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ABSTRACT

The objective of this paper is see how well Singapore's exchange rate regime has coped with exchange rate volatility before and after the Asian financial crisis by comparing the performance of Singapore's actual regime in minimising the volatility of the nominal effective exchange rate (NEER) and the bilateral rate against the US$ against some counterfactual regimes and the corresponding performance of eight other East Asian countries. In contrast to previous counterfactual exercises, such as Williamson (1998a) and Ohno (1999) which compute the weights for effective exchange rates on the basis of simple bloc aggregates, we apply a more disaggregated methodology using a larger number of trade partners. We also utilize ARCH/GARCH techniques to obtain estimates of heteroskedastic variances to better capture the time-varying characteristics of volatility for the actual and simulated exchange rate regimes. Our findings confirm that Singapore's managed floating exchange rate system has delivered relatively low currency volatility. Although there are gains in volatility reduction for all countries in the sample from the adoption of either a unilateral or common basket peg, particularly post-crisis, these gains are relatively low for Singapore, largely because low actual volatility. Finally, there are additional gains for non-dollar peggers from stabilizing intra-EA exchange rates against the dollar if they were to adopt a basket peg, especially post-crisis, but the gains for Singapore are again relatively modest.

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"Currency systems are like marriage: whichever one you find yourself in, you think another one might be better" – George Soros.[1]

1. Introduction

In the aftermath of the Asian financial crisis, the issue of the choice of exchange rate regime for East Asian (EA) countries re-emerged. The crisis had demonstrated, amongst other things, that unilateral exchange rate regimes (including de facto dollar pegging) hadn't coped very well in the 1990s faced with massive capital inflows into the region (Kwan et al, 1998), with the possible exceptions of Singapore and Taiwan. During the Asian crisis itself there was substantial exchange rate volatility and apart from China and Hong Kong, which stuck closely to the dollar, there were significant nominal and real depreciations. After the crisis currency volatility dropped significantly (Malaysia joined the dollar peggers in September 1998) but compared to the pre-crisis period both nominal and effective exchange rate movements have generally been more volatile.

The immediate response to Asian crisis was that a 'corner' solution might be better. Either keep convertibility and fix the currency, preferably backed up with a currency board, but abandon monetary independence; or keep monetary policy and convertibility but abandon currency management and adopt a free float. But a hard peg is perceived to be too rigid for most countries in EA, and with the notable exceptions of Hong Kong (and Brunei)[2]; they have not been in a hurry to give up monetary policy or their central banks. Even Malaysia, which adopted a formal peg to the dollar in September 1998, restricted convertibility in order to maintain some control over monetary policy and a returned to an intermediate exchange rate regime in 2005. On the other hand, the potential costs of a clean float are seen to be too

[1] Quoted in Barovick et al. (1999).

[2] Under a 'currency interchangeability arrangement' Brunei and Singapore accept each others' currency as 'customary tender' and exchange it at par into their own currency, periodically repatriating the accumulated stock of notes back to the country of origin. In essence, the arrangement is a currency union characterized by a one-for-one exchange rate and a joint managed floating exchange rate mechanism. There is no formal cooperative support mechanism but in practice a joint monetary policy is conducted by the Monetary Authority of Singapore. See Chan and Ngiam (1992).

great for emerging economies with weak financial infrastructure because of the risks of serious currency misalignment and destabilising speculation.

Recognition that the corner solutions may be unattractive or not feasible for many emerging countries in EA has put the emphasis back on intermediate exchange rate regimes. Insofar as there has been a greater degree of exchange rate flexibility since the Asian crisis intermediate regimes allow the simultaneous pursuit of exchange rate management within a range and some autonomy for a monetary policy rule. Indeed, a number of emerging economies in the region *appear* to have established institutions and mechanisms to implement monetary policy around an inflation target, including Korea (1998), Thailand (2000), Indonesia (2000) and the Philippines (2002). To date the empirical evidence is a bit thin and global inflationary pressures have been relatively subdued, but Ho and McCauley (2003) conclude that emerging market economies have responded more to exchange rate changes than would be required for inflation targeting but they have not been pre-occupied with exchange rate stabilization to the extent that inflation targeting has been compromised.

Some commentators, such as Rajan (2002) have suggested the adoption of unilateral basket pegs (UBP) to obtain partial insulation against movements in the major currencies, especially the dollar/yen rate for countries with reasonably diversified trade patterns, but a UBP still leaves considerable intra-EA instability since baskets would differ between countries with consequences for exports if the countries concerned are close competitors. An alternative solution is to move in the direction of a collective exchange rate mechanism, such as a common basket peg (CBP), particularly if this reduces exchange rate volatility and facilitates wider regional trade and monetary integration.

Singapore's exchange rate centred monetary policy is often cited as a good example of a successful intermediate exchange rate regime.[3] Since 1981 it has delivered low and stable inflation without sacrificing employment and has by and large avoided currency misalignment. Less understood, however, is how well the regime has coped with short-term volatility in financial markets.

The objective of this paper is see how well Singapore's exchange rate regime has coped with exchange rate volatility both before the Asian financial crisis and in the post-crisis period. The crisis period itself is omitted in view of the structural breaks in the time-series introduced by the massive devaluations between July 1997 and early 1998. A comparative dimension is added by assessing the performance of Singapore's actual regime in minimising the volatility

[3] See for example, Peebles and Wilson (2002, 2005).

of the nominal effective exchange rate (NEER) and the bilateral rate against the US$ in terms of some counterfactual regimes and the corresponding performance of eight other East Asian countries.[4] Our counterfactuals include a UBP, a CBP, and a hard peg against the US$, but in contrast to previous counterfactual exercises, such as Williamson (1998a) and Ohno (1999) which compute the weights for effective exchange rates on the basis of simple bloc aggregates, we apply a more disaggregated methodology using a larger number of trade partners. We also utilize ARCH/GARCH techniques to obtain estimates of heteroskedastic variances to better capture the time-varying characteristics of volatility for the actual and simulated exchange rate regimes.

Our findings confirm that Singapore's managed floating exchange rate system has delivered relatively low currency volatility. Although there are gains in effective volatility reduction for all countries in the sample from the adoption of either a unilateral or common basket peg, particularly post-crisis, these gains are relatively low for Singapore, largely because its actual volatility is relatively low. Finally, there are additional gains for non-dollar peggers from stabilizing intra-EA exchange rates against the dollar if they were to adopt a basket peg, especially post-crisis, but the gains for Singapore are again relatively modest.

We begin in **2** and **3** with some background on Singapore's exchange rate centred monetary policy and a review of the literature on the choice of exchange rate regime in the context of exchange rate volatility. This is followed in **4** with a discussion of the methodology which underpins our counterfactual experiments in relation to previous work. Our empirical results are presented in **5** and our key findings are then brought together in the form of a conclusion.

2. Singapore's Exchange Rate Regime[5]

Since 1981 monetary policy in Singapore has been centred on management of the exchange rate through a basket, band, and crawl framework, as popularised by Williamson (1998b), primarily to achieve price stability as a sound basis for sustainable economic growth. The Singapore dollar is managed against an un-published trade-weighted basket of currencies of its major trading partners and competitors and the trade-weighted exchange rate is allowed to fluctuate within a policy band. The level and slope of the policy band is announced semi-annually to the market and the regime is a managed float in the sense that the band provides a mechanism to accommodate short-run fluctuations in the foreign exchange markets and

[4] Singapore, Malaysia, Indonesia, Thailand, Philippines, China, Hong Kong, Taiwan and Korea.

[5] This section relies heavily on Khor et al (2004). For a broader perspective on Singapore's exchange rate regime in the context of its development strategy since 1965, see Peebles and Wilson (2002, 2004).

flexibility in managing the exchange rate. To ensure that the policy band remains consistent with the underlying fundamentals of the economy and to avoid misalignment in the currency, the policy band also incorporates a crawl feature.

The choice of the exchange rate as the intermediate target of monetary policy is predicated on the high degree of openness of the Singapore economy to trade and capital flows. Exports and imports are both in excess of 100% of GDP, while exports alone account for approximately two-thirds of final demand. As a result, changes in the value of the trade-weighted S$ have a significant effect on domestic inflation and the time path of real GDP. The trade-weighted exchange rate is, therefore, as close to an ideal intermediate target of monetary policy as might be expected. It is relatively controllable by the MAS, and bears a relatively powerful and stable relationship with price stability – the final policy target – over the medium term. On the other hand, the assignment of the exchange rate as the intermediate target of monetary policy implies that the MAS cedes control over domestic interest rates, which in the context of free mobility of capital, are largely determined by foreign interest rates and investor expectations of future movements in the S$. Typically, domestic interest rates have tended to be lower that US rates due to market expectations of a trend appreciation of the Singapore dollar.

Singapore's managed floating exchange rate regime is often, and justifiably, cited as a good example of a successful intermediate system, although this has been helped by a consistent and sensible long-term economic strategy supported by credible institutions.[6] Singapore's monetary policy has certainly been successful in achieving low and stable inflation over successive decades compared to her trading partners. Since 1981 domestic price inflation has averaged 1.8% compared with 4.0% for a trade-weighted average of foreign consumer price indexes (Khor et al, 2004). The exchange rate system has also provided the flexibility for the central Bank to avoid currency misalignment by allowing the equilibrium real exchange rate to respond to changes in underlying fundamentals, including a trend rise in the savings rate and higher productivity in the traded goods sector. Estimates of the equilibrium real effective exchange rate (REER) for Singapore using the behavioural equilibrium exchange rate methodology (Monetary Authority of Singapore, 2004) and the permanent equilibrium exchange rate theory (Clark and MacDonald, 2000) both suggest that the Singapore REER

[6] These include prudent fiscal policy and negligible public sector foreign debt, low domestic interest rates which have obviated the incentive to borrow abroad and build up large dollar liabilities, flexible factor and goods markets, and a sound regulatory system and financial supervision.

has generally tracked the long-run equilibrium rate well, except for the periods around the 1985 recession and the 1997-8 Asian financial crisis.

As far as exchange rate volatility is concerned, managing the Singapore dollar within a band has provided the flexibility to prevent short-term volatility in financial markets from adversely affecting the real economy.[7] Compared to other East Asian countries before the crisis, on a monthly basis, Singapore was quite stable on a bilateral US$ basis and had the lowest variation in effective terms (Table 1 and Figure 1).[8] China, Hong Kong, and to a lesser extent Indonesia and Thailand, were very stable against the US$ in terms of monthly changes, but with greater variation in their NEER and REER.. Malaysia was quite stable in dollar terms but with much more effective variation. De facto floaters Taiwan, Korea and the Philippines, on the other hand, had the highest volatility against the US$ and Korea and the Philippines also varied substantially in terms of the NEER and REER.

During the Asian crisis itself there was substantial exchange rate volatility in EA (Figure 1). Indeed mean instability (Table 1) was 4 to 5 times higher than pre-crisis, and apart from China and Hong Kong, which stuck closely to the dollar, there were significant nominal and real depreciations. Singapore depreciated least against the dollar after Taiwan by 20 percent and experienced substantially lower effective depreciation. In terms of currency instability, the Singapore dollar was the least volatile of the non-dollar peggers against the US$ and had the lowest effective instability after China and Hong Kong. Malaysia and the Philippines were moderately stable in terms of currency volatility but suffered depreciations of 40 to 50 percent against the dollar and 30 to 40 percent in effective terms. Indonesia, Korea and Thailand had the highest volatility and underwent substantial depreciations, with the Indonesian rupiah falling by a massive 111% against the US$ and by similar amounts for the NEER and REER.

In the post-crisis period average currency volatility dropped substantially compared to the crisis period but was still higher than in the pre-crisis period, with significant increases for Indonesia and Thailand (Table 1, Figure 1). On the basket measures Singapore was again the most stable but as in the pre-crisis period there was greater variability against the US$.

To some extent the increase in volatility post-crisis compared to pre-crisis reflected a move towards greater exchange rate flexibility in the EA region, with the notable exception of

[7] Saktiandi et al (2003), for example, applied a variety of statistical and econometric techniques and could find little evidence of a trade-off between exchange rate volatility and volatility in key macroeconomic variables, such as the money supply, interest rates, and trade volumes.

Malaysia which joined the hard dollar peggers in September 1998. Korea (1998), Thailand (2000), Indonesia (2000) and the Philippines (2002) all adopted de jure inflation targeting regimes over this period and Singapore was prepared to widen its target exchange rate policy band when necessary to adjust to external shocks.

We shall return to the comparison of exchange rate volatility in **5** below using a higher frequency and more sensitive measure of currency volatility.

3. Exchange rate volatility and the choice of exchange rate regime[9]

The Asian financial crisis demonstrated, amongst other things, that unilateral exchange rate regimes (including de facto dollar pegging) hadn't coped very well in the 1990s faced with massive capital inflows into the region (Kwan et al, 1998), with the possible exceptions of Singapore and Taiwan, where success was probably more a function of good macroeconomic fundamentals than the nature of their foreign exchange rate regimes per se, although both countries wisely allowed their currencies to appreciate to some degree in response to the inflow of capital and so avoided the trap of trying to peg too tightly to the dollar to retain export competitiveness. It helped that this was consistent with their domestic policy priority of price stability.

Other countries, notably Thailand, Indonesia and Malaysia eventually succumbed to the 'triad of incompatibilities', namely the difficulty, if not impossibility, of juggling three economic policy objectives in the air at once: 'managing the currency' (in effect dollar pegging), retaining some autonomy in domestic monetary policy, and integrating with international capital markets through partial or full currency convertibility. Their response to the inflow of capital in the 1990s was to stop it from appreciating the real effective exchange rate (REER), which would have eroded export competitiveness, by buying foreign assets and simultaneously sterilizing the impact of the inflow on the domestic money supply (and thus on goods and asset markets) by issuing domestic assets. This was done quite successfully for some time before the bubble burst.

De facto dollar pegging made the juggling act more difficult[10] insofar as a dollar appreciation against the yen increased the real exchange rate leading to overvaluation, reduced foreign

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[8] Taking the whole period between the first quarter of 1981 and the second quarter of 2004 the monthly standard deviation of the Singapore NEER was 1.47, which is quite stable compared to the US$ NEER of 3.44 and the yen NEER of 4.62 (Khor et al, 2004).

[9] For a discussion of the spectrum of exchange rate regimes, see Frankel (1999).

[10] Although the dollar peg may have been good for the Asian 'miracle' between 1985 and 1995 insofar as the stability it produced within a climate of unilateral liberalization and open regionalism increased trade and

direct investment and implicit dollar pegging encouraged undesirable un-hedged short-term capital inflows by creating the perception that the central bank would defend the rate against the dollar come what may, so loans could safely be repaid in dollars at a more or less fixed rate.

Stability in EA currencies was also complicated prior to the Asian crisis by the wide variety of officially declared exchange rate regimes and monetary policies (Table 2), the lack of transparency as to how these regimes were *actually* operated, and the different responses of individual countries to the Asian financial crisis itself.

Hong Kong had a hard fix to the dollar from October 1983 and operated a quasi currency board. Malaysia, Korea, Singapore and Indonesia were all officially managed floating but for Singapore this meant managing the Singapore dollar against an unpublished trade-weighted basket with the primary objective of maintaining low and stable inflation by neutralizing import price rises, while the Indonesian rupiah seemed to be managed in terms of a crawling basket peg to allow the currency to depreciate steadily over time to offset a domestic inflation rate which persistently exceeded that of its competitors. Malaysia appeared to be operating a 'dirty float' to keep exports competitive while Korea relied on a market average exchange rate system under which the exchange rate of the won against the US$ was determined by market forces in the interbank foreign exchange market with the Bank of Korea as one of the market participants.

Thailand, on the other hand, officially operated a multi-currency basket peg prior to the crisis but in practice pegged quite closely to the dollar, ostensibly to maintain export competitiveness. Japan and the Philippines were free floating but the Philippine regime was rather opaque. China was supposed to be managed floating since 1990 but, in fact, fixed rigidly to the dollar from the beginning of 1994.

There is now a substantial literature looking at the impact of exchange rate volatility on trade and capital flows. For comprehensive surveys see Cote (1994), Bachetta and Van Winloop (2000) and more recently, McKenzie (1999).[11] The evidence appears to be very mixed, but according to McKenzie, recent empirical studies have had "greater success in deriving a

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investment, and encouraged the relocation of production from Japan as yen appreciation made it cheaper to produce abroad in the Asian 'dollar zone.'

[11] A related issue is whether exchange rate volatility varies systematically across exchange rate regimes. According to Flood and Rose (1999) it does not. This does not rule out, however, the possibility that a particular regime has worked well for a given country. Khor et. al. (2004), for example, make the case that Singapore's exchange rate-centred monetary policy since 1981, based on a basket, band and crawl, has been successful in preventing short-term external shocks, including financial instability, from adversely affecting real domestic variables and at the same time has left sufficient flexibility to prevent misalignment.

statistically significant relationship between volatility and trade" (p. 100). Calvo and Reinhart (2002) reach a similar conclusion.[12]

The underlying problem for EA from the exchange rate point of view is that the diversity of exchange rate regimes in the region transmits fluctuations in major currencies into fluctuations in bilateral regional exchange rates and alters relative competitiveness. In particular, a country which de facto pegs more tightly against the US dollar compared to its export competitors finds itself unable to compete when the dollar appreciates strongly against the yen and the euro. A classic case of this 'third currency' effect was in April 1995 when the dollar appreciated sharply against the yen thereby reducing the competitiveness of Asian countries relative to Japan and the European Union (EU). The global slowdown in 2001 and 2002, together with yen weakness generated similar problems. Those countries which resisted devaluation found their NEER rising with potentially damaging effects on their current accounts.[13] On the other hand, as the yen rises against the dollar Asian economies gain competitiveness against Japanese goods in both domestic and foreign markets and this generates a cyclical upswing in their exports, output and investment. [14] Matters are made worse by the asymmetric needs of specific countries. Korea, for example, is more competitive in export markets with Japan, while the poorer countries in the Association of Southeast Asian Nations (ASEAN) such as Indonesia and the Philippines, and China are more concerned about relative currency fluctuations among themselves.[15]

A relatively simple solution is for each country to adopt a UBP. This would automatically provide some insulation against movements in the major currencies, especially the dollar/yen rate, and reduce volatility in the NEER and REER. It is also relevant to countries with reasonably diversified trade patterns and thus no obvious single candidate for an exchange

[12] The application of trade gravity models (Frankel and Rose, 2002; Glick and Rose, 2001; Rose 2000) also suggests that institutionally fixed exchange rate regimes which reduce volatility, such as a common currency, a currency board, or dollarization, can increase trade and national income.

[13] It is actually quite difficult to find hard evidence of a long-term negative relationship between the real trade balance and real exchange rate appreciation for East Asian countries (Wilson, 2001).

[14] Other channels through which exchange rate instability can be transmitted to EA countries are through FDI, external debt, and the inflation pass-through effect (see Kwan 1998). As the yen appreciates Japanese manufacturers shift their production to lower cost EA countries stimulating their growth, but simultaneously increasing the domestic currency burden of their yen-denominated external debt, and raising the costs of machinery and intermediate inputs purchased from Japan.

[15] As Kwan (1998) has pointed out, implicit dollar pegging generates a peculiar asymmetry in which instability of the yen/dollar rate seriously impacts on EA's relations with Japan but not so much with respect to the USA, even if the link with the dollar is weaker, as in the post crisis period. This is precisely one reason why Japan is anxious to include discussions about the exchange rate in post-crisis forums concerned with Asian monetary cooperation.

rate anchor.[16] However, insofar as trade structures, and therefore the baskets, would differ amongst the EA9 countries, UBPs will not necessarily reduce intra-EA exchange rate volatility caused by fluctuations in the currencies of their respective trading partners, with consequences for exports if the EA countries concerned are close competitors. This is, therefore, one empirical question which can be addressed through counterfactual analysis.

A second question relates to the trade-off between the benefits of a UBP in reducing effective exchange rate volatility for a specific country and the potential increase in volatility against a particular major currency, such as the US dollar, and therefore against other competitors in the EA bloc. The outcome is hard to predict ex ante since it depends on the composition of the baskets for each country and on the magnitude of actual exchange rate fluctuations.

If EA countries are concerned about both 'excessive' volatility against the major currencies and intra-bloc fluctuations, then a collective solution becomes quite attractive.[17] Although the Asian financial crisis increased economic disparities in the EA region, thus making monetary integration more difficult, it rekindled political interest in Asian monetary and exchange rate cooperation by reducing the credibility of implicit unilateral dollar pegging. but this does not seem to have solved the problem of the collective 'fear of floating'.[18]

There is pretty much universal agreement, even amongst those who advocate further monetary and exchange rate cooperation in EA, that an East Asian monetary union is a long way off in terms of a significant pooling of sovereignty into common institutions, and the adoption of a common exchange rate mechanism. But there is some disagreement as to *how far* EA or a subset of EA countries satisfy the economic criteria for a monetary union (Wilson, 2005). Advocates of a common EA exchange rate policy, such as Williamson (1998a) and McKinnon (2000), do assume that EA countries are sufficiently close as trading partners and competitors in world markets to justify a common monetary arrangement.

If lingering political problems could be put aside between Japan and her neighbours, a currency bloc with EA countries pegging to the yen as a group or increasing the weight of the

[16] As Rajan (2002) has argued, the weakness of pegging to one currency is not the same thing as the weakness of pegging in general. If soft pegging to the US dollar is sub-optimal then it would be better to adopt a more flexible peg against a diversified basket with suitable variability in the width of the band or in the precise operation of the regime to suit the needs of individual countries.

[17] For a more comprehensive discussion of the pros and cons of alternative collective exchange rate solutions for EA, including an Asian analogue to the European ERM, in the context of closer monetary cooperation, see Wilson (2006).

[18] According to Calvo and Reinhart (2002) dollar pegging is a rational response to capital market conditions in emerging economies where the domestic currency can't be used to borrow abroad so all domestic investments have a currency mismatch (borrow in foreign for projects which generate domestic currency) and a maturity mismatch (long-term projects financed by short-term borrowing). In the absence of hedging facilities agents

yen in their unilateral currency baskets would be a neat solution (Taguchi, 1998, Kwan 1998, 2000, 2001). Japan is already a 'hegemon' of sorts given its importance in regional trade and investment and its developed country status, and there is some trade invoicing in the yen. But a yen bloc seems rather remote. The Bank of Japan has hardly been a credible anchor for monetary policy in the last decade and the short-term capital market in Japan is not sufficiently liquid or deep to act as a regional currency centre and much of Japan's exports are in fact invoiced in the dollar. There are also some well-known asymmetries in the exchange rate policy objectives of some EA countries. Korea, for instance, tends historically to follow a depreciating yen to retain export competitiveness in the Japanese market, while Singapore, on the other hand, is more likely to follow an appreciating yen to subdue import prices and thus contain imported inflation.[19] Besides, there is little evidence so far of the emergence of a de facto yen bloc (Frankel 1993, Frankel and Wei, 1994, Benassy-Quere 1998).

An alternative solution would be to adopt an explicit peg unilaterally or collectively against the dollar (or attach a large weight to it in currency baskets) in order to stabilize intra-bloc exchange rates and long-run exchange rate expectations and to anchor regional price levels and gain the benefits of a larger dollar trading zone among close trading partners (McKinnon, 2000). This would build on the existing widespread use of the dollar in regional trade invoicing and reserve composition and the observation that EA was, in fact, a dollar bloc prior to the Asian financial crisis, and most EA countries still attach sizeable implicit or explicit weights post-crisis.

The re-emergence of some informal pegging to the dollar in EA may be a rational solution to the problems they face in an uncertain and competitive world, but it still represents a collective choice by default and leaves the region vulnerable to further competitive devaluations, currency contagion and crises. In this sense, 'informal dollar pegging in a non-optimal way' strengthens the case for a collective solution, which could be a more formal dollar peg. But pegging to the dollar to anchor regional price levels need not stabilize effective exchange rates, it provides no insulation against outside currencies (unless they also fix against the dollar) and it is not clear that EA countries are committed yet to stabilizing their price levels through exchange rate policy or in general need to adopt a nominal inflation anchor.

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borrow in the forex market, mostly in dollars, and for the short-term. Dollar pegging is thus a rational response to the fear of floating.

Hence the attraction of a CBP as recommended by Williamson (1998a). By using both common weights and a basket it would minimize the effects of fluctuations in major currencies and at the same time minimize intra-EA exchange rate instability. The basket can be used to stabilize the NEER or REER with a band to adjust for misalignments, and the collective weights would obviate the problem of 'beggar-thy-neighbour' competitive devaluations. In essence it would be a 'collective basket' instead of 'collective security' as in the East Asian dollar standard.

Of course, it cannot simultaneously anchor the price level, and it loses some of the simplicity of a collective dollar peg since there are also technical considerations in the choice of common weights[20] and the weights are unlikely to match exactly the optimal weights in a country's own basket, so the common NEER or REER may be too strong or two weak for some countries. Again, the trade-off between the UBP and the CBP is an empirical question which can also be addressed through counterfactual analysis.

4. Methodology

The starting-point for our analysis is the counterfactuals carried out on EA countries for the period before the Asian financial crisis by Williamson (1998a) and Ohno (1999).

Williamson conducted an experiment for nine EA countries which he assumed to be close competitors, between the end of 1994 and April 1995 when the yen appreciated sharply against the dollar. Most EA countries stayed with the dollar and so experienced a large actual fall in their NEER, more than they would have wanted. A UBP, by definition would have meant zero variation in the NEER but significant instability (cumulative sum of the monthly percentage change) bilaterally against the dollar and thus relative to each other. A CBP, on the other hand, with weights based on common extra-regional trade would have meant an identical 9.8% appreciation of all EA currencies against the dollar and modest changes in NEERs, and the exact composition of the basket was not crucial for obtaining the benefits of insulation. He concluded that a CBP which reflects the EA countries' average trade patterns, would produce the same result as UBPs in terms of stabilizing the NEER against volatility in third currency exchange rates, but with the advantage of eliminating intra-EA exchange rate volatility.

[19] The change in Korea's exchange rate regime to incorporate more flexibility combined with capital account liberalization may have increased the co-movement between the won and the yen (Kang et al. 2003).
[20] See Bird and Rajan (2002).

Ohno's (1999) counterfactuals were based on 10 EA countries using monthly data over the period January 1990 to June 1997. He finds that there are hardly any differences between a CBP and a UBP in terms of the standard deviation of the level of the CPI based REER. Furthermore, only Singapore, Malaysia, Hong Kong and Taiwan would benefit from either a UBP or a CBP in terms of reducing instability compared to actual.

Both the Williamson and Ohno counterfactuals use simple trade weights (exports plus imports). For Williamson the weights for his NEER and UBPs are based on three blocs: the United States, Japan and Western Europe, and he computes his common basket peg using the weighted average of the extra-regional trade of the EA countries, assigning the weights to the 3 blocs in a fashion similar to the unilateral basket pegs. Ohno uses a larger number (30) of trading partners which are common to all the EA countries to calculate his REER instead of just 3 blocs. But his computations of the unilateral and common basket pegs contain only three currencies: the U.S dollar, yen and the European Currency Unit.

Our analysis will apply a more detailed methodology for calculating the weights for the NEER and basket pegs, cover both the pre-crisis and post-crisis periods, and utilize a more time sensitive measure of volatility. In addition we will include a hypothetical hard peg to broaden the spectrum of exchange rate regimes considered.

Sample and time period

Our sample comprises China, Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand. The counterfactuals are computed both before the Asian financial crisis (July 1994 to June 1997) and after the crisis (February 1998 to March 2003) which enables us to go beyond the 4 months used in the Williamson (1998a) experiments and to extend Ohno's (1999) study of the pre-crisis period to the post crisis era. The crisis period itself is omitted as a period of exceptional volatility in exchange rates.

The Thai crisis is usually dated from July 2 1997 when the Baht fell by 6.6% against the US dollar in one day and triggered an IMF standby loan and banking crisis. On a monthly basis it fell by 14.9% in July compared to only 0.36% in June, but the question is whether the inclusion of June 1997 in the pre-crisis period exaggerates volatility, since there were speculative attacks against the Baht in the middle of the month. However, if the sample is restricted to the period before these attacks volatility estimates are very similar to those from the full sample.

A more difficult problem is how to interpret the results for Malaysia in the post crisis period given its decision to peg the ringgit to the US dollar in September 1998 following a period of

high volatility. Clearly, if the whole post-crisis period is used Malaysia is a relatively high volatility country but after September 1998 it effectively joined the dollar peggers and the results would be more akin to those for China and Hong Kong.[21] Since the purpose of the present paper is to compare exchange rate regimes across the sample and there is no good reason to begin the post-crisis period to coincide with a regime change in any one country, we decided to stick with our original periods, but the results for Malaysia need to be interpreted in this light.

Effective exchange rates

The NEER for a country measures the value of that country's currency against a basket of other currencies and is a weighted average exchange rate against the other currencies in the basket, expressed as an index relative to a base date. The REER is corrected for relative inflation between the home country and its trading partners. The weights used are often based on trade flows, thus enabling the REER to act as an indicator of competitiveness, in the sense that a rise indicates an appreciation of the home country's real exchange rate relative to its trading partners.[22]

Import weights are fairly easy to compute since they are based on bilateral imports. However, export weights are more complex and can be computed in a number of ways.[23] The bilateral export weighting system used by Williamson (1998a) and Ohno (1999) is the simplest but does not account for indirect competition between trading partners in third markets. A multilateral export weighting system computes the weights on the basis of a competing country's share of exports in world trade, thus factoring in competition in third markets, but ignores the specific export markets of individual countries and may lead to an overestimation of the importance of small economies which trade amongst themselves, but have large export sectors.

The weights used for the computations of the NEER and REER in this paper were kindly supplied by Dominique Desruelle and are based on geometric averages and follow the methodology set out in the International Monetary Fund's Information Notice System (see Zanello and Desruelle, 1997). A double weighting system is employed to capture both direct

[21] Using the standard deviation of monthly changes in Table 2, volatility against the dollar drops from 1.43 to 0.33 or from the third highest in the sample to the third lowest behind China and Hong Kong. The outcomes are similar for the NEER and the REER.

[22] Note that from the point of view of an 'optimal basket' for a country with significant capital inflows, a trade-weighted basket need not be optimal. See Yoshino et. al. (2004).

[23] For a discussion of these problems, see Lafrance, Osakwe and St. Amant (1998).

and third-market competition [24] and the weights are calculated separately for trade in manufactures, non-oil primary commodities, and tourism services and are then aggregated. The impact of seasonal variation in prices on the computed REER was removed by adjusting the CPI using the X-12-ARIMA approach. Despite its well-known drawbacks, we use the CPI to compute the monthly REER for the graphics since CPI data is easily obtained and can be used as a basis for REER comparison across the different EA countries.[25] Both the NEER and REER are computed using July 1995 as the base month, and the weights were computed using data from 1988 - 1990. [26] A rise in the NEER and REER signifies an appreciation of the home country's nominal and real exchange rate respectively.

Volatility measures

There is no unique measure of volatility[27] but the ARCH (Engle, 1982) and the GARCH (Bollerslev, 1986) estimates specifically allow heteroskedasticity in the variance to capture periods of tranquillity and volatility in a time series. Hence to measure volatility in the actual and hypothetical regimes we compute the conditional (heteroskedastic) variance (CV) in logs of first differences using an ARCH-GARCH modelling strategy.[28] More details of the procedures adopted are given in Appendix I.

Counterfactuals

Counterfactual exercises are carried out for all EA9 countries using the methodology originally set out by Takagi (1986). Further details on these computations and the assumptions behind them can be found in Appendix II. The hypothetical regimes include a UBP, a CBP and a hard peg (HP) against the US dollar. The hard peg is assumed to have no band width and the rate to peg a country's currency to the dollar is based on the average bilateral exchange rate with the dollar from January to June 1994. The currency weights for

[24] The geometric average is preferred to the arithmetic average as there could be distortions in the arithmetic index when the base period is changed, and percentage changes in an arithmetic index will differ in size depending on whether bilateral exchange rates are defined in units of home currency per foreign currency unit or vice versa (Ellis, 2001).

[25] For the pros and cons of different price indices, see Kipici and Kesriyeli (1997), Lafrance, Osakwe and St-Amant, (1998) and Abeysinghe and Wilson (2002).

[26] The weights here are fixed and ideally they should be updated regularly, but empirical work by Chinn (2002) suggests that fixed weight and variable weight REERs tend to move closely together.

[27] Using standard deviations of changes in exchange rates tends to capture short-term instability, especially if high frequency data is used, while standard deviations of levels of exchange rates are more indicative of medium term instability. See the review by McKenzie (1999).

[28] We also computed the unconditional (homoskedastic) variance (UV) as a robustness check and the ratios of the means of the UVs to the means of the CVs. Since the ratios for both the NEER and bilateral exchange rates are all close to unity, the results are robust to both measures.

the UBPs are chosen be the same as those used in the compilation of the NEER and REER based on the individual trading partners of the respective countries. The computations for the common basket peg are carried out in a similar fashion but the weights are obtained by taking the weighted average of the weights assigned to the common trade partners of all the EA countries.

6. Results

Actual volatility:

Figures 2a and 2b plot the volatility time profile of Singapore's NEER and bilateral exchange rate against the US dollar for the pre-crisis and post-crisis periods using annualised conditional standard deviations (ACSD) from the ARCH/GARCH daily conditional variances. The crisis period itself is excluded.

The plots show the familiar cluster pattern around peaks of volatility followed by periods of relative tranquillity.[29] Two distinct periods of heightened volatility are observed: immediately after the Asian financial crisis in 1998 and, to a much lesser extent, around the 2001 recession following the global slowdown in the information technology sector. Both NEER and bilateral volatility appear to be quite low in the pre-crisis period with average ACSDs of 3.70 and 3.61 respectively. Average volatility was significantly higher post-crisis: 1.61 that of the pre-crisis period for the NEER and 1.92 for the S$:US$ rate but for most of the time quickly settled down to the post-crisis average.[30]

Column 1 in tables 3 and 4 compares Singapore's average volatility profile (proxied by the ACSDs) with eight other countries in the East Asian region. Pre-crisis Singapore has the lowest volatility in the NEER at 3.70 compared to a mean across the entire sample of 5.39 (Table 3). Relatively high values are observed for the Philippines, Korea and Indonesia. On a bilateral basis the value for Singapore of 3.61 is actually higher than the sample mean of 2.95 but if the dollar peggers (China and Hong Kong) are excluded, the sample mean falls to a relatively low value of 3.71 and there is little difference in the ACSDs for the non-dollar peggers.

[29] Controlling for cross movements in the major currencies is not done here since previous work on Singapore suggests that it makes little difference (Khor et al, 2004).

[30] These results are consistent with Khor et al (2004) which used a similar methodology to the present one but looked at volatility in the S$ NEER over a longer time horizon between 1980 and 2002. The 1985-6 recession also stands out as a period of heightened instability in their study and their 20 year historical average for the ACSD of 5.2 (excluding periods of high instability, such as the Asian financial crisis) is similar to our averages for the pre-crisis and post-crisis periods.

Post-crisis the story is a little different. The NEER ACSD for Singapore (5.94) is now substantially lower than the sample mean (11.90) even if the extreme value for Indonesia is excluded (9.47) but both China and Hong Kong now have lower volatility than the Republic. Singapore is, however, the lowest of the non-dollar peggers. In terms of volatility against the US dollar, there are much bigger differences between countries than in the pre-crisis period. Excluding the dollar peggers (Malaysia is included) Singapore does much better than her competitors except Taiwan with an ACSD of 6.74 compared to 13.84 (10.80 for the full sample).

Counterfactuals:

Columns 2 to 5 in Tables 3 and 4 tabulate the ACSDs for the hypothetical exchange rate regimes for the East Asian sample. The regimes with the lowest ACSD are highlighted in bold for convenience. The regime gains are simply the difference between the hypothetical regime and the actual. A large negative value signifies a high degree of volatility reduction. A plot of the actual and counterfactual regimes on a monthly basis is also provided for Singapore in Figure 3.

In terms of the NEER the hypothetical UBP minimizes volatility for all countries both before and after the crisis and provides the highest regime gains compared to actual. Mean pre-crisis gains are much smaller than post-crisis (-5.18 and -11.34, respectively) and the range is not very wide between the lowest for Singapore (-3,5) and the highest for Indonesia (-6.1). The countries which gain most from the UBP are those which have higher actual volatility, such as the Philippines, Korea and Indonesia pre-crisis and Indonesia, Korea, Philippines and Thailand post-crisis (Malaysia also over the whole period). On the other hand, the gains are lowest for Singapore and Hong Kong (in the first period) and China, Hong Kong, Singapore and Taiwan (in the second) because their actual volatility is relatively low.

Although the gains for the CBP are always less than those from the hypothetical UBP in both sample periods, the absolute differences between the two regimes appear to be very small. Post-crisis, Singapore would give up the most gains by switching from a UBP (-5.09) to a CBP (-2.76). Pre-crisis the sample mean for the UBP is -5.18 compared to -4.73 for the CBP while the corresponding numbers for the post-crisis period are -11.34 and -10.57. This confirms previous work by Ohno (1999) and Williamson, (1998a) and suggests that in volatility terms, at least, the extra costs of a CBP may not be substantial and this strengthens the case for a common basket peg for EA countries in the longer run.

In terms of the NEER, the gains from a hypothetical hard peg, by contrast, are negligible and zero by definition for the dollar peggers. Pre-crisis average instability would increase by 3.57 (negligible for Singapore) and although there is a gain in mean volatility reduction across the EA9 post-crisis, it is small compared to the basket pegs at -0.41 and again is negligible for Singapore. There might be some benefit to Thailand in the second period, but it is less than half the gains from the basket pegs.

In terms of bilateral exchange rates against the dollar, volatility is zero by definition for the hypothetical HP, so the focus is on the basket pegs. Of course under the CBP, since all countries peg their currencies to the same set of countries in the basket with the same weights, volatility will be the same for all countries so intra-EA9 exchange rates are constant. But the gains compared to actual can still differ between the two regimes. If EA9 adopt UBPs, their own NEERs will be stabilized but intra-EA9 exchange rates[31] will continue to fluctuate. The question then arises as to whether EA countries gain an **additional** or net benefit of relatively stable intra-bloc exchange rates against the dollar if they were to adopt a UBP. In other words, is there a trade-off between reducing instability in the NEER with a UBP but simultaneously increasing instability against the dollar and thus against other EA countries?

Table 5 and Figure 4 show the trade-off between basket pegs and bilateral volatility against the US dollar for Singapore and the rest of the East Asian sample. Before the Asian crisis, for the dollar peggers (China and Hong Kong) which, by definition, have low bilateral instability but relatively high instability in their NEERs there would be little to gain if they were to adopt a UBP to stabilize the NEER net of the effect this would have on bilateral instability. For the rest of the EA9 there would be net gains, especially for Korea and the Philippines, since a fall in effective instability would be accompanied by a fall in bilateral instability, but they do not seem to be very great except possibly for Korea and the Philippines. Singapore gains the least as far as the non-dollar peggers are concerned (-2.83). The results for the CBP are generally similar to those for the UBP.

Once again things are a little different in the post-crisis period since high (low) volatility in bilateral terms tends to be closely associated with high (low) volatility in the NEER so, apart from the dollar peggers, there is no obvious trade-off between the two (Table 5). As pre-crisis, China and Hong Kong would gain little if they were to adopt a UBP (or CBP) to stabilize the NEER net of the effect this would have on bilateral instability but for the rest of

the sample, the gains from the baskets are larger than pre-crisis and could be quite significant for Indonesia, Malaysia (over the whole period), Philippines and Thailand. For Singapore, the gains (-6.62) are substantially less than the mean for the sample as a whole (-17.09) even if Indonesia is excluded (-12.25), and after Taiwan, are the smallest in the sample.

7. Conclusion

The objective of this paper is see how well Singapore's exchange rate regime has coped with exchange rate volatility both before the Asian financial crisis and in the post-crisis period. The crisis period itself is omitted in view of the structural breaks in the time-series introduced by the massive devaluations between July 1997 and early 1998. A comparative dimension is added by assessing the performance of Singapore's actual regime in minimising the volatility of the nominal effective exchange rate (NEER) and the bilateral rate against the US$ in terms of some counterfactual regimes and the corresponding performance of eight other East Asian countries.[32] Our counterfactuals include a UBP, a CBP, and a hard peg against the US$, but in contrast to previous counterfactual exercises, such as Williamson (1998a) and Ohno (1999) which compute the weights for effective exchange rates on the basis of simple bloc aggregates, we apply a more disaggregated methodology using a larger number of trade partners. We also utilize ARCH/GARCH techniques to obtain estimates of heteroskedastic variances to better capture the time-varying characteristics of volatility for the actual and simulated exchange rate regimes.

Our findings confirm that Singapore's managed floating exchange rate system has delivered relatively low currency volatility between July 1994 and March 2003 (excluding the Asian financial crisis). In the pre-crisis period Singapore had the lowest NEER volatility among the EA 9 and experienced quite low variation against the dollar and post-crisis the Republic is the lowest of the non-dollar peggers. In bilateral terms against the US dollar Singapore again does much better than the other non-dollar peggers .

In terms of counterfactuals there are gains in volatility reduction for all countries in the sample from the adoption of unilateral or common basket pegs, both pre- and post-crisis, although the regime gains are much smaller pre-crisis. These gains are lowest for Singapore in the first period and lowest after Taiwan in the second, largely because its actual volatility was relatively low. Although Singapore would give up the most gains by switching from a

[31] These can be calculated from the bilateral exchange rates since all the EA9 exchange rates are expressed in relation to the U.S dollar.

[32] Singapore, Malaysia, Indonesia, Thailand, Philippines, China, Hong Kong, Taiwan and Korea.

hypothetical UBP to a CBP in the post-crisis period, the difference between the two regimes is very small and in common with the other EA countries, the gains for Singapore from a counterfactual hard peg are negligible in terms of stabilizing the NEER.

Finally, there appears to be some additional or net gains for non-dollar peggers from stabilizing intra-EA exchange rates against the dollar if they were to adopt a basket peg, especially post-crisis, but the gains for Singapore are relatively modest.

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Appendix I: The ARCH-GARCH modelling procedure and data sources

ARCH-GARCH estimates

The procedure involved estimating the mean equation and the conditional variance simultaneously using the maximum likelihood method. The first step was to select the best fitting autoregressive integrated moving average (ARIMA) model for the mean equation using the Schwartz Bayesian criterion (SBC) and to test for the presence of serial autocorrelation in the residuals using the Ljung- Box Q statistic. The ARIMA model was chosen since the coefficients of the lag terms in the autoregressive moving average (ARMA) model are close to unity. Having determined the best fitting ARIMA model, the Lagrange multiplier (LM) test was used to check for ARCH disturbances by regressing the squared residuals ε_t^2 on a constant and q lagged values:

$$\varepsilon_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + u_t \qquad (1)$$

where u_t is a white noise process. If ARCH or GARCH disturbances are non-existent, the estimated values of $\sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2$ should be zero, indicating a constant variance of α_0.

An ARCH(q) process models the conditional variance as an autoregressive (AR) process using the square of the estimated residuals:

$$E_{t-1}\left(\varepsilon_t^2\right) = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + v_t \qquad (2)$$

where v_t is a white noise process and is independent of u_t. Equation (2) implies that the conditional variance of ε_t is dependent on the realized values of all the ε_{t-i}^2. Thus volatility in previous periods tends to persist and influence the conditional variance in the present period.

The GARCH(p,q) model differs from the ARCH(q) model in that it allows for both autoregressive and moving average components in the conditional variance h_t. For example, a GARCH(p,q) model based on the log of first differences of the exchange rate series R and an ARIMA (1,1,0) would take the form:

$$\Delta \ln R_t = a_0 + a_1 \Delta \ln R_{t-1} + \varepsilon_t \ , where \ \ \varepsilon_t \sim N(0, h_t)$$
$$E_{t-1}(\varepsilon_t^2) = h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i h_{t-i} + z_t \qquad (3)$$

where z_t is a white noise process, α_0 is the mean, $\sum_{i=1}^{q} \alpha_i \varepsilon_{t-1}^2$ (the ARCH terms) are interpreted as news about volatility from previous periods, and $\sum_{i=1}^{p} \beta_i h_{t-1}$ (the GARCH terms) are last period's forecast variance, implying a form of adaptive learning behaviour.

ARCH and GARCH processes were then compared using the SBC, and the best fitting model was selected to obtain the mean conditional variance.

Data and sources

Average monthly exchange rates and CPI data to calculate the monthly NEER and REER figures for graphical purposes were taken from the IMF's *International Financial Statistics*. China's CPI was downloaded from the Asian Development Bank's *Asia Recovery Information Centre* and Taiwan's exchange rate and CPI figures were obtained from the *Monthly Bulletin Of Statistics, The Republic Of China*. All the CPI figures are spliced together with July 1995 as the base month. Unfortunately Australian CPI data is published only on a quarterly basis so the quarterly figures were interpolated using a cubic spline with the last observation matched to the source data. Average daily exchange rate data for the ARCH and GARCH estimates were downloaded using Datastream International 2000 *Datastream Advance 3.5*.

Appendix II: The exchange rate counterfactuals

The hypothetical regimes include a UBP, a CBP and a hard peg (HP) against the US dollar. The hard peg is assumed to have no band width and the rate to peg a country's currency to the dollar is based on the average bilateral exchange rate with the dollar from January to June 1994. Since we are concerned with volatility in the NEER and bilateral exchange rates and not the optimal rate to peg to the dollar, pegging at an arbitrary rate will not affect the volatility of the NEER since it is expressed in terms of an index (July 1995=100), and the volatility of bilateral exchange rates will be zero regardless of the rate at which the currency is pegged. The currency weights for the UBPs are chosen be the same as those used in the compilation of the NEER and REER based on the individual trading partners of the respective countries.

Then we define D_i as the desired share of a foreign currency in the basket as:[33]

$$D_i = \frac{W_{ij} \times R_{i,t}}{R_{j,t}}$$

where *j* is an index that runs over country *i*'s trade partners. W_{ij} is the competitiveness weight put by country *i* on country *j*, R_i and R_j represent the nominal exchange rates of countries *i* and *j*, defined as the amount of U.S dollars per unit of local currency and are taken as the 1st reading of a particular period.

$R_{i,t+\tau}$, the nominal exchange rate at time $(t+\tau)$ under the basket peg is:

$$R_{i,t+\tau} = \sum_{i=1}^{n} \left(R_{j,t+\tau} \times D_i \right)$$

The computations for the common basket peg are carried out in a similar fashion but the weights are obtained by taking the weighted average of the weights assigned to the common trade partners of all the EA countries.

Of course these counterfactuals capture only one dimension of the choice of exchange rate regime insofar as they focus on the effects of alternative regimes on the stability of nominal exchange rates compared to actual in 'normal' times. They are not concerned with the 'optimal basket' based on a range of macroeconomic variables, such as the level of foreign debt or imported inflation (see Bird and Rajan, 2002), or are sufficient to ensure stability in exchange rate competitiveness in the absence of additional policies to adjust for the gap

[33] For a description of this methodology, see Takagi (1986).

between domestic and foreign inflation. In addition, the hypothetical exchange rate regimes operate under ceteris paribus conditions which rule out endogenous responses, such as the change in domestic prices due to exchange rate pass-through effects or changes in the structure of the economy arising from changes in the direction of trade (fixed trade weights) or inward foreign direct investment, which may be exogenous or endogenous to exchange rate changes.[34]

[34] The UBP simulations for one country also assume that other countries maintain the status quo. The outcome could be different if a number of EA countries adopted a UBP simultaneously. Similarly, in the case of the CBP, intra-EA exchange rates will, by definition, remain constant, but if all EA countries pegged simultaneously to a common basket there could well be feedback effects if this results in changes in US$ bilateral rates against other major currencies, such as the yen and the euro. I am grateful to Edward Robinson for pointing these implications out.

Table 1: East Asian exchange rate volatility July 1994 to March 2003

	Standard deviation of monthly changes			Cumulative depreciation		
	Bilateral	NEER	REER	Bilateral	NEER	REER
Pre-crisis:						
7/94-6/97						
China	0.26	1.12	1.27			
Hong Kong	0.05	0.99	1.15			
Indonesia	0.26	1.37	1.47			
Korea	1.43	1.41	1.44			
Malaysia	0.90	1.26	1.45			
Philippines	1.21	1.84	1.97			
Singapore	**0.73**	**0.67**	**0.74**			
Taiwan	1.02	1.05	1.23			
Thailand	0.41	0.97	1.13			
Average	0.70	1.19	1.32			
Crisis:						
7/97-1/98						
China	0.01	1.16	0.97	0.15	7.27	5.36
Hong Kong	0.08	1.19	1.39	0.01	9.00	11.71
Indonesia	8.65	10.67	12.11	-111.27	-102.16	-91.73
Korea	8.15	9.36	9.46	-57.33	-51.79	-46.86
Malaysia	2.98	3.61	3.99	-53.36	-41.37	-39.78
Philippines	2.85	3.70	4.08	-45.96	-34.84	-32.53
Singapore	**1.74**	**1.55**	**1.58**	**-20.15**	**-3.11**	**-3.610**
Taiwan	2.18	2.69	2.93	-18.95	-10.42	-9.25
Thailand	5.23	6.01	6.73	-49.77	-40.02	-34.44
Average	3.54	4.44	4.80			
Post-crisis:						
2/98-3/03						
China	0.07	1.33	1.46			
Hong Kong	0.02	1.16	1.55			
Indonesia	2.12	2.56	4.87			
Korea	1.63	1.95	2.11			
Malaysia	1.43	1.69	1.93			
Philippines	1.29	1.60	2.09			
Singapore	**1.31**	**1.08**	**1.11**			
Taiwan	1.05	1.11	1.38			
Thailand	1.06	1.88	2.17			
Average	1.10	1.60	2.07			

Notes: The standard deviations are calculated from changes in the exchange rate indexes with March 1995=100; a negative sign for the cumulative depreciation implies a cumulative appreciation;

Sources: Calculated from International Monetary Fund, International Financial Statistics; Asian Development Bank, Asia Recovery Information Centre; Monthly Bulletin of Statistics, Republic of China.

Table 2: East Asian currency arrangements 1990, 1997, 2004

	Fixed to a single currency	Fixed to a composite	Managed float	Independent float	Convertibility	Monetary policy 2004
China	2004		1990, 1997		Partial	Exch. rate anchor
Hong Kong	1990, 1997, 2004				Full	Exch. rate anchor
Indonesia			1990, 1997, 2004		Partial	Monetary aggregate target
Japan				1990, 1997, 2004	Full	Other (1)
Korea			1990, 1997	2004	Partial	Inflation target
Malaysia	2004	1990	1997		Partial	Exch. rate anchor
Philippines				1990, 1997, 2004	Partial	Inflation target
Singapore			1990, 1997,2004		Full	Other (1)
Thailand		1990, 1997	2004		Partial	Inflation target

Note:

(1) No explicit anchor but monitors various monetary indicators

Source: *International Monetary Fund, Annual Report*, various years.

Table 3: Pre-crisis conditional volatility and regime gain

Country NEER		Actual	UBP	CBP	HP
China	Volatility	4.53	**0.21**	0.43	4.53
	Gain	-	**-4.32**	-4.1	0
Hong Kong	Volatility	3.82	**0.21**	0.90	3.82
	Gain	-	**-3.61**	-2.92	0
Indonesia	Volatility	6.32	**0.22**	0.83	6.15
	Gain	-	**-6.1**	-5.49	-0.17
Korea	Volatility	6.71	**0.25**	0.81	6.71
	Gain	-	**-6.46**	-5.9	0
Malaysia	Volatility	4.35	**0.18**	0.61	4.17
	Gain	-	**-4.17**	-3.74	-0.18
Philippines	Volatility	7.32	**0.20**	0.48	7.09
	Gain	-	**-7.12**	-6.84	-0.23
Singapore	Volatility	3.70	**0.20**	0.54	3.69
	Gain	-	**-3.5**	-3.16	-0.01
Taiwan	Volatility	5.66	**0.23**	0.43	5.36
	Gain	-	**-5.43**	-5.23	-0.3
Thailand	Volatility	6.11	**0.22**	0.89	5.29
	Gain	-	**-5.89**	-5.22	-0.82
Mean	Volatility	5.39	**0.21**	0.66	5.2
	Gain	-	**-5.18**	-4.73	3.57
BILATERAL:					
China	Volatility	**0.24**	4.67	4.76	-
	Gain	-	4.43	4.52	-
Hong Kong	Volatility	**0.31**	3.75	4.76	-
	Gain	-	3.44	4.45	-
Indonesia	Volatility	**2.79**	5.52	4.76	-
	Gain	-	2.73	1.97	-
Korea	Volatility	**4.29**	5.55	4.76	-
	Gain	-	1.26	0.47	-
Malaysia	Volatility	**3.34**	4.46	4.76	-
	Gain	-	1.12	1.42	-
Philippines	Volatility	4.56	**4.52**	4.76	-
	Gain	-	-0.04	0.2	-
Singapore	Volatility	**3.61**	4.28	4.76	-
	Gain	-	0.67	1.15	-
Taiwan	Volatility	**3.53**	5.04	4.76	-
	Gain	-	1.51	1.24	-
Thailand	Volatility	**3.85**	5.61	4.76	-
	Gain	-	1.76	0.91	-
Mean	Volatility	**2.95**	4.82	4.76	-
	Gain		1.88	1.81	

Table 4: Post-crisis volatility and regime gain

Country NEER		Actual	UBP	CBP	HP
China	Volatility	4.94	**0.51**	0.77	4.94
	Gain	-	**-4.43**	-4.17	0
Hong Kong	Volatility	4.23	**0.49**	0.81	4.23
	Gain	-	**-3.74**	-3.42	0
Indonesia	Volatility	31.34	**0.50**	1.51	31.32
	Gain	-	**-30.84**	-29.83	-0.02
Korea	Volatility	11.69	**0.54**	1.20	11.69
	Gain	-	**-11.15**	-10.49	0???
Malaysia	Volatility	21.91	**0.56**	1.21	22.58
	Gain	-	**-21.35**	-20.7	0.67
Philippines	Volatility	10.83	**0.55**	1.09	10.77
	Gain	-	**-10.28**	-9.74	-0.06
Singapore	Volatility	5.94	**0.85**	3.18	5.83
	Gain	-	**-5.09**	-2.76	-0.11
Taiwan	Volatility	6.19	**0.52**	0.78	6.08
	Gain	-	**-5.67**	-5.41	-0.11
Thailand	Volatility	10.07	**0.51**	1.46	5.99
	Gain	-	**-9.56**	-8.61	-4.08
Mean	Volatility	11.9	**0.56**	1.33	11.49
	Gain	-	**-11.34**	-10.57	-0.41
BILATERAL:					
China	Volatility	**0.07**	4.51	4.82	-
	Gain	-	4.44	4.75	-
Hong Kong	Volatility	**0.19**	3.81	4.82	-
	Gain	-	3.62	4.63	-
Indonesia	Volatility	30.76	5.79	**4.82**	-
	Gain	-	-24.97	**-25.94**	-
Korea	Volatility	10.63	5.39	**4.82**	-
	Gain	-	-5.24	**-5.81**	-
Malaysia	Volatility	23.23	4.96	**4.82**	-
	Gain	-	-18.27	**-18.41**	-
Philippines	Volatility	10.50	4.89	**4.82**	-
	Gain	-	-5.61	**-5.68**	-
Singapore	Volatility	6.74	5.21	**4.82**	-
	Gain	-	-1.53	**-1.92**	-
Taiwan	Volatility	**4.52**	5.02	4.82	-
	Gain	-	0.5	0.3	-
Thailand	Volatility	10.57	5.93	**4.82**	-
	Gain	-	-4.64	**-5.75**	-
Mean	Volatility	10.8	50.57	**4.82**	
	Gain		-5.74	**-5.98**	

Table 5: The trade- off between basket pegs and bilateral volatility

Net Gain	Pre-crisis UBP	Pre-crisis CBP	Post-crisis UBP	Post-crisis CBP
China	0.11	0.42	0.01	0.58
Hong Kong	-0.17	1.53	-0.12	1.21
Indonesia	-3.37	-3.52	-55.81	-55.77
Korea	-5.2	-5.43	-16.39	-16.3
Malaysia	-3.05	-2.32	-39.62	-39.11
Philippines	-7.16	-6.64	-15.89	-15.42
Singapore	-2.83	-2.01	-6.62	-4.68
Taiwan	-3.92	-3.99	-5.17	-5.11
Thailand	-4.11	-4.31	-14.2	-14.36
Mean	-3.3	-2.92	-17.09	-16.55

Note: the net gain is the reduction in volatility (ACSD) from the basket peg compared to actual plus the gain or loss in bilateral volatility compared to actual. A negative sign implies a gain.

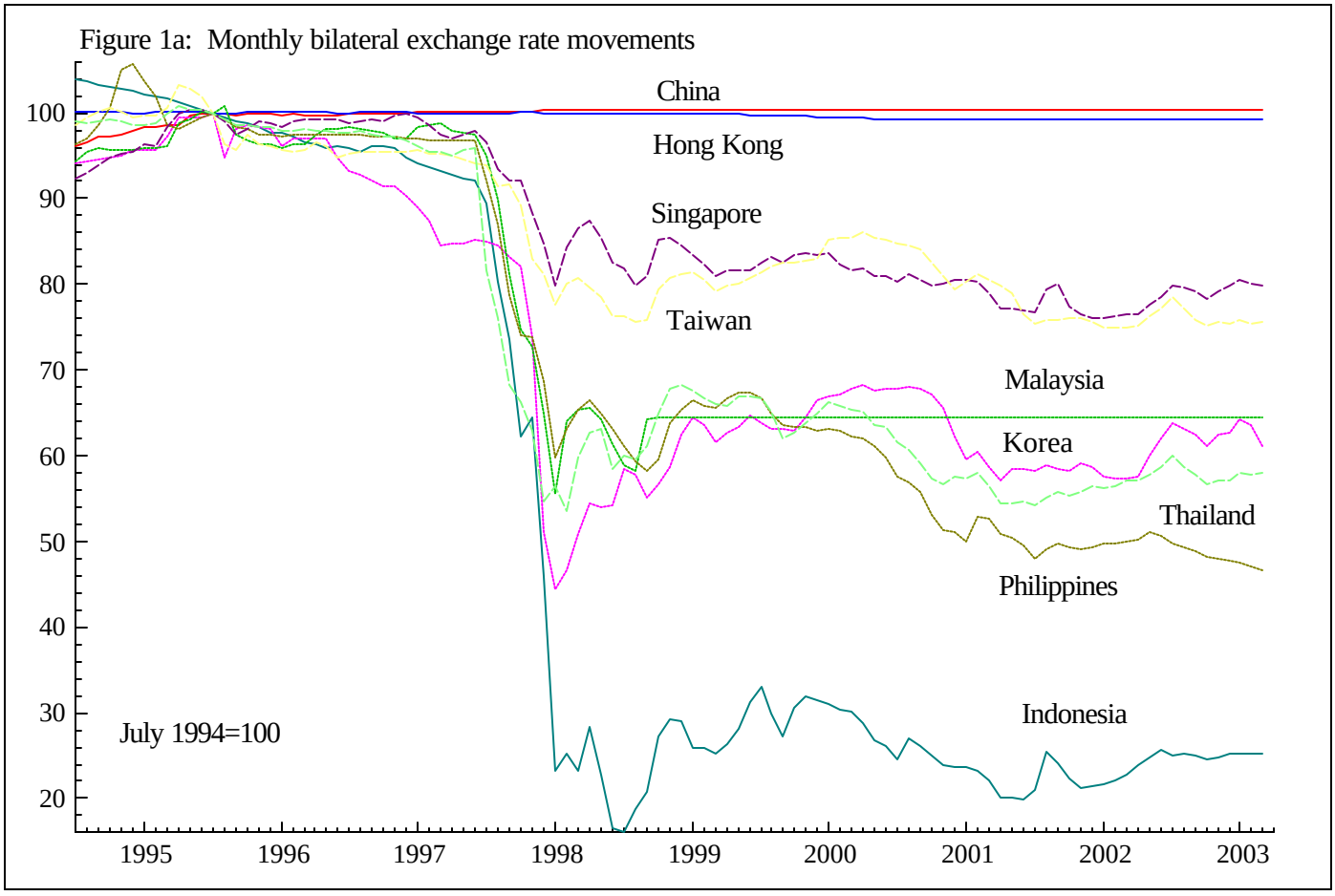
Figure 1a: Monthly bilateral exchange rate movements
China
Hong Kong
Singapore
Taiwan
Malaysia
Korea
Thailand
Philippines
Indonesia
July 1994=100
100
90
80
70
60
50
40
30
20
1995
1996
1997
1998
1999
2000
2001
2002
2003

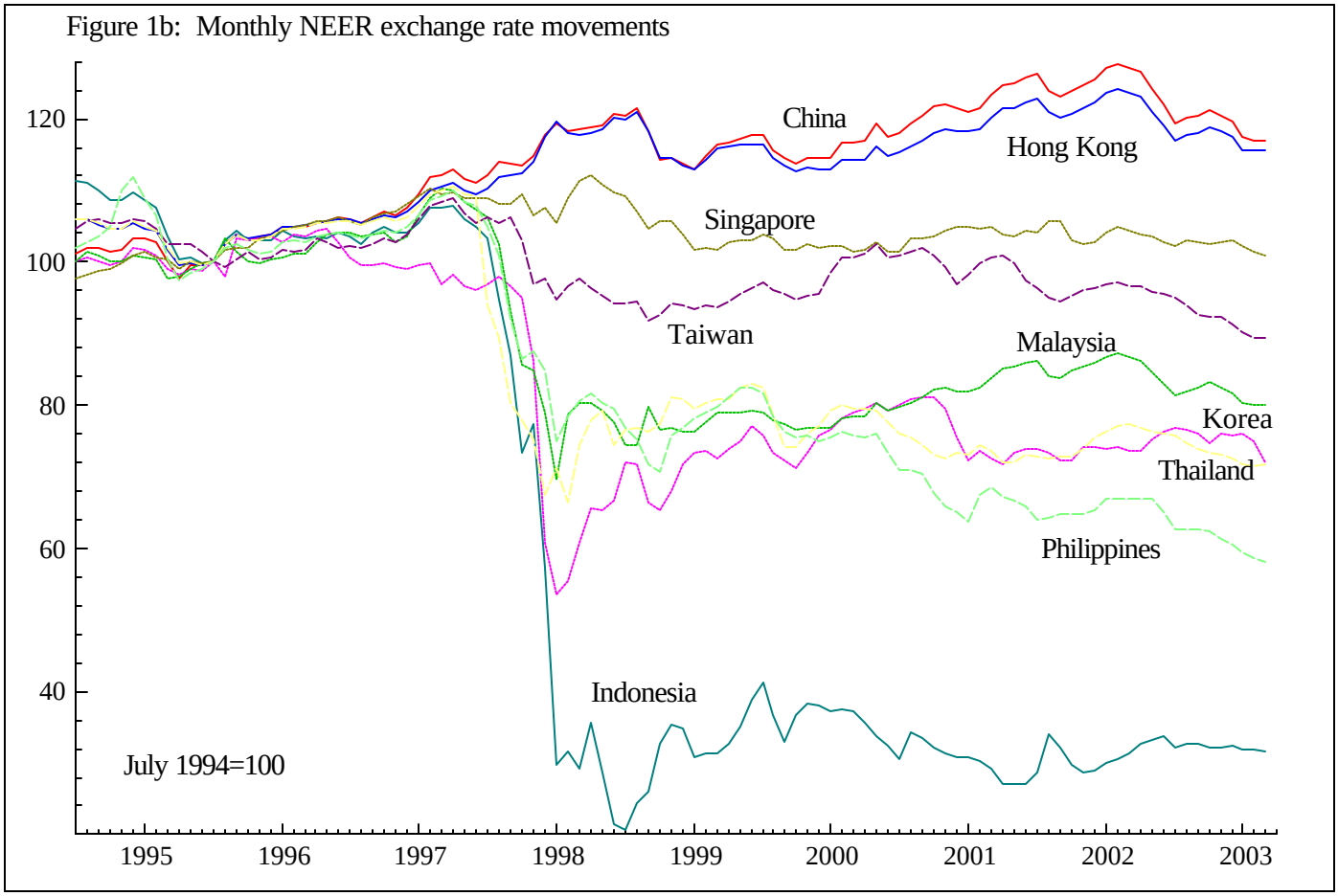
Figure 1b: Monthly NEER exchange rate movements
120
100
80
60
40
China
Hong Kong
Singapore
Taiwan
Malaysia
Korea
Thailand
Philippines
Indonesia
July 1994=100
1995
1996
1997
1998
1999
2000
2001
2002
2003

Figure 1c: Monthly REER exchange rate movements

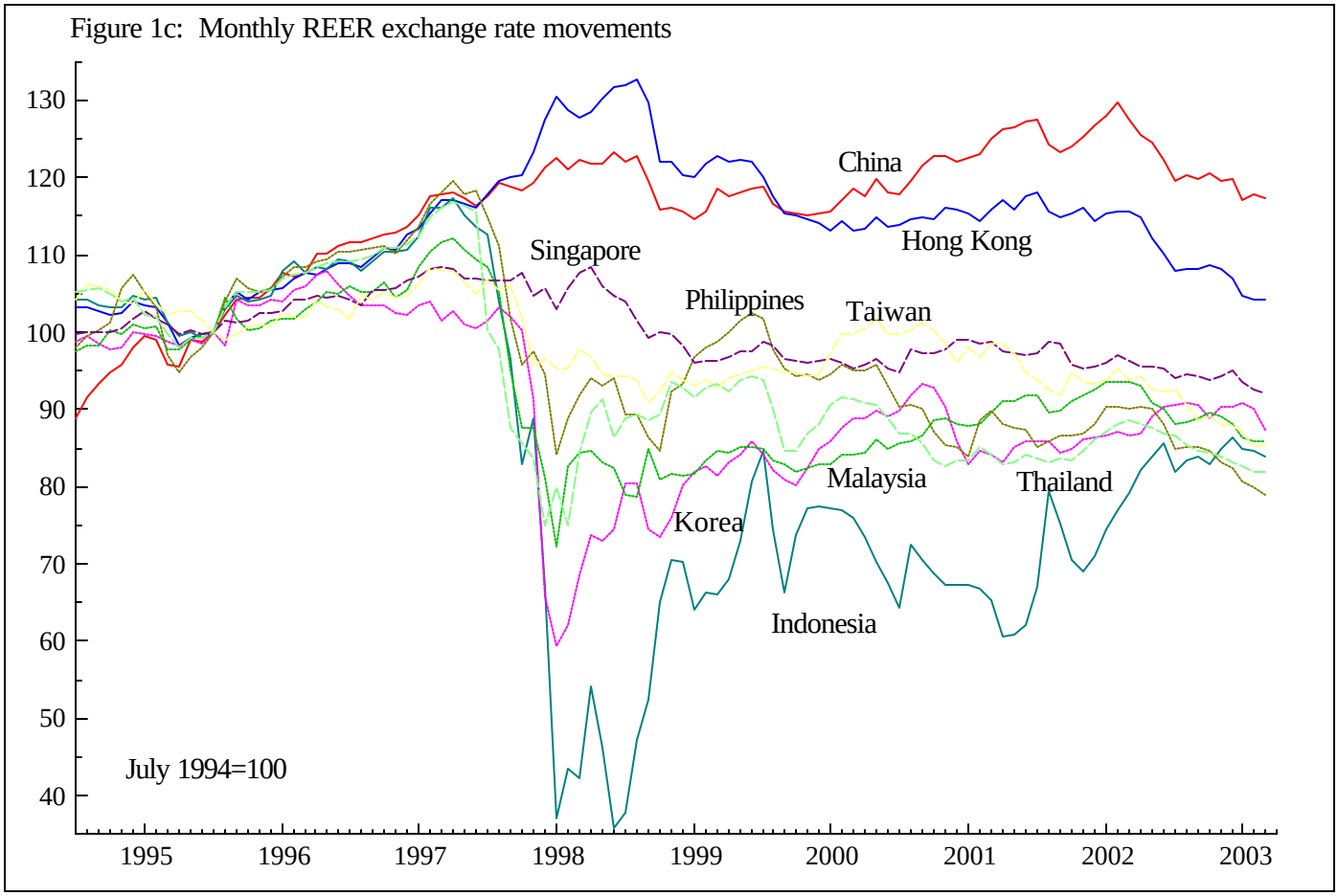

Figure 2a: Volatility of the S$ NEER

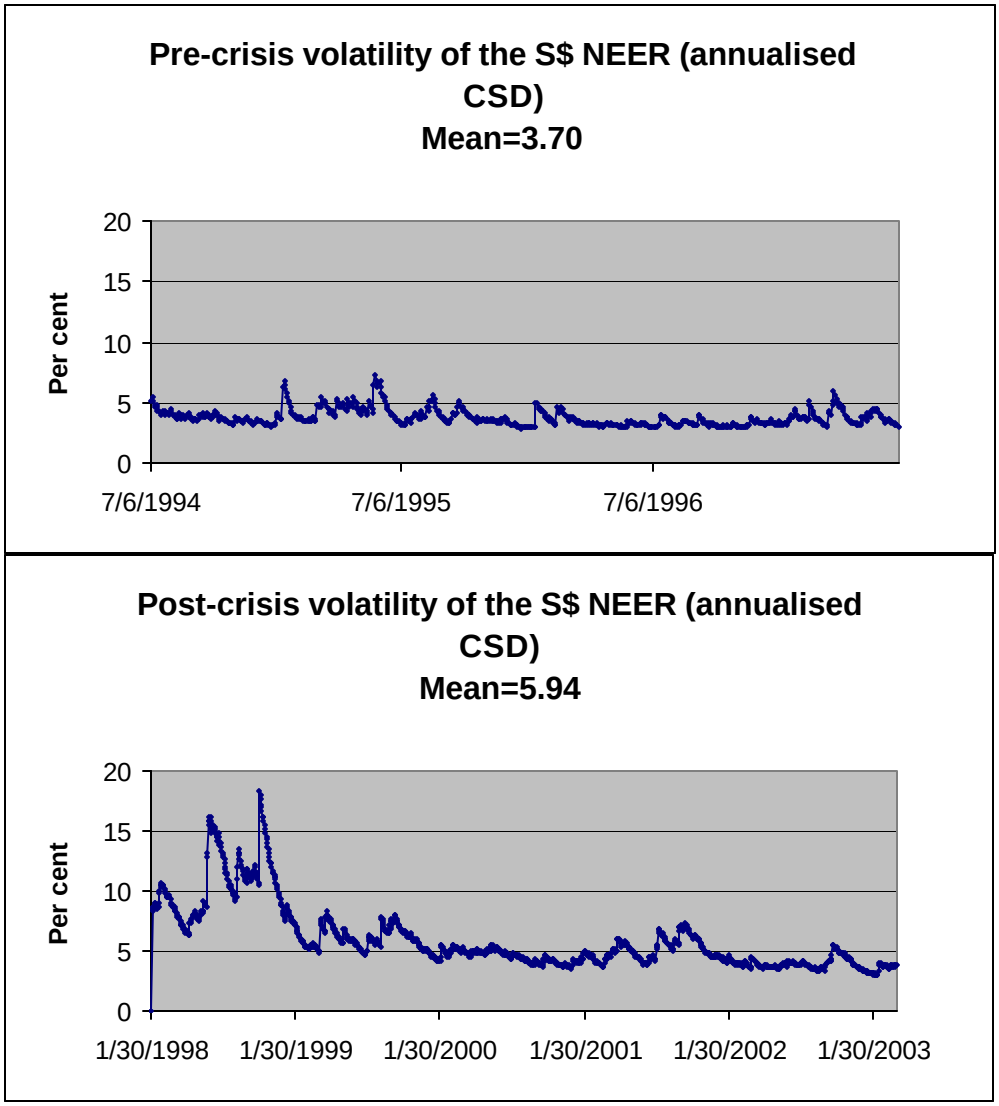

Figure 2b: Volatility of the S$:US$ bilateral exchange rate

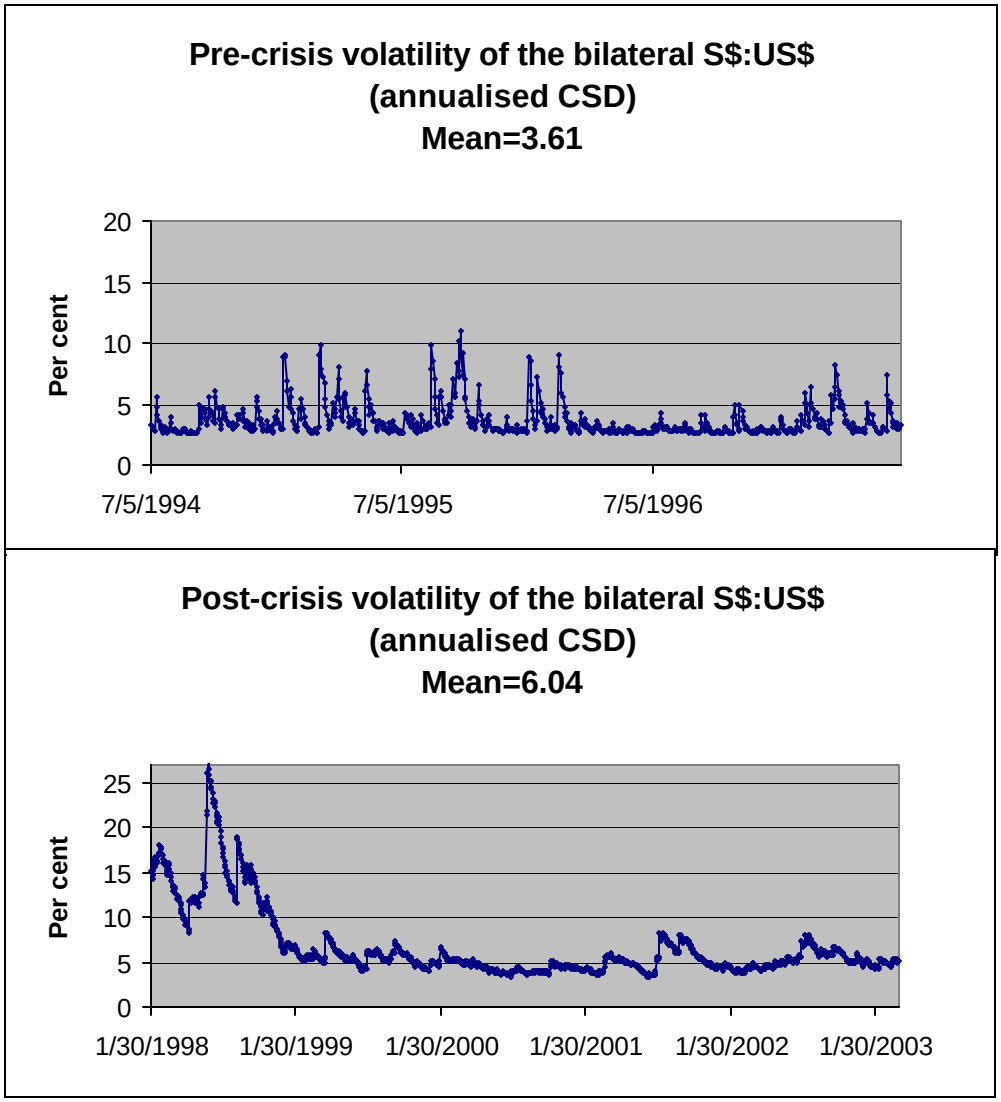

Figure3 15:23:44 15-Jul-2005

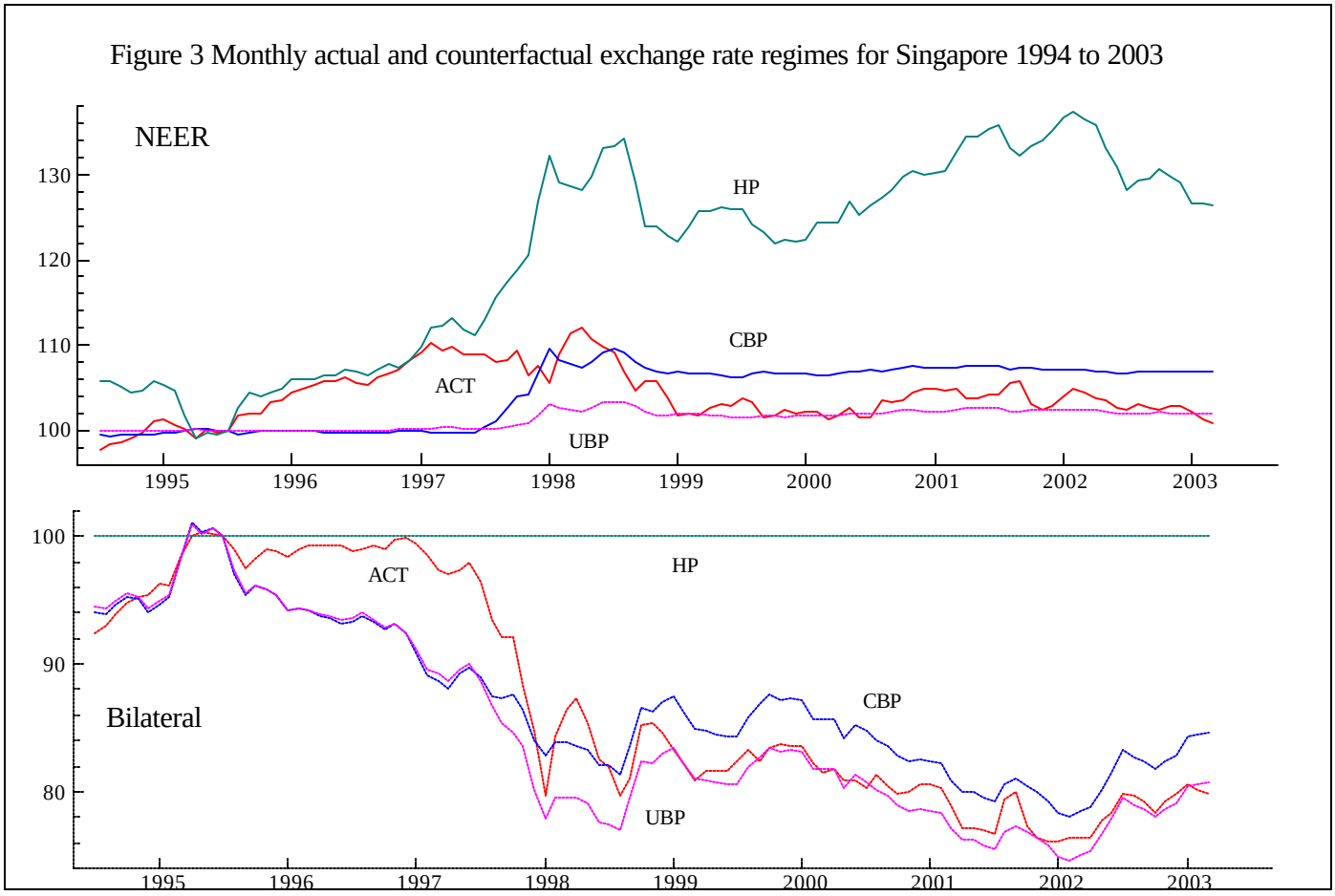

Figure 4: The trade-off in gains