On the other hand, the data presented also suggests that currency boards can be subject to credibility questions when established, and in volatile environments. We also develop a simple model of a currency board and its credibility that allows a comparison between a currency board and a peg regime in terms of inflation-unemployment performance, and credibility. The model extends the two-period credibility model of Drazen and Masson [1994] to allow the government to choose between a currency board and a standard pegged exchange rate regime. The government chooses among these two varieties of a peg regime by maximizing a social welfare function. We do not consider the alternative of choosing flexible rates, but allow policymakers to devalue and exit the currency board.

The operation of a currency board differs from the standard fixed exchange rate regime considered as a paradigm in textbooks. Peg and currency board structures have different institutional setups. First, currency board arrangements represent a mechanism to effectively tie the hands of monetary authorities. The capacity to devalue is severely restricted by requiring parliamentary approval and other restrictions. In effect, authorities cannot react to a crisis by sudden devaluation. Furthermore, currency boards severely restrict the central bank's ability to conduct an independent monetary policy. Restrictions on the use of exchange rate and monetary policy aim to align domestic inflation with that of the currency or currencies chosen as anchor. Our model does not explicitly model monetary policy, but it comprises the inflation credibility effect of currency boards and embodies the notion that currency boards have limited policy stabilization instruments due to nominal exchange rate rigidity and restricted monetary policy instruments.

Second, the choice of a currency board represents a signal that affects the credibility of policymakers. In the model presented, this feature can provide greater exchange rate credibility to currency board arrangements compared with pegged regimes. By choosing an exchange rate regime that subjects the economy to more lasting employment shocks but ensures inflation stability, the authorities send a strong signal that they are tough in pursuing stabilization.

The choice of a currency board versus a standard peg involves a trade-off between the costs and benefits of each regime. Currency boards can be welfare-improving due to their inflation stabilization and credibility properties. Inflation is stabilized because the institutional arrangement implies that monetary authorities tie their hand and prevent a devaluation. Because agents know that the authorities have tied their hands, expected inflation tends to be lower under a currency board than under a standard peg. Currency boards can be costly because they are limited in their use of unexpected devaluation to offset unemployment shocks The persistency of unemployment shocks translates into greater subsequent unemployment and could cause exit of the currency board. In contrast, a benefit of the standard peg is its flexibility to devalue to offset large enough income or unemployment shocks. The cost is that it generates expected inflation. [2]

When the option to devalue is not used, the standard peg leads to lower inflation than expected, which represents a contractionary policy that increases unemployment relative to the currency board arrangement. In fact, we show that, by reducing the magnitude of the negative employment effect that arises from expected but unrealized inflation, currency boards can produce less unemployment than standard peg regimes that abstain from devaluation.

The results of the theoretical and empirical analyses suggest that the details of a fixed rate regime matter. The fixed versus flexible comparison might not be fine enough to yield useful policy prescriptions in many circumstances. The institutional details underlying the operation of currency regimes have signalling and credibility effects that are taken into account by market participants in assessing monetary regimes and forming expectations. The peg versus currency board issue is not likely to be settled into a single choice but should rather depend on conditions

[2] An additional cost of the standard peg arises when devaluations are initially contractionary (see Edwards [1986]), an effect that we do not consider and that favors the currency board over the standard peg.

under which currency boards are likely to work better than a standard currency peg, and vice versa. A policy lesson is clear, though. If a country adopts a standard peg, it is better to make use of devaluation in the face of large enough shocks than to try to be tough. Otherwise, a credibility cost is paid while the benefits are foregone.

II. Do Currency Board Regimes Operate Differently from Other Pegged Regimes?

This section examines recent time series behavior of selected macroeconomic and financial variables for currency board countries and similar economies. Comparing similar countries and focusing on periods in which countries face similar shocks, is a first step in separating the effects of environmental variables (that change across countries and in a given country from period to period), and the effects of different exchange rate regimes.

The analysis focuses on the currency board regimes of (1) Hong Kong SAR compared with East Asian countries, before and after the 1997-98 East Asian crisis, (2) Argentina compared with other Latin American countries, and, (3) Estonia and Lithuania compared with Latvia (which does not have a currency board and has a peg in terms of SDR). We also touch upon other currency board experiences such as Bulgaria after July 1997.

The East Asian experience is particularly interesting in that it represents a shock that affected all economies in the region. Yet countries differed in their behavior during the crisis. In particular, the Hong Kong currency board had a different pattern of behavior. First, the dire effects predicted by many analysts did not take place. Except during the periodic speculative attacks, especially in October 1997, early 1998 and August 1998, when the Russian effective debt default and ruble devaluation touched off a worldwide mini-crisis, there was no especially painful exchange rate or interest rate adjustment. On the other hand, Hong Kong SAR fell into recession earlier than Singapore and was the region's laggard in 1999. Second, the comparative behavior of Hong Kong SAR and other East Asian countries was not due to markedly different fundamentals. International reserve levels were among the highest worldwide, budget deficits were under relative control, and growth was very fast. Most market participants considered East Asian countries' fundamentals to be adequate before the crisis erupted in 1997, although some countries had weak banking systems, excessive short-term debt and declining stock markets.

The informal evidence presented suggests that currency boards operate differently from other exchange rate regimes. The evidence on Hong Kong SAR and Argentina shows lower currency market spreads and greater short-term interest rate stability than comparable peg or floating rate regimes. This is so despite the fact that Hong Kong SAR does not have a noticeable higher level of the ratio of reserves-to-M2 compared with other countries in the region. The increases in forward premia during the East Asian crisis were smaller in Hong Kong SAR than in East Asian countries and comparable to the increases experienced in Singapore. Currency boards tend to stabilize inflation relative to standard pegs or flexible rates, even for countries that established the currency board under high-inflation conditions such as Argentina, Bulgaria and Estonia. On the down side, some currency board countries showed greater real effective exchange rate appreciation than similar peg regime countries and tended to be more responsive to negative employment shocks. The high unemployment rates in Argentina contrast with other currency boards, while the Estonian currency board was plagued by high interest rates in 1997-98. Estonian interest rates, however, declined drastically in 1999.

A. Operational Efficiency: Lower Currency Market Bid-Ask Spreads

Hong Kong SAR and Singapore are two major financial centers in East Asia. Both economies are highly liquid and have low bid-ask spreads in foreign exchange markets. The pre-crisis experience indicates far lower transaction costs in the currency board regime. This is due to the low volatility of the Hong Kong dollar. Empirical studies show that exchange rate volatility is the most important determinant of currency spreads. Because the Hong Kong dollar was not highly traded before the crisis, it is difficult to attribute the low spreads on the Hong Kong dollars to volume effects. In fact, until the Asian crisis, the Thai baht was the most liquid regional currency, followed by the Malaysian ringitt and the Indonesian rupiah (see International Capital Market Report [1998] and Becker, Chadha and Sy [2000] for further analysis). After the crisis, the Hong Kong dollar became along with the Singapore dollar the most traded regional currencies.

Figure 1 depicts currency market bid-ask spreads for various East Asian and Latin American countries during the period 1990-98. What information can we obtain from bid-ask spreads? Under normal (i.e., non-crisis) conditions, we can utilize the level of the exchange rate spread as a measure of the operational efficiency of the foreign exchange market. The data suggests that the operational efficiency of the Hong Kong currency board regime is much greater than that of other East Asian countries. The pre-crisis bid-ask spreads fluctuated around 0.01 percent in Hong Kong SAR compared with 0.05 in Singapore. The Hong Kong percentage spreads were even lower than the Japanese spreads (see Figure 1). For the Thai baht, the Indonesian rupiah, the Malaysian ringitt, and the Philippines peso, the pre-crisis spreads fluctuated roughly around .5 percent, levels that were 10 times higher than the Singapore dollar spreads, and 50 times higher than the Hong Kong dollar spreads. The puzzle of carrying higher spreads despite higher volumes compared with the Hong Kong dollar is due to higher volatility of the exchange rate compared with remarkable stability of the Hong Kong dollar.

For all East Asian countries shown there was a substantial increase in the bid-ask currency spread during the East Asian crisis. In the case of the Hong Kong dollar, however, there were only some short-term spikes, and the increase in the spread was far less than that of other currencies in the sample. The Indonesian rupiah had the largest increase in its spreads, which were hovering around 0.10 percent before the crisis emerged, surging to rates that fluctuated between 2 and 9 percent during October 1997-April 1998. Percentage spreads on the Singapore dollar more than doubled during the crisis and were slow to return to pre-crisis levels compared with the Hong Kong dollar.

Table 2 presents the evidence on the average and standard deviation of the bid-ask spreads before and during the East Asian crisis. The large increase in the spreads during June-September 1997 and October 1997-April 1998 represents a substantial and persistent turbulence. The currency board regime had far lower spreads than other countries, and was affected by the crisis to a lesser extent than the other countries. Changes in the pattern of spread behavior, such as the large and fluctuating exchange rate spreads during the crisis, represent a breakdown of operational efficiency and reflect differences in market participants' perceptions of the path of future rates. By minimizing actual exchange rate volatility a currency board can be seen as an institutional element contributing to reduce transaction costs.

B. Financial Volatility: Fluctuations of Interest Rate Spreads

Because currency boards lack two major policy instruments, central bank credit policy and devaluation, many observers predict that they should exhibit relatively high interest rate volatility (e.g., Roubini [1998]). For instance, the Hong Kong Monetary Authority has few instruments available (e.g., required reserves) to expand credit to counteract credit market tightness and prevent interest rate increases. The peg rigidity prevents the monetary authorities from utilizing planned exchange rate devaluations to stimulate exports and employment and offset upward interest rate pressures.

We find that currency boards tend to align domestic to anchor currency interest rates and show smaller rate volatility than the rest of the sample. Table 3 reports average interest rate differentials and its volatility during the past years. The currency board countries have lower interest rates and lower volatility than the other countries in the sample. The only exception concerns Lithuania's currency board arrangement, which faced high interest rates due to rumors of devaluation and a loss of credibility in the early stages of the currency board but experienced remarkable interest rate convergence after the newly-established currency board achieved credibility. Estonia's currency board was hit by a banking crisis and plagued by double-digit interest rates in 1997-98. By mid-1999, however, Estonian money market rates had declined to 3 percent after a successful restructuring and strengthening of the banking system. For a comprehensive review of financial sector developments in Estonia, see IMF [1999a].

Figure 2 shows money market interest rate spreads for various East Asian countries since 1990. The Hong Kong series show that spreads relative to the US dollar were nearly zero between 1990-1997, except for the blips of 1991 and the short lived early-1995 increase to 2 percent during the Mexican crisis. Interest spread volatility was quite low and Hong Kong interest rates closely followed U.S. interest rates. This behavior pattern is quite different from all the other East Asian economies, including Singapore. Pre-crisis interest rate spreads in relation to the dollar, were more volatile than Hong Kong spreads in all the other countries examined.

The East Asian crisis dramatically changed the pattern of spread behavior. In all cases examined, including Hong Kong interest rate spreads surged during the crisis. In the case of Hong Kong SAR and Singapore, interest rates spreads had declined by April 1998, and were at levels similar to pre-crisis levels. In the other countries shown, interest rate spreads remained high in April 1998. The rapid convergence of interest rate spreads to normalcy reflects the ability of Singapore and Hong Kong SAR to keep inflation under control and to sustain speculative attacks. Rapid interest rate convergence also reflects the rapid return to low expectations of devaluations in these countries. In the case of other East Asian economies, interest rate spreads remained quite high throughout late 1998, when interest rates declined sharply throughout the region.

Asian countries' interest rates surged in August 1998 when Asian currencies came under attack after Russia effectively defaulted on its debt and devalued the ruble. The Hong Kong dollar faced speculative pressures, capital outflows, interest rates surged, and forward rates on the Hong Kong dollar went up substantially. This financial profile indicated that the credibility of the currency board had come into question. The mini-crisis was surmounted and interest rates fell back to levels similar to those in the U.S.. In this episode, the Hong Kong authorities relaxed the spirit of the currency board rules by heavily intervening in the stock market to prop up and actually reverse a falling trend in stock prices. The episode suggests that interest rate convergence can break down and hinges on maintaining the credibility of the currency board. A similar conclusion follows from the 1997-98 interest rates increase in Estonia

The rough similarity between the money market interest rate spread behavior in Hong Kong SAR and Singapore before and after the East Asian crisis stands out because Hong Kong monetary policy instruments are limited. Yet, the change in interest spreads during the crisis is similar to the case of Singapore. Crisis and pre-crisis evidence strongly suggests that the presumed interest volatility of currency boards is simply not there in the case of Hong Kong SAR.

Figures 2(b) and 2(c) show money market interest rates in the major Latin American and the Baltic countries. Short-term interest rates in Argentina converged to single-digit levels by 1995 and have remained at those levels since. This behavior of interest rates differs dramatically from the behavior of interest rates in Brazil, Chile, and Mexico, although it should be mentioned that long-term interest rates surged during the Tequila crisis in early 1995 and after Russia defaulted in 1998. In the Baltics, interest rates converged to world markets under the Estonian and Lithuanian currency boards but also under the Latvian peg regime.

C. Credibility of the Peg: Forward Premia

Because forward premia reflect risk factors and the possibility of a devaluation, the behavior of forward premia can shed light into the credibility of the currency board relative to other peg regimes. Although forward premia are equal to interest rates differentials in normal periods, interest parity breaks down when there is turbulence. We find that the increases in forward premia during the East Asian crisis were smaller in Hong Kong SAR than in East Asian countries and comparable to the increases experienced in Singapore. However, forward exchange rate behavior in periods of speculative attacks indicates that the Asian crisis negatively affected Hong Kong's currency board credibility.

Figure 3 shows the 3-month forward rates (vis à vis the U.S. dollar) for Hong Kong SAR and Singapore (because forward markets are not yet as developed in Latin America and the Baltic Countries as in Asia, we limit our discussion to the East Asian economies). The forward premium on the Hong Kong dollar, which had been very low during the decade, began to increase in October 1997 and went up to almost 1 percent in early 1998, going back to near-zero levels in April 1998. The increased premia imply that the sustainability of the currency board peg was brought into question during October 1997-March 1998, and suggest that the credibility of the currency board itself might have been undermined at the height of the crisis. An acute episode of loss of credibility and speculative attacks took place in August 1998, as discussed above.

However, Figure 3 shows that the increases in the forward premia were less than in Singapore and other Asian countries. The strength of the credibility of the Hong Kong dollar can not be attributed simply to the large amount of international reserves held by the monetary authority because, relative to the size of the financial sector, Hong Kong's international reserves are comparable to those of other countries in the region and lower than those of Singapore (see below).

The forward premium on the Singapore dollar exhibits a striking behavior during the crisis. First, it remained negative throughout 1997, and was barely affected by the October crisis. In the first quarter of 1998, the forward premium increased to 0.08 percent, far less than in the Hong Kong SAR case. The small effect of the crisis on forward markets suggests that the large amount of reserves held, and the policy of early devaluation followed by the Singapore monetary authority, paid good results. The Singapore dollar was left to depreciate in July 17, 1997, right at the beginning of the crisis. This depreciation seems to have been undertaken at the right time at an adequate level, and did not seem to generate further expectations of devaluation (as the forward premia remained negative for 6 months after the devaluation). The stabilizing effects of early depreciation did not isolate Singapore from the August 1998 crisis, when the forward premia reached 3 percent.

The behavior of forward premia suggests that models of currency boards should allow for the possibility of devaluation as an escape clause (see Obstfeld [1997]) and for currency board breakdown or abandonment (exit alternative). In terms of agents' expectations, the difference between the currency board and other types of exchange regimes is a matter of degree.

D. Support of the Peg: International Reserves

The level of international reserves in relation to the monetary base or the money supply is often perceived to be a major element in a currency board. The argument is that the currency board must count on enough reserves to sustain the credibility of the peg level and back the money supply. Hong Kong SAR has over $90 billion in international reserves and is among the three top holders of international reserves worldwide. The high absolute level of reserves is often mentioned as a key reason why Hong Kong's currency board has operated better than other peg regimes in the area. China's announced intentions to support the Hong Kong dollar if necessary lends further credibility.

In order to assess the level of international reserves, we must measure them relative to the money supply and in comparison with other countries. We find that the level of international reserves in relation to M1 is far lower than Singapore and comparable to Thailand. Another indicator of the adequacy of foreign exchange reserves is the ratio of international reserves to M2, that is, the ratio of reserves to a broad measure of the money supply. We find that the ratio of international reserves to M2 is also far lower than for Singapore, and average for the regions.

Table 4 shows these reserve ratios for various countries before and after the 1997 crisis. Before the crisis, the ratio of international reserves to M2 was near 16 percent for Korea and Indonesia, 20 percent in Thailand, 24 percent in Hong Kong SAR and 21 percent in the Philippines, and almost 100 percent in Singapore. The Hong Kong reserve ratio was not much higher than for the countries in crisis, and was indeed much lower than that for Singapore. Notice however, that Thailand's reserves were largely committed in the forward market in mid-1997. Moreover, the loss of confidence in Korea was accelerated during the crisis due to uncertainty about the size of its usable reserves, which differed substantially from measured reserves. This difference arose as a result of foreign currency deposits placed by the Bank of Korea with foreign branches of domestic banks that became illiquid.

The comparison of international reserve ratios suggests that a high level of reserves relative to key monetary aggregates is not a requirement for a well-behaved currency board. Because Hong Kong SAR is a liquid economy counting with highly developed and open financial markets, its money supply levels are high in relation to the levels of international reserves. The gigantic level of reserves turns out to be average when expressed in relation to the money supply. The argument that Hong Kong SAR did better than other East Asian countries simply due to the large level of reserves is thus subject to dispute.

E. Macroeconomic Performance: Inflation Stability

Currency boards rapidly brought low inflation to Argentina, Bulgaria, Lithuania, and Estonia after a period of three-digit inflation in those countries. On the other hand, in the case of Hong Kong SAR, a relatively low inflation country before the establishment of the currency board, there was no clear inflation-reducing effect, until a deflationary adjustment to real exchange rate appreciation due to devaluations in East Asia.

Figure 4 depicts inflation in various Asian countries since the seventies. All Asian countries examined have achieved single-digit inflation rates since the mid-eighties, beating a previous period of double-digit inflation. The establishment of the Hong Kong currency board in 1983 did not result in a reduction of inflation. Instead, inflation gradually increased up to 10 percent in the early nineties, and gradually declined to around 5 percent in 1997. In fact, Singapore (whose currency appreciated with respect to the U.S. dollar), Taiwan Province of China, Malaysia, and Thailand exhibited lower average inflation than Hong Kong SAR during 1983-98. The fluctuations in Hong Kong inflation were related to fluctuating non-traded goods prices in a service economy in which real estate values are a significant element, and did not result in a deterioration of Hong Kong SAR's trade performance. In 1999, however, both Hong Kong SAR, and Argentina experienced deflation.

F. International Competitiveness: Effective Real Exchange Rates

A currency board guarantees nominal exchange rate stability with respect to the anchor currency used to peg the exchange rate. On the other hand, a peg regime cannot guarantee real effective exchange stability. First, nontraded goods prices in a currency board such as Hong Kong can differ from nontraded goods prices in the U.S. due to differences in the growth of productivity in various sectors. For that reason, bilateral real exchange rate stability is not perfect (as Hong Kong's real exchange rate appreciation shows). Second, a currency board that uses the U.S. dollar as an anchor does not stabilize nominal exchange rates with the currencies of other trading partners.

We find that currency boards experienced substantial real effective exchange rate variability and are subject to substantial appreciations. Figure 5a shows that the Hong Kong dollar has experienced a substantial real appreciation since the eighties, and was the only Asian currency examined that appreciated in real terms during the 1997-98 crisis. This real appreciation compounded the substantial appreciation experienced during 1995-97 (resulting from the appreciation of the U.S. dollar during that period). When the dollar continued to appreciate during 1997 and most of 1998, the Hong Kong dollar appreciated while its main East Asian trading partners (except China) experienced real depreciations. As mentioned above, the Hong Kong dollar's appreciation trend since the eighties is related to structural factors and did not result in poor trade performance.

The Latin American and Baltic Countries illustrate cases in which inflation inertia following the introduction of a currency board (see Figure 5b) was associated with substantial real appreciations during the initial years of currency board operation. In Argentina, the peso appreciated substantially following the establishment of a currency board in 1991. This experience contrasts with that of Chile, which successfully followed a policy of maintaining remarkably stable real effective exchange rates.

In the three Baltic countries, inflation and real effective exchange rate behavior has followed a similar pattern since 1992, resulting in substantial appreciations over time (including a rapid real appreciation of the three countries during 1998). In particular, the appreciation of the currency board countries, Estonia and Lithuania, is not greater to that of Latvia. Richards and Tersman's [1996] analysis of the experience up to 1995 attributes Baltic Countries' real appreciation to the initial real undervaluation of the three transition economies. They also argue that real appreciation and inflation could become a structural phenomenon due to the more rapid productivity growth in the tradeable than in the non-tradeable goods sector. A recent study of real effective exchange rate and external sustainability in the Baltics finds that appreciation was inevitable because the Estonian kroon, the Lithuania litas and the Latvian lats were undervalued when the peg regimes were established. In addition, appreciation since 1998 is due to the large depreciation of the Russian ruble (see IMF [1999b]).

The previous analysis suggests that, because currency boards produce stable inflation, the major source of real exchange rate fluctuation is not domestic inflation but rather the fluctuations in the anchor currency's nominal exchange rate with respect to other trading partners. Furthermore, when the major trading partners are depreciating, the rigidity of the nominal exchange rate results in real appreciations. This is the case of Argentina after the Brazilian 1999 depreciation. In order to keep the effective exchange rate relatively stable, the monetary authority could peg with respect to a currency basket. However, one might lose inflation stability in the process (e.g., if some of the currencies in the basket are those of countries experiencing high inflation).

On the one hand, stable domestic inflation hinges on pegging to a currency of a country that has stable inflation. On the other hand, effective real exchange rate stability hinges on pegging to currencies that might not have stable inflation. If a country establishes a currency board using as an anchor the currency of a low-inflation country (say, the U.S.), it ensures inflation stability. However, if the anchor currency appreciates, the currency board would share the appreciation, and would experience an effective exchange rate appreciation. The trade-off between stable inflation and stable effective exchange rate is unavoidable because it is in the nature of establishing a rigid peg to a particular currency.

Potential real effective exchange rate instability can plague both standard pegs and currency boards. The problem is more acute with the currency board because there is no possibility of devaluation to offset an appreciation of the anchor currency. The effective appreciation problem is likely to be quite significant in practice in some cases. For instance, the Argentinian peso experienced an effective appreciation due to the depreciation of the real during early 1999. In contrast, Djibouti's currency board (established in March 1949) provides an example of remarkable real effective exchange rate stability since the mid-eighties (see Baliño, Enoch, Ize, Santiprabhob, and Stella [1997]).

G. Macroeconomic Performance: Unemployment and Growth

There is very little systematic work assessing the macroeconomic performance of currency boards through statistical testing or simulations. Ghosh, Gulde, and Wolf [1998] compare currency boards with other pegged exchange rate regimes. They find that currency board arrangements are associated with better inflation and higher average output growth than other forms of pegged exchange rate regimes. While the above paper is concerned with average growth performance, the issue of growth volatility is addressed by Kwan and Lui [1996] who perform a simulation analysis of currency boards versus a flexible exchange rate regime. In their simulations, currency boards tend to slow down output growth, but reduce inflation. Also, demand shocks do lead to greater output volatility under the currency board. In particular, they find that if the government that adopts the currency board is able to discipline itself, the volatility of the economy might be lower than that of the flexible regime.

Our review suggests that currency boards do tend to stabilize inflation relative to standard pegs or flexible rates, while they tend to be more responsive to negative employment shocks, although there is no growth deterioration on average. The model presented below is motivated by this unemployment-inflation trade off.

Figure 6 depicts the unemployment experience of currency board countries compared with similar countries. Observers predicted that Hong Kong SAR would undergo a painful high interest rate adjustment process during the Asian crisis, associated with slow growth and high unemployment. In fact, interest rates became unstable, economic growth slowed down during 1997, and Hong Kong SAR fell into recession in 1998. The unemployment rate increased to 5 percent up from 2-3 percent before the crisis. This experience contrasts with Singapore, that continued to grow until late 1998, and Taiwan Province of China, that did not experience any contraction during 1997-98. Even though the increase in unemployment was sharper than for Singapore, the Philippines and Taiwan Province of China, it was less sharp than the increases in the hard-hit economies in the area. In short, the Hong Kong economy was not much more responsive than similar countries to the negative demand shocks affecting the region.

The establishment of the Argentinian currency board in 1991 is associated with a large increase in unemployment, which went from 6 percent to about 18 percent during 1992-95 and had only declined to 14 percent in 1998. Among the currency board regimes examined this is the case that best illustrates that labor market inflexibilities imply that a currency board can be associated with a large rise in unemployment that is not experienced by similar economies.

The dynamics of unemployment under the Lithuanian and Estonian currency board is quite similar to that of Latvia (which does not have a currency board). In all three cases there was a sharp increase during the early nineties' transition. In Estonia, unemployment settled at about 10 percent, while unemployment settled at lower levels (6-7 percent) in Lithuania and Latvia.

III. Modeling the Credibility of Alternative Regimes

Our empirical analysis suggests the conclusion that currency board arrangements seem to excel in terms of average performance. In those periods in which economies are hit by large shocks, however, currency boards can do worse than other regimes featuring flexibility. This was the case of the slowdowns and sluggish recoveries of Hong Kong SAR and Argentina during and after the East Asian and Brazilian crises. We develop a credibility model that incorporates both features: currency boards outperform standard pegs on average even if they do worse in extreme situations.

We extend Drazen and Masson [1994] model of the trade-off between reputation and stabilization faced by a government planner that solves a social loss minimization problem à la Barro and Gordon [1983]. Drazen and Masson developed a standard peg regime model in which the government decides whether or not to devalue. We allow the government to choose between a currency board and a standard peg regime. The government can have a "tough" or "weak" attitude with respect to inflation. The tough government assigns a higher weight to welfare losses from inflation than a weak government. In particular, the tough government will be more willing to abstain from devaluation and let unemployment go up in order to keep inflation low. Because the private sector does not observe the government type, it must infer the type from observations of the policies followed by the government. In Drazen and Masson's model the observed policies comprise whether or not the currency was devalued in the previous period. In this model (further examined in Oliva, Rivera-Batiz and Sy [1999]), there is the additional information of whether or not the government adopted a currency board.

In the standard peg regime, the level of the exchange rate is endogenously-determined, depending on the shocks hitting the economy and how the government solves the trade-off between reputation and economic pressures. For instance, a policy of unexpected devaluation is assumed to be able to reduce unemployment. This short-term beneficial effect must be traded-off against the loss of government reputation for toughness. A government that abstains from devaluation when times are bad, enhances reputation as a "tough" policymaker that puts a low weight on inflation (because unemployment would decline if a devaluation policy would be followed). On the other hand, abstaining from devaluation when times are bad (i.e., "tough" policy) means that the unemployment pressure is maintained (compared with the case of an unemployment-reducing devaluation). As long as unemployment exhibits persistence effects, the "tough" government faces a higher future unemployment rate than the "weak" government. In short, when there is persistency in unemployment there is a trade-off between reputational and future stabilization considerations.

The currency board imposes a no-devaluation rule unless the currency board is abolished. This paper imposes the condition that there is no devaluation in the first period, but devaluation can be realized subsequently by exiting the currency board. For instance, exiting might require the authorization of the parliament, causing a one-period delay. The currency board's institutional structure means that the adoption of that regime sends a strong signal for toughness and for a no-devaluation stance in the period immediately after the currency board adoption, but not necessarily afterwards. In our model we have a forced currency board exit when adverse enough shocks hit the economy in the second period. In a longer time horizon than the two-period model considered here, one could think about the uncertain duration of reform (Calvo and Drazen [(1996)]) and voluntary exit after the stabilization role of the currency board has been fulfilled (see Eichengreen, Masson, and others [1998]).

The previous discussion suggests that, when there is an unknown government type, one should distinguish between the reputation of the policy maker and the credibility of policies. Following a "tough" policy can enhance the reputation of the policymaker as a "tough" one, while undermining the credibility of the "tough" policy itself. This result can arise when the trade-off between following a tough policy and the benefits from relaxing it are worsened in the future as a consequence of following a tough policy today.

Suppose that a tough government continues to face high unemployment in the future whereas a weak government reduces the unemployment pressure by its devaluation policy. The greater unemployment pressure faced by the tough government could lower the credibility of the commitment to keep the exchange rate fixed in the future (even if the tough type is confirmed by the no-devaluation policy). The credibility of the policy is lowered if the incentives to devalue are maintained over time because the persistent devaluation incentives would be taken into account by the public when formulating expectations about devaluation. Policy credibility is lowered when the private sector perceives that the trade off between reputation and the relaxation of policies is worsened by a tough policy, and the incentives to devalue are larger as pressures are maintained over time (in contrast with a weak government that eliminates the unemployment pressure immediately through devaluation).

In this paper, we address the issue of regime credibility and the costs of sending a signal about the government attitudes toward inflation (i.e., toughness) to the private sector. Compared with the standard peg, the adoption of a currency board sends a clear no-devaluation signal in the period following the adoption of the currency board. But this means that unemployment pressures will accumulate over time. The reason is that a limited capacity to conduct macroeconomic policy implies that unemployment tends to be more persistent under a currency board than under a standard peg. The question arises concerning the comparative credibility and stabilization properties of a standard peg and currency board after the initial period.

A. The Sequential Game and the Choice of Regime

The role of credibility and stabilization in the choice of alternative regimes can be modeled using a three stage game. The status quo is a standard peg regime with a given exchange rate. The game begins when nature assigns the government's type, which is weak or tough. The government's type is private information for the government. The private sector's prior is that each type is equally likely. After the type is assigned, the government chooses the currency regime (i.e., currency board or standard peg). The private sector will form expectations of inflation for date one conditional on the currency regime. If the private sector observes a currency board, then it knows that there will be no devaluation in period one no matter the value of the shock hitting the economy. This means that the government has tied its hand. If the government has chosen a standard peg, the private sector knows that the government will devalue sometimes depending on the value of the shock hitting the economy in period one.

The monetary authority[3] has the power to act for two periods. In the first period, the monetary authority observes the shock hitting the economy. Under a standard peg, the government will devalue if the shock is large enough, otherwise it will not devalue (appreciation is not allowed in the model). If there is a currency board, however, the government cannot devalue. In the second period, the authority observes the second period shock and then decides whether or not to devalue under a peg or whether or not to abandon the currency board. The authority is assumed to be unconcerned about what happens after it abandons power. The government is assumed to hold an informational advantage over the private sector because the former observes the shock when it makes policy decisions whereas the private sector is assumed not to observe this shock. Specifically, when the private sector forms its expectations of inflation in the second period, it has observed the currency regime and the first period policy, but not the second period shock.

The peg regime allows the choice between keeping the previously-set peg or devaluing at a given rate Δs in period 1 as well as in period 2. In contrast, a currency board is constrained not to devalue in period 1 but there is the possibility of devaluing and exiting the currency board in period 2. The private sector solves a signal extraction forecasting problem. The observed monetary authorities' decisions about the exchange rate regime, and whether or not the standard peg was devalued in the first period, are used by the private sector to assess two probabilities. The private sector determines, first, the posterior probability that the government is tough or weak, and second, the probability of devaluation in period 2 given observed policy in period 1. In the second period, the government decides whether or not to devalue the peg, or whether or not to exit the currency board, and the game ends.

B. Unemployment Function

The gap between actual unemployment and the natural unemployment rate, u_t - u_N, is assumed to depend positively on an unemployment-increasing shock η_t, negatively on the deviation of inflation from expected inflation, π_t - π_t^E, and positively on the previous deviation of unemployment from the natural rate of unemployment, u_{t-1} - u_N. Algebraically

[3]We assume that the monetary authority acts as a disinterested agent for the government and use the two terms interchangeably.

$$u_t = u_N + \eta_t - \sqrt{a}\left[\left(\pi_t - \pi_t^E\right) - \delta\left(u_{t-1} - u_N\right)\right], t = 1, 2. \tag{1}$$

Making the two periods explicit, we have

$$\begin{aligned} u_1 &= u_N + \eta_1 - \sqrt{a}\left(\pi_1 - \pi_1^E\right) \\ u_2 &= u_N + \eta_2 - \sqrt{a}\left[\left(\pi_2 - \pi_2^E\right) - \delta\left(u_1 - u_N\right)\right] \end{aligned} \tag{2}$$

where the unemployment gap inherited in period 1 is assumed to be zero, that is, u_0 - u_N = 0.

The previous equation can be derived from a model in which private agents commit to nominal contracts that fix wages one period ahead. The private sector must forecast next period inflation in order to specify the nominal wage commitment. If actual inflation at t exceeds the inflation forecast formed at t - 1, real wages at time t will be less than anticipated and employment will rise.

The choice of a currency board instead of a pegged rate regime indicates that the government will not devalue in the first period. This means that the government will be willing to sustain larger unemployment in both the first and the second period (due to persistence). Ceteris paribus, the greater the value of the persistence parameter δ, the greater the value of unemployment in the second period arising from an unemployment-increasing shock in the first period.

C. Government Loss Function

The government minimizes a two-period quadratic loss function $\Lambda^i = L_1^i + \beta E L_2^i$, where the superscript $i \in \{T, W\}$ indicates whether the government is "tough" (T) or "weak" (W), β is the government discount rate, and E is the expected value operator. Algebraically

$$\begin{aligned} \Lambda^i &= L_1^i + \beta E L_2^i = \theta_u^i\left(u_1 - u_N + K\right)^2 + \theta_\pi^i \pi_1^2 \\ &\quad + \beta E_1\left[\theta_u^i\left(u_2 - u_N + K\right)^2 + \theta_\pi^i \pi_2^2\right] \\ &= \theta_u^i\left(u_1 - u_N + K\right)^2 + \pi_1^2 \ + \beta E_1\left[\theta_u^i\left(u_2 - u_N + K\right)^2 + \pi_2^2\right], \end{aligned} \tag{3}$$

where the weights of the terms representing present and future unemployment, depend on the government type. For simplicity, the weights of the terms representing unemployment are set equal to 1 ($\theta_u^T = \theta_u^W = 1$) and $\theta_\pi^W < \theta_\pi^T$. This means that both types of governments are equally tough as concerns unemployment but differ in their willingness to accept high inflation.

The first period loss, L_1^i, is deterministic given the information available at time 1, which includes the value of the shock at period 1. The second period loss is random, and the government minimization problem involves the present value of the expected loss in the second period, βEL_2^i. Each period's loss function depends on the square of (1) the deviations of the unemployment rate from the natural rate of unemployment, u - u_N, plus the contribution K of distortions to the natural unemployment rate (if the natural unemployment rate u_N is large due to distortions, the unemployment gap might not reflect the total loss from unemployment), and, (2) expected inflation, π.

D. Unexpected Devaluation and Unexpected Inflation

We assume that purchasing power parity always hold, that is, $P_t = S_t P_t^*$, where P_t is the domestic price level, S_t represents the spot price of foreign currency, and P_t^* is the foreign price level. Measuring variables in logarithmic terms (indicated by small-case letters) and assuming that P_t^* is constant and normalized to one (so that $p_t^* = 0$) implies that the logarithmic price level p_t equals the log exchange rate s_t, $p_t = s_t + p_t^* = s_t$. Inflation and unexpected inflation are given by

$$\begin{aligned} \pi_t &= p_t - p_{t-1} = s_t - s_{t-1} \qquad (4) \\ \pi_t - \pi_t^E &= (s_t - s_{t-1}) - (E_{t-1}s_t - s_{t-1}) \\ &= s_t - E_{t-1}s_t. \end{aligned}$$

The previous equation implies that devaluation leads to inflation, and that unexpected exchange rate changes are equivalent to unexpected changes in the price level. An unexpected devaluation reduces welfare by increasing inflation, but the unexpected inflation increases welfare by reducing unemployment.

IV. The Probability of Devaluation when the Government Type is Unknown

We examine first whether or not the monetary authorities will devalue in the second period given their actions in the first period. The size of the devaluation is denoted by Δs and is taken as given in the analysis. The key variable to be determined is the probability of second-period devaluation, given the observation of the policy followed in the first period (currency board, and peg regime with or without devaluation).

The probability of devaluation in the second period depends on three key factors in this model:

(1) whether the government is tough or weak, that is, the unobserved value of the index $i \in \{T, W\}$. At the beginning of the game, the priors are such that the prior probability of the government being tough is equal to the probability that the government is weak ($P(T) = P(W) = \frac{1}{2}$).

(2) the observed date 1 choice between a peg (P) and a currency board regime (CB).

(3) whether there is a devaluation in period 1 (D_1) or the exchange rate is kept fixed (F_1).

The set of possible period-1 policy actions is denoted $I_1 = \{ (D_1, P), (F_1, P), (F_1, CB)\}$, where I_1 is the information available after observing government actions at period 1. Notice that neither devaluation nor exit is allowed under the currency board regime in period 1. Because the currency board is not allowed to devalue in the first period, we will drop the F_1 argument.

A. Probabilities of Devaluation Conditional on Type, Regime, and Observed Policy

Because we do not consider a change of regime from period 1 to period 2, policy actions are limited to devaluation or no devaluation. We begin by computing the probabilities of devaluation in the second period, $P^i(D_2 \mid I_1)$, conditional on the government type $i \in \{T, W\}$, and observed choices in period 1

$$P^i(D_2 \mid D_1, P), P^i(D_2 \mid F_1, P), P^i(D_2 \mid CB).$$

The definition of the types means that, given the observed first period policy, the "weak" government will have a higher probability of period-2 devaluation than the "tough" government

$$P^W(D_2 \mid I_1) > P^T(D_2 \mid I_1).$$

B. Devaluation Probabilities with Unknown Types and Observed Policy

The probability of devaluation next period depends on the government type. The parameters representing the effect of type in the loss function, θ_π^T and θ_π^W, are assumed to be known, but not the government type. Because the government type is unknown, the probability of devaluation in the second period, given the policy followed in the first period, should be computed on the basis of the likelihood that the government is tough or weak.

The probabilities of devaluation in period 2 given the lack of information about the government type i, but conditional on the observed policy choice at time 1, are given by

$$P(D_2 \mid I_1) = p(W \mid I_1)P^W(D_2 \mid I_1) + (1 - p(W \mid I_1))P^T(D_2 \mid I_1),$$

where $P(D_2 \mid I_1)$ represents the probabilities of devaluation in period 2 given the information available at period 1, and $p(W \mid I_1)$ is the updated probability that the government is of type W given the observed choices at period 1. Notice that $1 - p(W \mid I_1) = p(T \mid I_1)$. All the probabilities are computed for a given distribution of the shock in period 2. The probabilities of no-devaluation in period 2 are computed as 1 minus the probability of devaluation in period 2 (i.e., $P(F_2 \mid I_1) = 1 - P(D_2 \mid I_1)$).

In order to compute the probabilities of devaluation given the first period action, $P(D_2 \mid I_1)$, we must first determine the likelihood of the type given the observed policy. In particular, we must compute:

(1) $P(W \mid I_1)$, that is, the probability that the government is weak given the information about the policy action followed in period 1, and,

(2) $P^W(D_2 \mid I_1)$ and $P^T(D_2 \mid I_1)$, that is, the probabilities of devaluation in period 2 conditional on the type and the policy followed in period 1.

We proceed to show how to compute these probabilities.

C. Determination of the Critical Unemployment Shock in Period 2

Figure 7 depicts the determination of the critical value of the shocks that makes the government indifferent between devaluating and keeping the peg. Notice that a currency board does not allow devaluation in the first period and that devaluation in the second period can be interpreted as exiting the currency board.

There is a critical value $\widehat{\epsilon}_2$ of the second period shock $\epsilon_2 = \frac{\eta_t}{\sqrt{a}}$ such that:

(1) if the realization of ϵ_2 is below the critical value $\widehat{\epsilon}_2^i(j,P)$ or $\widehat{\epsilon}_2^i(CB)$, where $j \in \{D_1, F_1\}$, a policy of maintaining the previous parity in the second period is optimal in the sense of quadratic loss minimization.

(2) if the realization of ϵ_2 is above the critical value $\widehat{\epsilon}_2^i(j,P)$ or $\widehat{\epsilon}_2^i(CB)$, $j \in \{D_1, F_1\}$, then a devaluation is optimal.

Notice that the critical value of the shock is dependent both on the type of government (as indicated by the superscript $i \in \{T, W\}$), and on the previously-observed policy $I_1 \in \{(D_1, P), (F_1, P), CB\}$.

The critical values of the shock $\widehat{\epsilon}_2^i(CB) \equiv \frac{\eta_t}{\sqrt{a}}$ and $\widehat{\epsilon}_2^i(j,P) \equiv \frac{\eta_t}{\sqrt{a}}$ can be obtained by minimizing the loss function in period 2, given the information about period-1 policy action

$$
\begin{aligned}
\widehat{\epsilon}_2^i(CB) &= \frac{\left(a+\theta_\pi^i\right)\Delta s}{2a} - \kappa - P(D_2 \mid CB)\Delta s - \delta\left(u_1(CB) - u_N\right), \\
\widehat{\epsilon}_2^i(j,P) &= \frac{\left(a+\theta_\pi^i\right)\Delta s}{2a} - \kappa - P(D_2 \mid j,P)\Delta s - \delta\left(u_1(j,P) - u_N\right)
\end{aligned}
$$

where $i \in \{T, W\}$, $j \in \{D_1, F_1\}$, Δs is the assumed fixed devaluation amount, and $\kappa \equiv \frac{K}{\sqrt{a}}$.

The unemployment rate at time 2 is a function of the policy followed by the government at time 1. For any given government type, the greater the unemployment at time 1, the lower the value of the critical shock at time 2. This effect is due to the persistence of unemployment as represented by the δ coefficient, and disappears if there is no persistence (i.e., $\delta = 0$).

How do peg and currency boards compare in terms of stabilization? Let us focus on the case in which a low unemployment shock implies that the peg regime authorities will abstain from first period devaluation. If that happens, the critical unemployment shock that touches off a devaluation in the second period will be higher under a currency board than under a peg that did not sustain devaluation in period 1: $\widetilde{\epsilon}_2^i(F_1, P) < \widetilde{\epsilon}_2^i\,(CB)$. A peg regime that does not devalue produces a lower inflation than expected, which represents a contractionary policy that, ceteris paribus, increases unemployment relative to the currency board. From equation (2) it is easy to see that if there is no devaluation in the first period, unemployment under the peg regime u_1^P will be greater than under a currency board u_1^{CB}, $u_1^P = u_N + \eta_1 + \sqrt{a}\,\pi_1^E > u_1^{CB} = u_N + \eta_1$.

The currency board eliminates the possibility of devaluation in the first period and thus breaks inflation expectations. Therefore there is no incentive to devalue and generate inflation in the first period in order to avoid unrealized inflation expectations. In contrast, the unexpectedly low inflation taking place when a peg regime does not devalue generates a contractionary effect relative to currency boards. Recall that expected inflation is always positive in the first period under a peg, and that an inflation rate that is less than expected inflation increases unemployment in this model.

A currency board sends a strong signal of stable prices in the period following its adoption. The probability of first period devaluation under the currency board must be smaller than under a peg, and unemployment will be lower than a peg regime that abstains from devaluation in the first period. This is the argument that the effectiveness of a currency board can be greater than the under a peg. The argument hinges on credibility properties of currency boards.

The argument for a peg regime hinges on the notion that a high enough unemployment shock requires a devaluation which is not possible under a currency board. In general, lack of policy flexibility effects work against the currency board while low inflation credibility effects work in favor of the currency board. Regime choice hinges on the trade off between these two opposing effects.

D. Conditional Devaluation Probability Given Types and Observed Policy

We can compute the conditional probabilities of devaluation given types and observed policy in the case in which the distribution of ϵ is uniform between $-v$ and $+v$

$$\epsilon \;\sim\; U[-v, v].$$

The interior solution for $i \in \{W, T\}$is

$$P^i(D_2 \quad | \quad I_1) = prob\left(\epsilon_2 > \widehat{\epsilon}_2^i\left(I_1\right)\right) = \frac{\left(v - \widehat{\epsilon}_2^i\left(I_1\right)\right)}{2v} \tag{5}$$

The previous formula represents the length of the segment where the value of the shock exceeds the critical value, that is, $v - \widehat{\epsilon}_2^i\,(j, P)$ and $v - \widehat{\epsilon}_2^i\,(CB)$, $j \in \{D_1, F_1\}$, divided by the length of the sample space ($2v$). We now have formulas for the conditional probabilities of devaluation given the types and the observed period-1 policies. We proceed to compute the conditional probabilities of the policymakers' types.

E. Conditional Probability of Types Given Observed Policy

The probability of the type given the observed policy in period 1 is obtained through Bayesian methods. Recall that equating the prior probabilities of "weak" and "tough" type, $P(W) = P(T) = \frac{1}{2}$, yields

$$P(W \quad | \quad I_1, P) = \frac{P(I_1 \mid W)}{P(I_1 \mid W) + P(I_1 \mid T)} = \frac{P^W(I_1)}{P^W(I_1) + P^T(I_1)}.$$

The conditional probabilities of being "tough" are simply 1 minus the corresponding probability of being "weak". We now have all probabilities needed to compute the conditional probabilities of devaluation in period 2, given the policies followed in period 1.

F. How Observed Policy Affects the Probability of Devaluation

We are particularly interested comparing the probabilities of devaluation of a currency board and a standard peg regime that abstains from devaluation in period 1. The solution for the probability of period-2 devaluation is given a currency board is

$$P\left(D_2 \mid CB\right) \;\; =$$

$$p(W \quad | \quad CB)P^W(D_2 \mid CB) + (1 - p(W \mid CB))P^T(D_2 \mid CB)$$

where $P^W(CB)$ and $P^T(CB)$ are the probabilities that the weak and the tough types choose a currency board in period 1. Similar equations apply to $P(D_2 \mid F_1, P)$ and $P(D_2 \mid D_1, P)$.

V. CURRENCY REGIME CHOICE

Oliva, Rivera-Batiz and Sy [1999] examine the mathematical details of the currency board versus standard peg model. Figure 8 illustrates the choice of currency regime as a function of the unemployment persistence parameter δ. The figure compares the value of the expected loss function $E(\Lambda)$ for a currency board and a peg regime for different magnitudes of the unemployment persistence parameter δ. Notice that expected loss increases with the magnitude of the persistence parameter δ and that there is a different curve for a tough and a weak government. The loss functions associated with the weak government lie below those associated with the tough government. The parameters used are: $\Delta s = 0.1$ $\kappa \equiv \frac{K}{\sqrt{a}} = 0.30$, $\alpha = 0.25$, $\upsilon = 0.30$, $\beta = 0.95$, $\theta_{\pi}^{T} = 1$, and $\theta_{\pi}^{W} = 0$.

Figure 8 illustrates a separating equilibrium case in which the tough government prefers the peg while the weak government prefers the currency board. Due to the strength and persistence of unrealized expectation effects, very high unemployment persistence leads the weak government to prefer the currency board as a disciplining device

A key element of exchange rate regime choice relates to how alternative regimes perform when there is devaluation and when there is no devaluation. The adjustable peg provides the option to devaluate to offset unemployment shocks while the no-devaluation constraint can become effective for the currency board. This policy flexibility effect favors the peg over the currency board. The peg versus currency board choice depends on whether or not the flexibility value of the peg dominates the negative welfare effects arising from (1) actual inflation and (2) unrealized anticipated devaluation (which entails a contractionary bias for peg regimes that do not devalue). Because these effects work in opposite directions, regime choice will depend on country-specific parameters.

VI. CONCLUSIONS

An expanding set of good experiences with currency boards have encouraged ample discussion about their macroeconomic and operational aspects (Osband and Villanueva [1993], Romer [1983], Hanke and Schuler [1994], Williamson [1995], Masson and Taylor [1993], and Enoch and Gulde [1997]). A number of macroeconomists have proposed currency board systems for Indonesia, Malaysia, Russia, Brazil, El Salvador and other countries.

We have looked at recent experiences with currency board regimes and presented a model in which the properties of currency boards and standard pegged regimes can be compared. The analysis represents a first step toward more detailed modelling. The model showed that, even if currency boards are limited in their use of devaluation to offset unemployment shocks, they can be welfare-improving due to their inflation stabilization and credibility properties. We also showed that, by reducing the magnitude of the negative employment effect that arises from expected but unrealized inflation, currency boards can produce less unemployment than standard peg regimes that abstain from devaluation. Finally, we demonstrated why a government that faces persistence unemployment would prefer a currency board (the Argentinian case).

There are costs and benefits from alternative exchange rate regimes. If the policymaker chooses a peg regime, then it has the benefit of the flexibility to devalue when the economy is hit by an adverse shock. Private agents, however, will anticipate this possibility when forming inflation expectations. If the policymakers abstains from using the flexibility to devalue, then there will be costs arising from the anticipated but unrealized inflation. If a government wants to be tough in the sense of pursuing inflation stability, a standard peg is not necessarily adequate. A financial analogy will help to clarify the issues involved. Choosing a peg amounts to buying an option to devalue. A tough government that chooses a standard peg is buying an option which it does not actually plan to exercise and the market will anticipate that. On the other hand, the currency board forfeits the option to devalue. There is a cost in terms of lack of flexibility but there is a gain in terms of lower inflation expectations. If the policymakers objectives are to be tough, then the currency board is preferred.

Empirically, we find that countries that adopted currency board arrangements in the nineties were able to adjust as rapidly, or more rapidly and lastingly, than other countries in similar situations. None of them devalued or was forced to exit the currency board. Inflation and interest rates generally converged toward the anchor currency levels. Foreign exchange market operational efficiency as measured by bid-ask spreads has been far greater in Argentina and Hong Kong SAR than in similar countries. On the down side, some currency board countries showed greater real effective exchange rate appreciation than similar peg regime countries. Also, forward exchange rate behavior in periods of speculative attacks indicates that the Asian crisis negatively affected Hong Kong's currency board credibility. Furthermore, currency boards stabilize inflation but tend to be more responsive to negative employment shocks as illustrated by the recessions experienced by Hong Kong SAR after the Asian crisis and by Argentina following the devaluation and subsequent depreciation of the real in January 1999.

Both theory and evidence suggest that currency boards operate differently from other variants of peg exchange rate regimes for comparable countries. The institutional details embodied in the design of a peg regime matter for their performance. The credibility of currency boards vis à vis other pegged regimes matters because exchange rate policy cannot be exactly specified in advance, and we thus face the possibility of devaluation at some point in time. Recent work on currency boards' historical performance and patterns of behavior in different circumstances suggests that (1) they are likely to be valid as a mechanism for reducing inflation and sharing the benefits of a currency area, and, (2) their performance depends on factors such as labor market flexibility, fiscal adjustment, and the specific escape rules and other institutional factors.

The peg versus currency board issue is not likely to be settled into a single choice but should rather depend on conditions under which currency boards are likely to work better than a standard currency peg, and vice versa. In addition, exchange rate policy is only one element along with other macroeconomic and structural policies. In particular, currency boards place limits on the monetary authority role as a lender of last resort function but this function can be outsourced and fulfilled by another institution. In addition there are escape clauses that can be used by the monetary authority, for example, when its reserves exceed the cover ratio of 100 percent.

Some policy lessons are clear. First, a government that adopts a standard peg gains policy flexibility and is better placed to make use of devaluation in the face of large enough shocks. Otherwise, a credibility cost is paid while the benefits of flexibility are foregone. Second, governments adopting currency boards renounce policy flexibility but will gain credibility, become disciplined, and can perform better on average than tough governments sticking to standard peg regimes. Indeed, the rigidity of currency boards can very well decrease production while a crisis lasts in the short run, but can also be associated with lower inflation and higher income growth on average.

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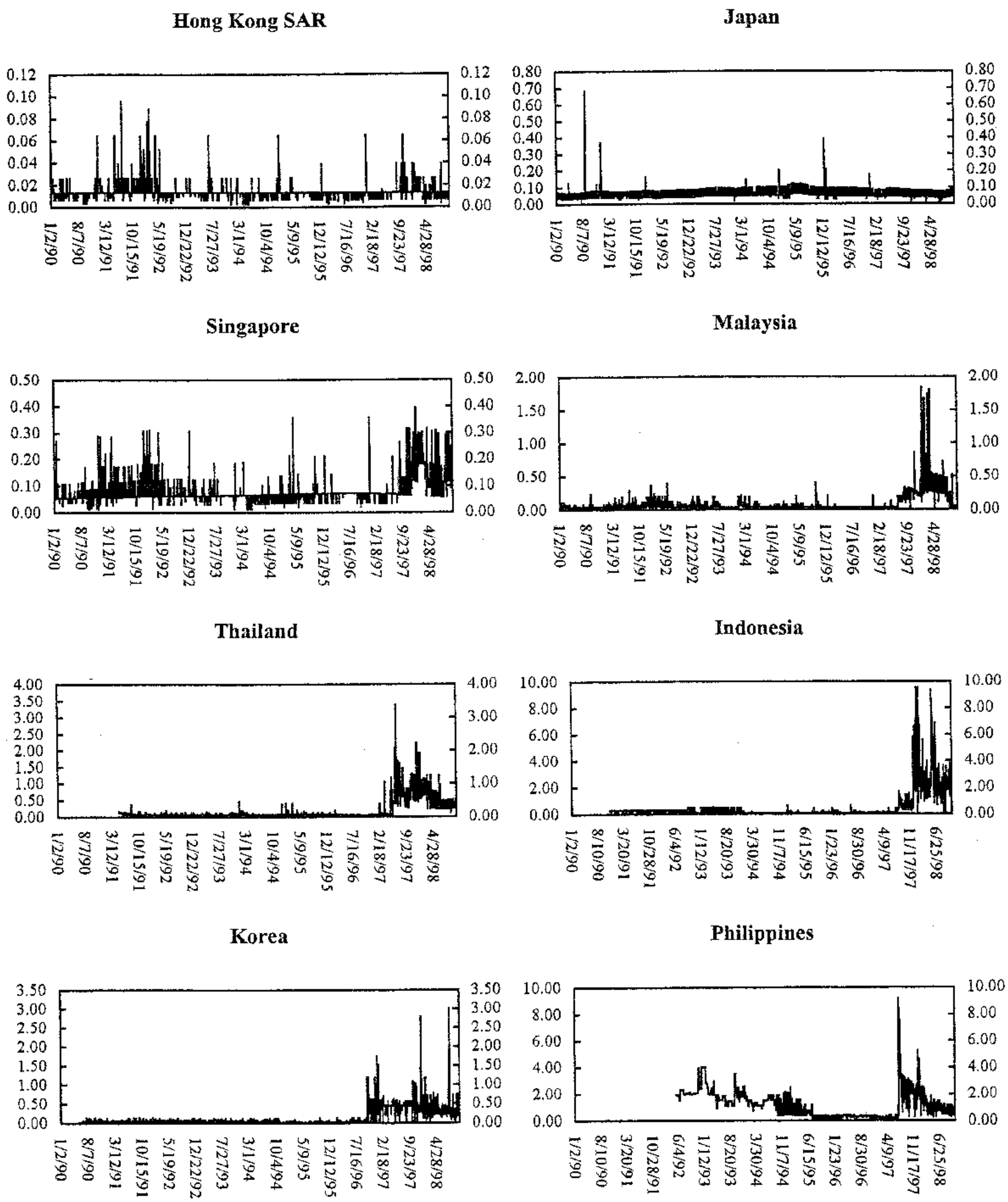
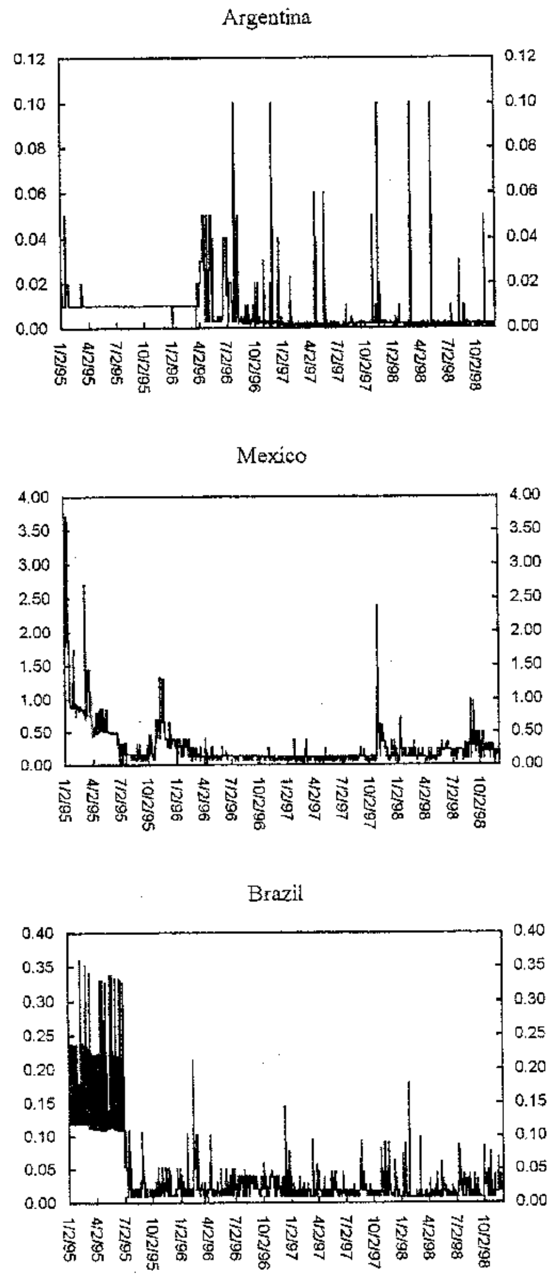
Figure 1a. Asia: Currency Percentage Bid-Ask Spreads
(In Percent), January 2, 1990-November 2, 1998



Sources: Reuters and Staff estimates.
1/ Daily Bid-Ask spreads over midpoint spot rate in percent.

Figure 1.b. Argentina, Mexico and Brazil: Percentage Bid-Ask Spreads

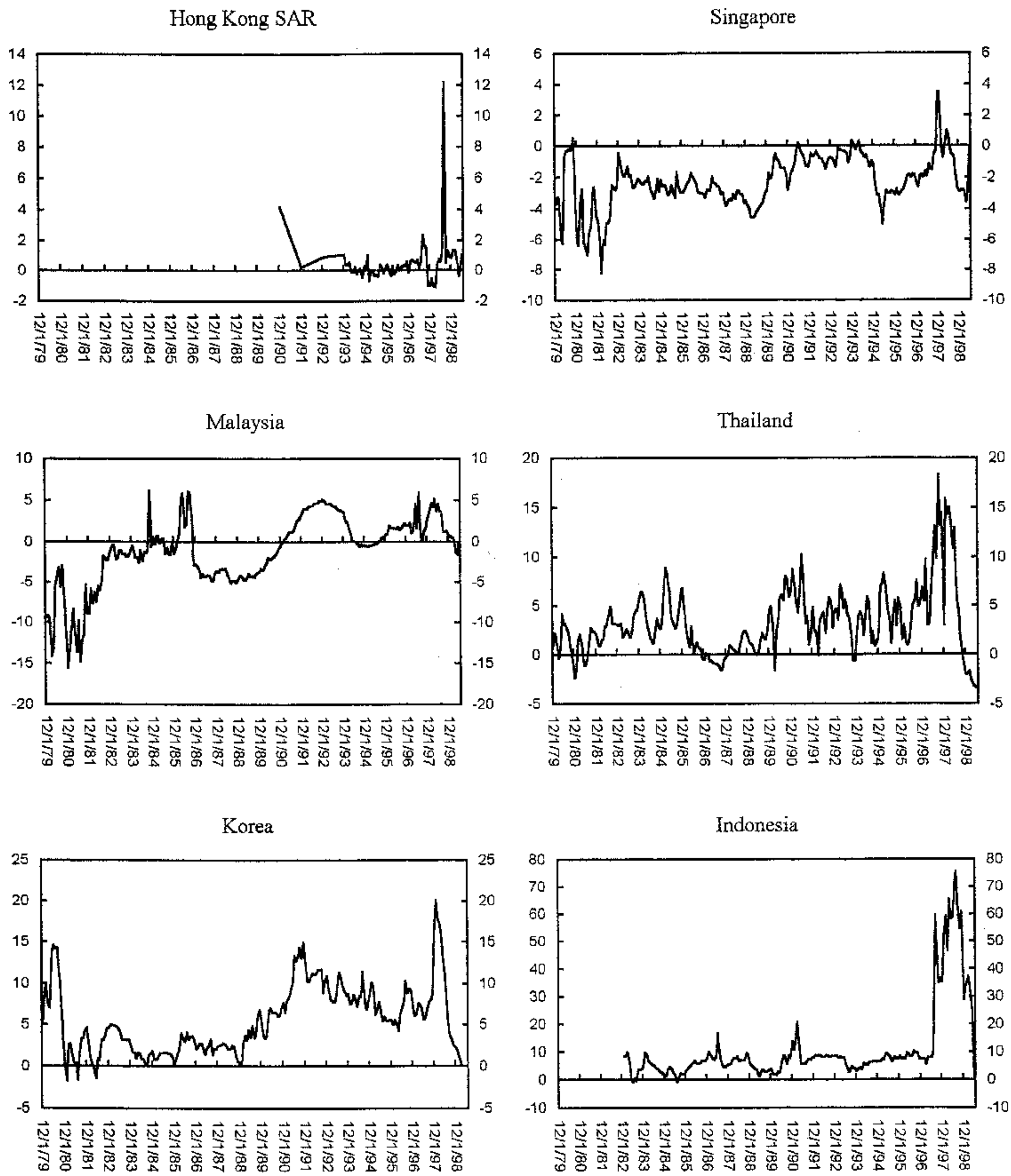
(In Percent), January 2, 1995-December 3, 1998



Sources: Reuters and Staff estimates

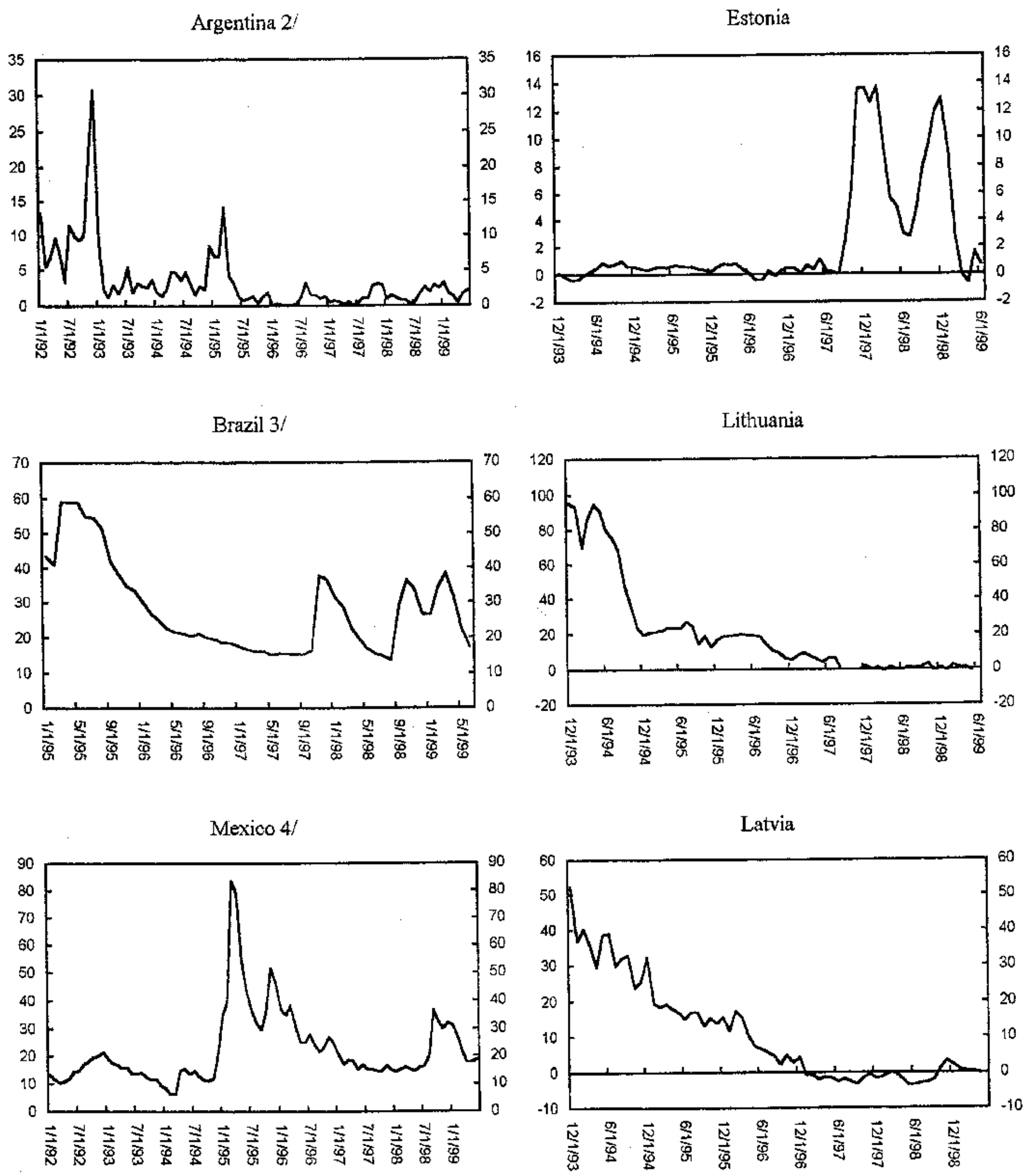
1/ Daily Bid-Ask spreads over midpoint spot rate in percent.

Figure 2.a. Asia: Money Market Rate Differentials 1/
(In percent), December 1979-June 1999



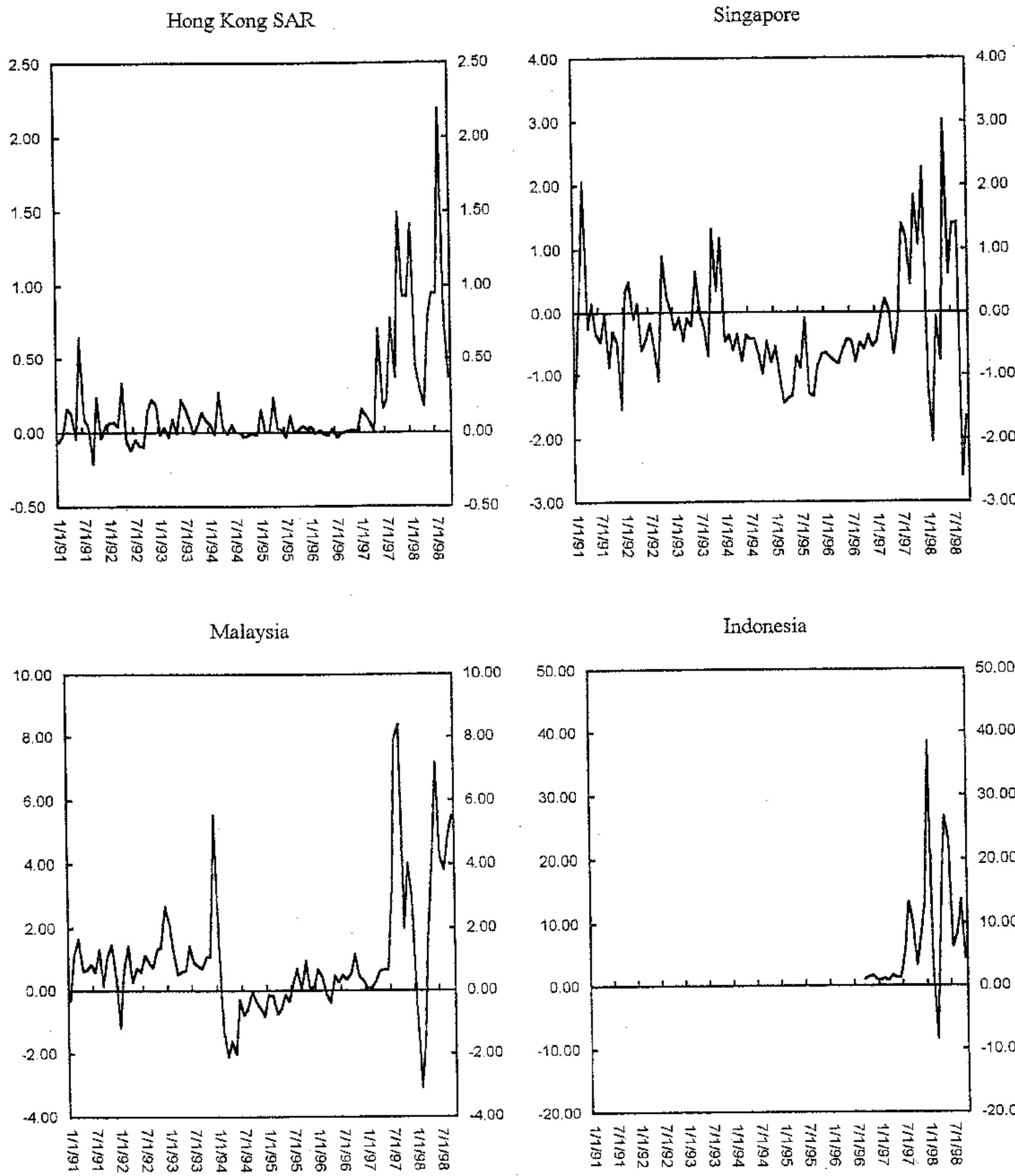
Sources: IMF, *IFS*
1/ Money market rates minus U.S. federal funds rates.

Figure 2.b. Latin America and Baltic Countries: Money Market Rate Differentials, 1/
(In Percent). Argentina and Mexico: Jan. 92- June 99, Brazil: Jan. 95-June 99, Baltic Countries: Dec.93-June 99.



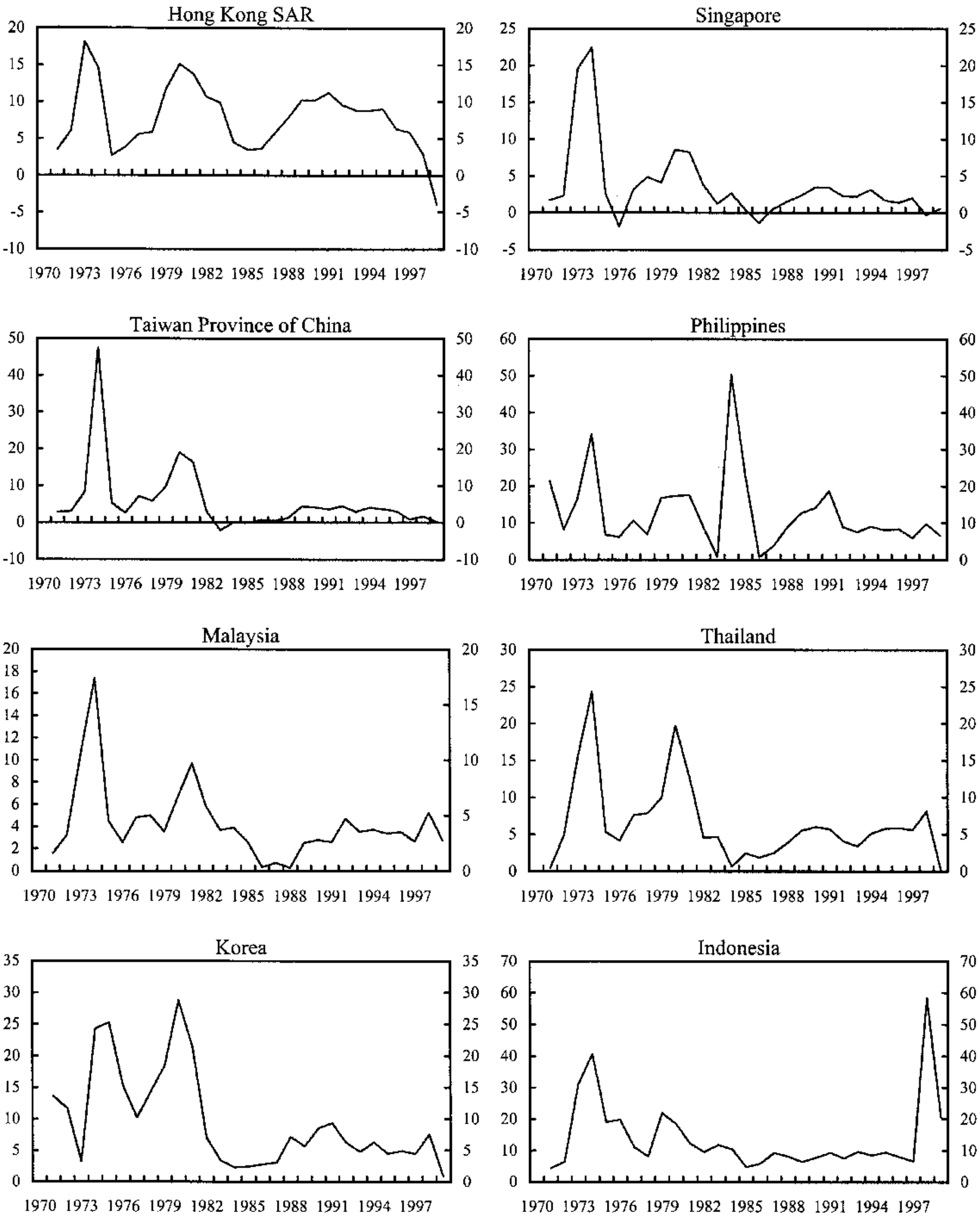
Sources: IMF, *IFS* and staff estimates
1/ Money market rates minus U.S. federal funds rates except for Estonia where German market rates are used. 2/ Money market rate represents average rates on loans denominated in peso of up to 15 days between domestic financial institutions, weighted by daily loan amounts. 3/ Money market rate represents the SELIC overnight rate weighted by loan amounts. This rate is a weighted average on loans between financial institutions involving firm sales of or repurchase agreements based on federal securities in the Special Settlement and Custody System (SELIC). 4/ Money market rate is the average of rates quoted by deposit money banks on 3-month bankers' acceptances. Beginning in March 1995, weighted average rate on loans between financial institutions (TIIE). The rate is weighted by daily loan amounts.

Figure 3. Hong Kong SAR, Singapore, Malaysia and Indonesia: 3-Month Forward Premia 1/
(In Percent), January 1991-October 1998



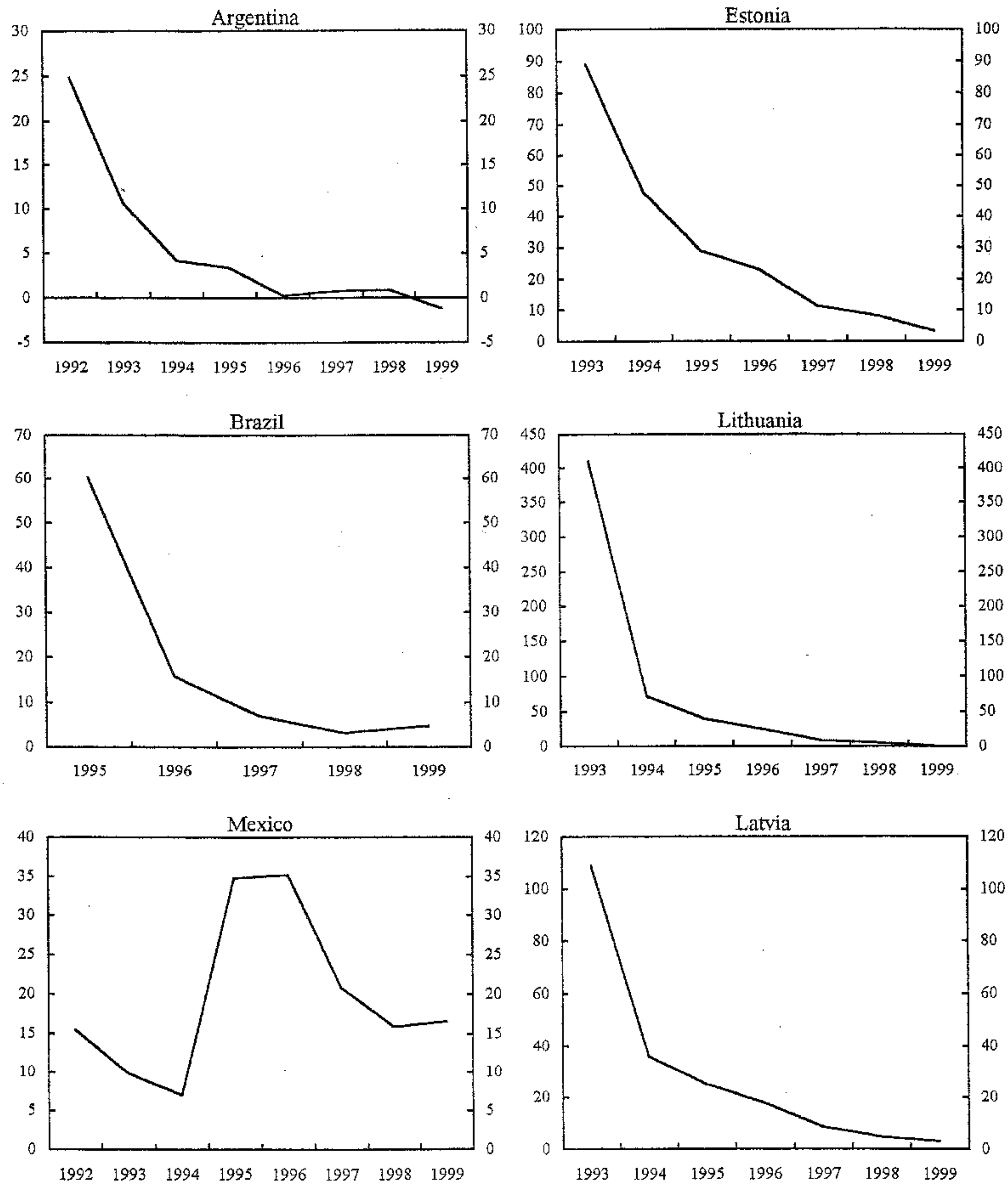
Sources: IMF, *INS*, Bloomberg and Staff estimates.
1/ Forward premium is the forward rate over the spot rate minus one.

Figure 4.a. Asia: Rate of Inflation 1/
(In Percent), 1970-1999



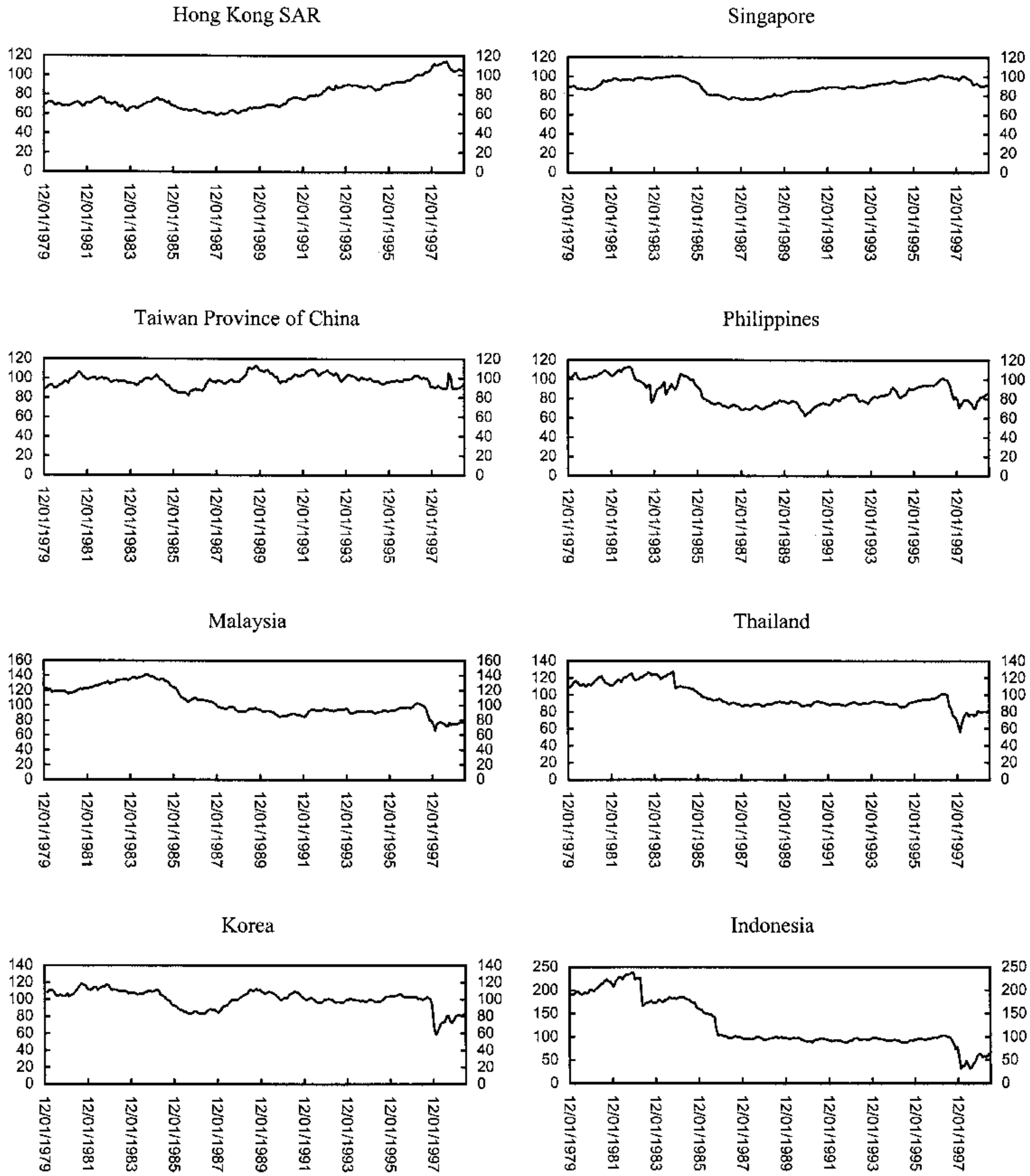
Sources: IMF, *WEO*
1/ Consumer Price Index

Figure 4.b. Latin America and Baltic Countries: Rate of Inflation 1/
(In Percent), 1992-1999



Sources: IMF, *WEO*
1/ Consumer Price Index

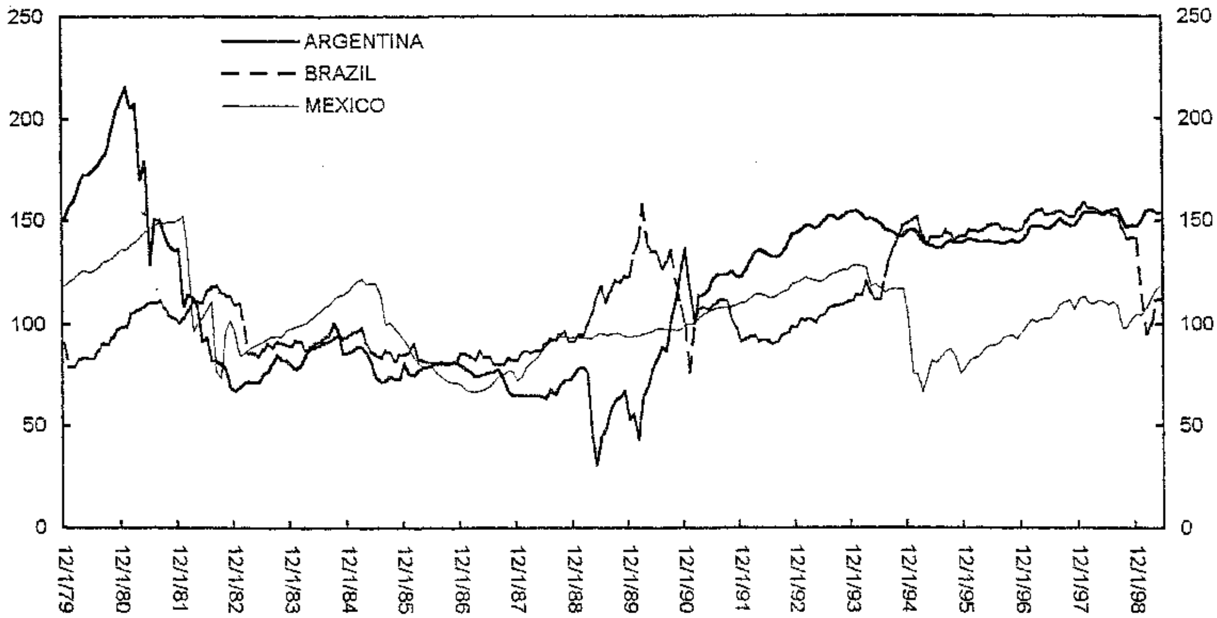
Figure 5.a. Asia: Real Effective Exchange Rates 1/
December, 1979- May, 1999



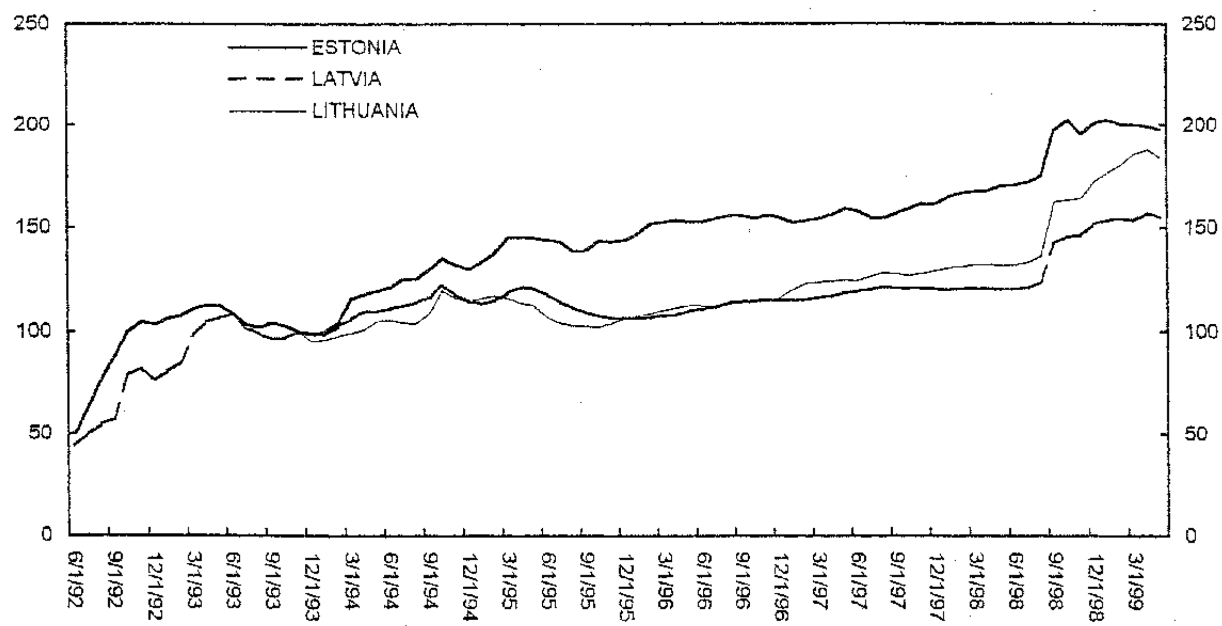
Sources: IMF, *INS*
1/ June 1997 = 100

Figure 5.b. Latin America and Baltic Countries: Real Effective Exchange Rates 1/
December, 1979-May, 1999

Latin America

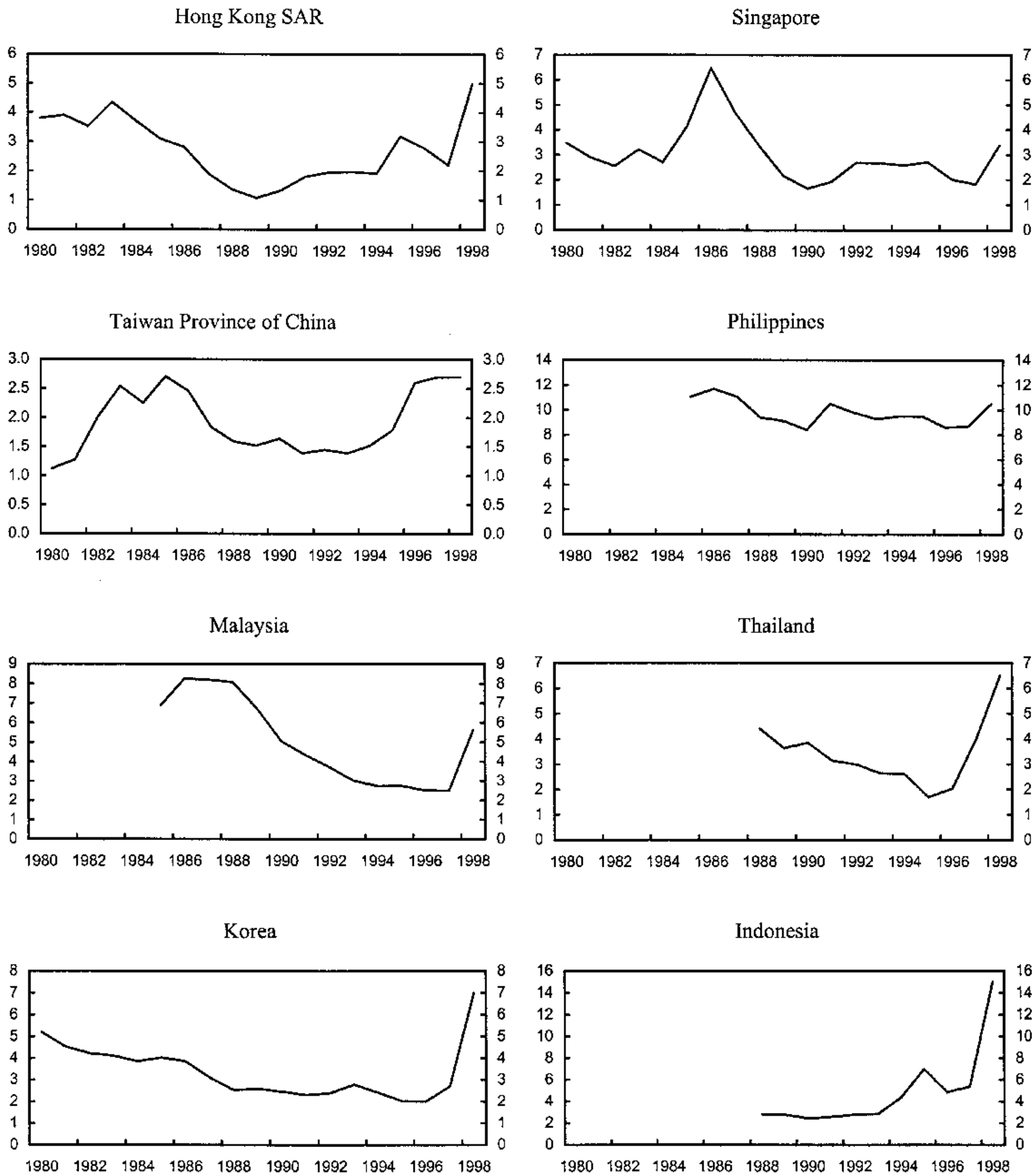


Baltic Countries



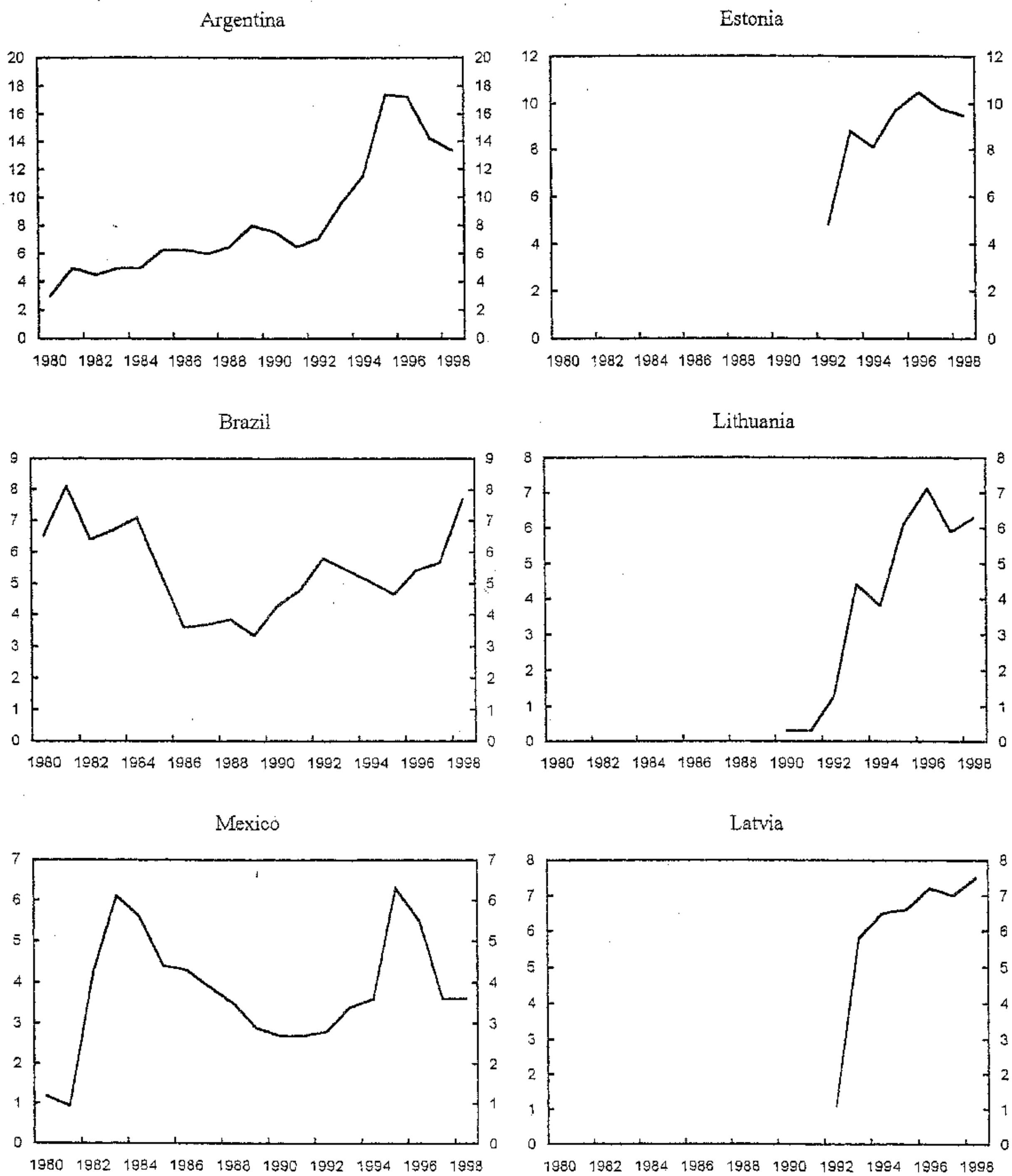
Sources: IMF, *INS* and Staff estimates.
1/ For Latin America, February 1991 = 100 and for Baltic countries November 93 =100.

Figure 6.a. Asia: Unemployment Rates
(In percent), 1980-1998



Sources: IMF, *WEO*

Figure 6.b. Latin America and Baltic Countries: Unemployment Rate
(In percent), 1980-1998



Sources: IMF, *WEO*

Figure 7: Critical Shocks

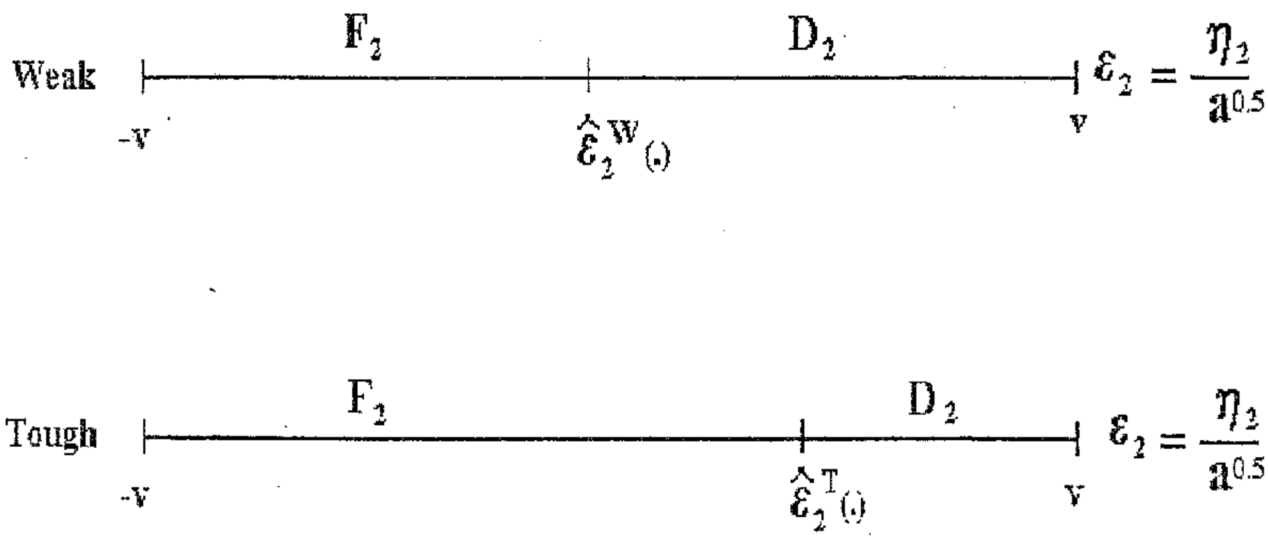
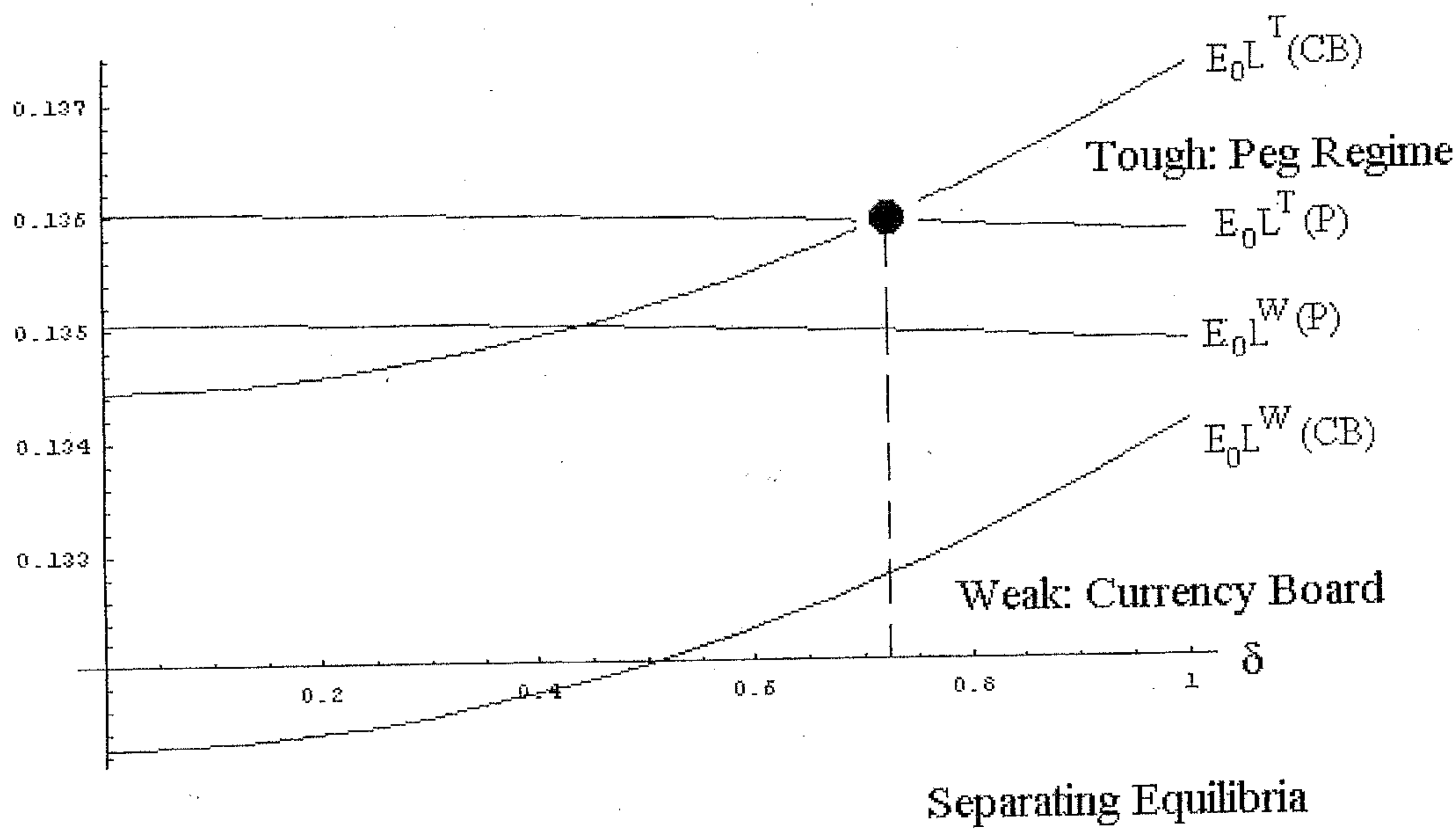


Figure 8: The Choice of Exchange Rate Regime



Currency Regime Choice (Separating, δ)

Table 1. Comparative Macroeconomic Performance 1/

	Number of Observa tions	Mean Inflation	Median Inflation	Mean M2 Growth	Median M2 Growth	Per Capita GDP Growth	Govt. Balance (% of GDP)
Currency Board	112	5.6	3.9	12.1	11.1	3.1	-2.7
Other Pegged	1089	22.3	8.4	25.1	13.7	0.9	-4.6
Float	714	43.1	9.2	47.4	16.0	1.7	-4.3
Full Sample	1915	29.0	8.4	32.7	32.7	1.3	-4.4

Sources: Adapted from Gulde, Keller and Kähkönen (1999).
1/ Data for 1975-1996.

Table 2. Asia: Exchange Rate Volatility and Spreads

Volatility 1/
(In Percent)

	Pre-Crisis	Crisis	Full Sample
Thailand	36.46	197.1	89.62
Indonesia	11.61	485.7	19.96
Korea	17.19	255.4	102.9
Malaysia	20.8	165.8	67.39
Philippines	38.46	143.3	73.75
Singapore	23.51	79.87	37.9
Hong Kong	3.45	3.97	3.53
Japan	68.33	98.28	73.63

Bid-Ask Spreads 2/
(In Percent)

	Pre-Crisis	Crisis	Full Sample
Thailand	0.087	0.683	0.193
Indonesia	0.159	2.159	0.495
Korea	0.075	0.422	0.128
Malaysia	0.052	0.283	0.087
Philippines	1.062	1.635	1.181
Singapore	0.071	0.14	0.081
Hong Kong	0.013	0.014	0.013
Japan	0.062	0.057	0.061

Sources: Reuters and Staff estimates.

1/ Standard deviation of the exchange rate return.

2/ Absolute spreads divided by the midpoint exchange rate.

Table 3. Money Market Rate Differentials: Mean and Volatility 1/
(in percent)

	Mean	Volatility 2/
Hong-Kong SAR	0.47	1.60
Singapore	-1.61	1.57
Korea	8.30	3.36
Thailand	4.96	5.01
Malaysia	1.37	1.65
Indonesia	20.99	21.26
Estonia	2.49	4.13
Latvia	10.75	14.10
Lithuania	20.76	27.37
Argentina	1.79	2.26
Brazil	28.35	13.00
Mexico	27.76	14.74

Sources: IMF, *IFS* and Staff Calculations.
1/ Data from December 1993 to June 1999 except for Argentina, Brazil, and Mexico (January 1995-June 1999).
2/ Standard Deviation.

Table 4. Reserve/M1 and Reserve/M2 ratios for Asia 1/

Reserve/M1

	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97
Hong Kong SAR	2.75	2.86	2.92	3.48	3.71	3.79	4.05
Indonesia	0.81	0.84	0.80	0.85	1.03	1.14	1.13
Korea	0.77	0.84	0.83	0.87	0.81	0.79	0.81
Malaysia	0.89	0.87	0.85	0.74	0.83	0.87	0.94
Philippines	1.15	1.10	1.09	1.02	1.16	1.38	1.27
Singapore	4.13	4.17	4.08	4.17	4.20	4.22	4.27
Thailand	2.24	1.94	2.04	2.40	2.00	2.61	2.95

Reserve/M2

	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97
Hong Kong SAR	0.23	0.23	0.24	0.28	0.29	0.30	0.31
Indonesia	0.16	0.16	0.16	0.17	0.18	0.21	0.20
Korea	0.15	0.16	0.16	0.16	0.14	0.14	0.15
Malaysia	0.28	0.28	0.27	0.23	0.26	0.27	0.29
Philippines	0.22	0.21	0.21	0.19	0.20	0.24	0.22
Singapore	0.97	0.97	0.97	0.97	0.98	0.98	0.98
Thailand	0.24	0.21	0.20	0.23	0.21	0.25	0.28

Sources: IMF, *IFS*, and Staff estimates

1/ International reserves minus gold/M1 or M2