MONETARY POLICY AND EXCHANGE RATE ARRANGEMENTS IN EAST ASIA BEFORE AND AFTER THE CRISIS.

by

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MONETARY POLICY AND EXCHANGE RATE ARRANGEMENTS IN EAST ASIA BEFORE AND AFTER THE CRISIS.

Abstract

This dissertation examines the monetary policy and exchange rate regime choices made by central banks in East Asia before and after the Asian Crisis in 1997-8. The crisis was something of a defining moment in the way central banks conducted their monetary policy and all of the crisis-affected economies – Korea, Thailand, Indonesia, Malaysia and the Philippines substantially changed their policies thereafter.[1] Chapter 2 offers an empirical overview and analysis of the monetary policy and exchange rate arrangements before and after the crisis.

Before the crisis, each of the countries mentioned above conducted largely exchange rate based monetary policy that centred around a soft US dollar peg (although Philippines was more of a chaotic managed float). Reserves were used to manipulate the value of the local currency against the US dollar and, as such, the central banks of these countries subordinated much of their monetary policy, and therefore interest rate movements, to the US. Any attempt at establishing monetary control was with the aid of sterilised intervention. As such Chapter 3 of this dissertation presents a model assessing the effectiveness of sterilised intervention and the effect of sterilisation on domestic interest rates. The results indicate significant evidence of sterilisation before the crisis in all the countries sampled. Furthermore, the existence of sterilisation had a weak impact on the domestic interest rate for Korea, Thailand, the Philippines and Malaysia, but a stronger effect in Indonesia. When the model is generalised to incorporate a lag structure using a VAR, the effects are stronger across the board.

[1] Singapore and Taiwan were also affected. Data for Taiwan is difficult to obtain and Singapore's regime is rather unusual and didn't lend itself to the type analysis conducted in this dissertation.

After the crisis, Malaysia (Spetember 1998) instituted a system of rigidly fixed exchange rates and effective capital controls. Korea, Thailand, Indonesia and the Philippines instituted an inflation-targeting (IT) regime fashioned around a floating exchange rate. Chapter 4 focuses on the effectiveness of IT regimes in East Asia. A simple analytical model is specified and calibrated using data for Thailand. The model is then simulated to examine a range of different policy positions; and the stochastic and dynamic properties of the model are generated and analysed. The results show that IT is more effective when the exchange rate is included as part of the central bank's set of objectives. An important feature of the parameterisation of the model is the existence of possible contractionary devaluation, which further promotes the uses of exchange rate augmented IT based policies.

One of the main results from the study in Chapter 2 is that, while there was a general increase in the flexibility of exchange rates, they did not float as freely as they do in countries like Australia and the USA – countries known to be 'floaters'. There seems to be a fear of floating (FoF) in many cases. Chapter 5 analyses the existence of, and possible justification for, FoF and examines the effectiveness of different optimal monetary policy types using a small open-economy model and dynamic programming techniques. The policies examined are solved in the model as optimal policy under discretion. The numerical results indicate that, for most model configurations, those polices with exchange rate involvement perform well and in some cases are the most suited policy. This suggests that there may be some justification for fear of floating attitudes amongst central banks. FoF policies appear to control exchange rate movements with relatively little cost to inflation for most scenarios examined.

Chapter 6 offers some concluding remarks and discusses the scope for future research on this topic.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and beliefs, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Tony Cavoli, 17th February, 2005.

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1
Introduction

This dissertation examines selected issues relating to exchange rate and monetary policy arrangements in East Asia before and after the Asian Crisis of 1997-8. Specifically, it seeks to answer some questions about how central banks have conducted their monetary policy pre and post-crisis and seeks to assess how effective those policy actions have been – and continue to be.

Central to the issue of monetary policy effectiveness is the choice of exchange rate regime and the central bank's view about the degree of exchange rate flexibility that it is prepared to allow. The degree of flexibility permitted has consequences for how a central bank conducts its domestic monetary policy and how it might need to insulate the domestic economy from external influences. Of course, this is the well-known "Impossible Trinity". A country must sacrifice one of the following three characteristics: a fixed exchange rate, domestic monetary independence or perfect capital mobility (see Frankel, 1999). A floating exchange rate permits the central bank to pursue the other objectives. An exchange rate with some degree of fixity, on the other hand, means that the central bank abandons a corresponding degree of monetary independence or imposes capital controls such that domestic monetary conditions can be altered without fear of that policy being reversed through capital flows.

One of the interesting aspects of this hypothesis is that, assuming high capital mobility, the choice between exchange rate regimes became a discrete one – one either allows full flexibility or none at all.[1] This is referred to in the literature as the

[1] Either fixed to one currency or a basket of currencies

corners hypothesis or bipolar view. The idea that the exchange rate/monetary policy choice could be taken as being along a continuum of regimes between fully floating and rigidly fixed was not, for a time after the crisis, seen as a legitimate policy prescription.

The question is: was there a material shift in emphasis in monetary and exchange rate policy after the crisis? It is widely cited in the recent literature on exchange rate regimes (and examined in Chapter 2 in this dissertation) that most of the developing economies in Southeast Asia maintained a *de facto* US dollar peg for much of the decade before the crisis. This was especially true of Thailand, Korea and Indonesia and less true of Malaysia and the Philippines. After the crisis, the policy action from Malaysia was very swift. In September 1998, it implemented a firm peg to the US dollar and imposed capital controls to preserve that peg (the fixed corner). The monetary policy choices made by the other countries seemed to centre around allowing greater exchange rate flexibility. As such, gradually, Korea, Thailand, Indonesia and the Philippines implemented inflation targeting (IT) regimes. The normative literature governing IT provided something of a checklist for an effective IT regime.[2] The checklist included flexible exchange rates, central bank independence, greater transparency and a monetary policy rule where the policy instrument should be a short-term nominal interest rate. Each of the new floaters amended their respective Central Bank Act to allow for an IT arrangement.

Given the context described above, the chapters in this dissertation investigate the nature of monetary policy in the period before and after the crisis.

Chapter 2 attempts to substantiate the differences between pre-crisis and post-crisis exchange rate arrangements by examining the degree of exchange rate flexibility

[2] See Taylor (2001) and his description of 'New Normative Macroeconomics', see also Masson et al (1997)

in the five crisis affected countries, Korea, Thailand, Indonesia, Malaysia and the Philippines. The chapter seeks to establish whether the exchange rates of Korea, Thailand and Indonesia have become more flexible. The paper is largely empirical and essentially provides the stylised facts that act as motivation for the subsequent chapters. The first part of the empirical analysis examines the behaviour of the volatility of the exchange rate, the nominal interest rate and foreign reserves. The aim is to obtain a measure of the extent of intervention undertaken by central banks to smooth the variability of exchange rates. The second part of the empirical section presents further estimates of the degree of fixity of each of the local currencies to the US dollar and to the Japanese yen. The chapter concludes that exchange rates are indeed more flexible after the crisis but there is evidence in the latter part of the sample of a reversion to a US dollar peg for some of the countries examined. There is also evidence to suggest that the yen has become more influential in determining the value of some East Asian currencies after the crisis.

Chapter 3 is concerned with pre-crisis monetary policy. This chapter uses a simple open economy interest rate determination model to empirically examine two aspects of pre-crisis policy. First, it looks at the effectiveness of sterilisation policy before the crisis. Second, it investigates whether sterilisation of the inflow of capital in any way helped keep interest rates high. The model is a version of the one used in Edwards and Khan (1985) appropriately adapted to include the effects of sterilisation. An interesting feature of the model is that capital mobility is captured and its interaction with domestic sterilisation plays a significant part in the overall effect on the domestic interest rate. The empirical section is concerned with the effect of reserve flows on the interest rate and is divided into two parts. The first tests for a contemporaneous effect of the basic model using OLS and IV methods. The second generalises the model to assess for lagged effects by way of VAR analysis. The results show that there are some contemporaneous effects of sterilisation on the domestic interest rate though the effect is stronger when estimating the lagged model.

Chapter 4 looks at the existence of IT regimes in East Asia. Using a simple open economy macro model based on Ball (1999), this chapter examines the effect of an IT arrangement in an East Asian context. Using some OLS estimates, the model's parameters are calibrated, in the standard way, for Thailand. The model is solved using standard linear programming methods. Numerical simulations of a variety of different IT policy rules are generated and analysed. These policies include strict and flexible IT under commitment and under discretion as well as simple fixed monetary policy rules. In keeping with what central banks do, the chapter is concerned with policies that target the CPI, rather than domestic, inflation. The results reveal many of the usual characteristics of IT regimes in industrial economies, notably the trade-offs between output and inflation and between inflation and the exchange rate and that policy performance is affected by different shocks. The main point of departure in this particular parameterisation of the model is the effect of possible contractionary depreciation, especially in those rules that react to real exchange rate movements.

Chapter 5 looks at the issue of optimal monetary policy in the context of "fear of floating". The recent literature highlights three factors that may induce a fear of floating by central banks, namely openness, exchange rate pass-through and adverse balance sheet effects due to liability dollarisation. This chapter examines a range of policy configurations in an open macro model that contains the above characteristics and assesses the most suited policy for each scenario. The policy configurations differ by the degree of exchange rate involvement in the specification of optimal policy. In contrast to other recent contributions, this chapter looks beyond IT and also investigates those policies whose formulation, through the specification of the central bank loss function, bears some resemblance to intermediate exchange rate regimes. The aim is to ascertain whether intermediate policies are the answer for economies that are affected by fear of floating on the part of central banks. The scenarios are mainly based on some reduced form additions to the basic Svensson (2000) model and on deviations from a set of baseline parameters. Optimal discretionary policy is modelled using dynamic programming techniques. The numerical results indicate that, for most model configurations, those polices with exchange rate involvement perform well and in some cases are the most suited policy. This suggests that fear of floating attitudes amongst central banks may well be justified. This justification is further enhanced by the conclusion that fear of floating policies appear to control exchange rate movements with relatively little cost to inflation for most scenarios examined.

Chapter 6 presents some thoughts on the policy implications of the issues examined in this dissertation and scope for further research.

2
Exchange Rate Regime Choice in East Asia Pre and Post Crisis

2.1 Introduction

This Chapter compares and contrasts the exchange rate arrangements for Korea, Thailand, Indonesia, Malaysia and the Philippines before and after the crisis. The aim is to ascertain whether or not the exchange rate regime became more flexible in Korea, Thailand and Indonesia (and less flexible in Malaysia) as is asserted by the central banks and the IMF records for official exchange rate classifications.

The Chapter begins by briefly summarising the official (*de jure*) exchange rate classifications for the five economies. Using data from the early 1990s, it concludes that the regime of Korea and Indonesia changed from a managed float to a full float, Thailand's regime changed from a basket to a full float, Malaysia's regime changed from being a basket peg to a fixed exchange rate and the Philippines exchange rate regime did not change.

The Chapter then examines the *de facto* regimes by investigating the trends in the behaviour of exchange rates, interest rates and reserves for the period 1990 to 2004 and conducts more formal tests for the degree of exchange rate flexibility and the extent of intervention policies employed to control the level and volatility of the currency. [1] The unconditional volatility of exchange rates suggests that flexibility has increased significantly post-crisis (except Malaysia). However, exchange rate variation needs to be examined along with variation in interest rates and foreign reserves in order to

[1] There are a number of recent papers on the topic of regime classification – for instance Calvo and Reinhart (2002), Frankel (2003), Rogoff et al (2003), Kim (2003), Shambaugh (2004) and Willett (2004). This chapter is not concerned with classifying exchange rate regimes *per se* but with detecting the transition of regime from before to after the crisis.

ascertain the degree of possible intervention in the foreign exchange (FX) markets. Hence, observing the volatilities of interest rates and reserves with exchange rate volatility allows the opportunity to assess possible monetary policy actions taken by central banks.

The results of the empirical investigation suggest that exchange rate flexibility has increased after the crisis for Korea, Thailand, Indonesia and the Philippines. Exchange rate flexibility for Malaysia has reduced.[2] These results hold more significantly when assessing the local currency against the US dollar than for the local currency against the yen or the real effective exchange rate (REER). A comparison of the degree of flexibility with some industrial economies that float shows that there is evidence to suggest that there may be a reversion to a US dollar peg for some of the countries that claim that they are floating and pursuing an inflation target. Further analysis of the degree of influence of the US dollar and the yen shows that there is a possibility of a yen peg post-crisis.

The remainder of the Chapter is structured as follows: the next section presents an outline of the *de jure* exchange rate classifications for the above economies. The general conclusion is that most countries had fixed-but-adjustable pegs before the crisis. After the crisis, Malaysia adopted a rigidly fixed regime while Korea, Thailand and Indonesia implemented inflation targeting monetary policy systems operating alongside a floating exchange rate. Section 2.3 tests the assertion that the exchange rate regime has become more flexible for Korea, Thailand, Indonesia and the Philippines after the crisis. This section examines the behaviour of exchange rate volatility, interest rate volatility and reserves volatility for the period January 1990 to June 2004. The interaction

[2] It is important to note here that one of the most significant issues in the literature on *de facto* regimes is the inherent complexities in assessing the difference between policy driven and market driven movements in exchange rates.

between exchange rates, interest rates and reserves offers insight into whether exchange rates floated freely or were possibly managed through central bank manipulation of interest rates and/or reserves. The focus is on the difference in the variability of these variables pre and post-crisis. An exchange rate flexibility index based on Bayoumi and Eichengreen (1998), Glick and Wihlborg (1997) and Baig (2001) is used to provide a neat summary measure of the degree of flexibility (or, inversely, intervention). The indices confirm that exchange rate regimes have become more flexible, particularly with respect to the US dollar. Section 2.4 presents some more formal tests on the extent to which each of the currencies examined were pegged to the US dollar and to the Japanese yen using a variation on the Frankel and Wei (1994) methodology that has subsequently been used in Beng (2000) and Baig (2001). The application of a Kalman Filter allows for the assessment of the time variation of the degree of influence of the US dollar and the yen. The results indicate that the importance of the yen in East Asia has increased post-crisis. Section 2.5 concludes.

2.2 Summarising the *De Jure* Exchange Rate Classifications in East Asia

In many ways, the Asian crisis acted as a catalyst for policymakers and researchers to reconsider the choice of exchange rate regime in that region. It is almost universally accepted that, for most countries examined in this study (the Philippines is possibly an exception), the exchange rate regime prior to the crisis was a fixed-but-adjustable arrangement – usually to the US dollar, sometimes to a basket of currencies. Table 2.1 (at the end of this Chapter) presents an outline of how the exchange rate regimes have changed for the five crisis-affected countries. From this, it can be seen that Korea, Thailand and Indonesia adopted a managed floating, basket and managed floating regime respectively. Malaysia had employed a basket peg and the Philippine's currency floated.

After the crisis, regimes of the fixed-but-adjustable type were deemed inappropriate for developing economies for a number of reasons.[3] Agents treated the regime as being irrevocably fixed and, as such, there was little incentive to hedge foreign currency loans or, indeed, to develop liquid markets in hedge instruments. Furthermore, as the exchanges rates were not rigidly fixed, speculative pressure on the currency to devalue caused investors to close out open positions or to take short positions in that currency in expectation of profiting from the one-way bet that occurs when authorities give in and finally allow it to depreciate.[4] In the immediate aftermath of the crisis, the policy response to the fixed-but-adjustable pre-crisis regimes took the form of the "hollowing out" or "bipolar view" of exchange rate arrangements. To summarise, this view holds that fixed-but-adjustable regimes are inherently crisis-prone and thus lack credibility. In choosing their exchange rate regime, central banks should select one where the currency is either institutionally fixed, such as a currency board or dollarization, or one where the exchange rate is fully floating (see Frankel, 1999, Fischer, 2001 and Rajan, 2002a for a discussion).

There are two probable justifications for the bipolar view. The first is an empirical one. As Mussa et al (2000) point out, the countries that responded well after the crisis generally had either floating exchange rates or rigidly fixed ones. The second justification is found by appealing to the impossible trinity of the effectiveness of monetary policy. If capital mobility is high, a central bank cannot maintain a fixed exchange rate and an independent domestic monetary policy. Authorities can only have

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[3] For an account of these problems written before the crisis, see Obstfeld and Rogoff (1995a)

[4] See Grenfell (2000) and Bubula and Oktar-Robe (2003) for a good description.

one or the other. Institutionally fixed regimes offer a degree of credibility in that, firstly, a nation's currency would be pegged to that of a stable, low inflation anchor country and, secondly, that the nature of the peg is such that speculators see no incentive to place downward pressure on the domestic currency. A fully floating exchange rate reduces the possibility of destabilising speculation and allows the authorities to concentrate on domestic monetary policy matters without the instrument of policy being compromised by an exchange rate objective.

According to the *de jure* classifications, it would appear that the five crisis affected economies heeded the advice offered by the proponents of the bipolar view. Malaysia's policy response to the crisis was to institute a rigidly fixed ringgit to the US dollar and to impose further capital account restrictions. The central banks of Korea, Thailand, Indonesia and the Philippines sought to design inflation targeting (IT) arrangements. The normative literature in relation to IT regimes holds that these are best implemented with a fully floating exchange rate (see Taylor, 2000a, Taylor, 2001, Masson et al, 1997 and Chapter 4 in this dissertation). As such, Korea, Thailand and Indonesia began to (and the Philippines continued to) float their currencies. Figure 2.1 confirms the discussion above in that the economies examined appeared to conform to the policy prescriptions of the bipolar view. Malaysia implemented a credible (to this point) peg protected by capital controls, whereas Korea, Thailand and Indonesia elected to float their currencies and, along with the Philippines, implement an IT regime in the style of many industrial economies such as Australia, UK, Canada, Sweden and New Zealand.

Figure 2.1 shows that, informally, exchange rates do appear to be more flexible for four of the five countries examined and the exchange rate for Malaysia has become less flexible -- especially against the US dollar where it has not exhibited any movement at all. The difference in the degree of variation in Figure 2.1 seems to be more marked for the local currencies against the US dollar, suggesting it as the anchor currency of choice for the countries examined. This particular aspect of possible exchange rate fixity is revisited more formally in later sections.

2.3. Pre and Post-Crisis Behaviour of Exchange Rates, Interest Rates and Reserves

The previous section concluded with how the crisis-affected economies in East Asia brought about changes to their exchange rate/monetary policy regimes. It is argued by their respective central banks that Korea, Thailand and Indonesia have all allowed their currencies to float after the crisis.[5] As a plausible reflection of their commitment to a floating exchange rate regime, these countries – along with the Philippines – have sought to adopt IT regimes where the nominal anchor of monetary policy is the rate of inflation.

To assess the accuracy of these claims, the subsequent sections empirically examine the *de facto* regimes – that is, regimes that are classified according to observation and empirical estimation rather than from central bank statements. The first part investigates the trends in the behaviour of exchange rates, interest rates and reserves for the crisis-affected countries for the period 1990 to 2004. The relationship between the volatilities of exchange rates, interest rates and reserves is important from a policy perspective in that it offers insight into whether central banks used interest rates or reserves to manage currency movements.

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[5] Indonesia's transition through exchange rate regimes went through many stages – see Siregar and Rajan (2003).

In order to assist with the comparison, the second part of the section splits the sample into the pre-crisis and post-crisis periods. The volatility of exchange rates, interest rates and reserves for pre and post crisis samples are compared for each country. In addition, following Baig (2001) and Calvo and Reinhart (2002), the volatilities in this section are compared to those of known floaters. The third part of this section presents flexibility indices based on the interaction of the volatility of exchange rates, interest rates and reserves for the pre and post crisis sample periods. The data are from the IMF IFS CD and from the ADB-ARIC database and are monthly observations from January 1990 to June 2004. Exchange rates per US dollar are taken from line RF of IFS, exchange rates per yen are calculated from the US/yen rate and REERs are from the ADB-ARIC database. Reserves data are taken from lines 11, 14 and 16c of IFS and interest rates are taken from line 60B of IFS.

2.3.1 Standard Deviations of Exchange Rates, Interest Rates and Reserves.

Figure 2.2a – 2.2c presents annual (calendar year) standard deviations of monthly percentage changes in exchange rates for the crisis-affected countries.[6] Figure 2.2a shows the local currency against the US dollar, Figure 2.2b are exchange rates against the yen and Figure 2c are the real effective exchange rates (REER).

For much of the crisis period of 1997-8, each exchange rate exhibited a substantial increase in variability. The largest jump in volatility occurred in Indonesia whilst the Philippines recorded a much less significant variation during this period. The differences in exchange rate volatility before and after the crisis are quite noticeable in Figure 2.2a where the each of the local currencies against the US dollar are shown. The

[6] Using the 12 monthly observations corresponding to a calendar year and computing the standard deviations for those observations. The standard deviations for 2004 are for the 6 months ending June.

exchange rate volatilities in Korea, Thailand and Indonesia are significantly higher in the post-crisis period. As expected, there is no currency volatility for the ringgit against the US dollar. The differences in variability for the Philippines seem immaterial when eyeballing the data. Exchange rate volatility against the yen (Figure 2.2b) does not show the same pattern as against the US dollar for either pre or post-crisis. The results for the REERs (Figure 2.2c) show similar but not as marked a difference between pre and post-crisis as the volatilities of local currencies per US dollars. This is a possible indication of the fact that the US dollar and the yen both have observable positive weights in the basket that comprises the REER and hence will influence it in some way. The exchange rate volatilities offer evidence to support the change in *de jure* regimes after the crisis in that volatility has increased in Korea, Thailand and Indonesia and has decreased in the case of Malaysia.

In order to present a more complete account of the possible change of regime, the volatility of interest rates and reserves must also be taken into account. Figure 2.3 examines the money market interest rates in annual standard deviation of monthly first differences. In contrast to reserve volatility, the difference between before and after the crisis, after considering the increased variability for 1997-8, is easy to see. Interest rates are clearly less volatile after the crisis – particularly for Korea, Thailand and the Philippines.

Figure 2.4 shows the (calendar) annual standard deviations of monthly percentage differences in foreign reserves scaled by lagged base money. The differences in reserve volatility between pre and post-crisis are not easily detectable for most countries – Korea being a notable exception where it seems that reserves volatility has increased after the crisis.

It has been noted often in the literature that exchange rate volatility alone cannot sufficiently explain the regime adopted by a country.[7] This is because central banks have at their disposal the use of interest rates and reserves as policy instruments to help manage currency movements. The following analyses the interaction between exchange rate volatility, interest rate volatility and reserves volatility to assess the extent to which central banks have intervened to manage exchange rate changes. The focus is on the difference in these interactions before and after the crisis.

As such, this section uses a similar method to Reinhart (2000) to compare pre-crisis with post-crisis regime based upon observations of the interactions between exchange rate, interest rate and reserve volatility. The information in Reinhart (2000, p66, Table 1) is adapted to formulate the following proposition:

> If, in the pre-crisis period, exchange rate volatility is low and reserves volatility and/or interest rate volatility is high (relative to post-crisis) then the post-crisis exchange rate regime is more flexible than pre-crisis (and vice-versa).

The proposition asserts that for a regime to be considered less flexible, it will have relatively low exchange rate volatility and this volatility will be offset by higher interest rate and/or reserves volatility since they are being used as instruments to smooth currency volatility. If, in the event of relatively low exchange rate volatility, reserve volatility is high but interest rate volatility is low, then it can be posited that reserves, through official intervention, are the primary policy instrument. If reserve volatility is low but interest rate volatility is high, then, plausibly, interest rates are assumed to be the main policy instrument.

The proposition can be examined by again appealing to Figures 2.2 to 2.4. It can be seen, at least for the local currency per US dollar and the REERs, that exchange rate volatility is higher post-crisis and that interest rates are less volatile. As stated above,

[7] Amongst others, Bayoumi and Eichengreen (1998), Baig (2001), Reinhart (2000), Calvo and Reinhart (2002).

the implication regarding the volatility of reserves is harder to categorically determine. The conclusion is that the exchange rate regimes for Korea, Thailand, Indonesia and the Philippines are more flexible after the crisis. The reverse is true for Thailand. However, this conclusion is clouded somewhat by the volatility of reserves where there is little evidence to support an increase in flexibility. Korea, in fact, seems to be using reserves more after the crisis than before while reserves do not appear to have significantly decreased post-crisis for Thailand and the Philippines.

2.3.2. Pre vs Post-Crisis Volatilities and Comparison with Known Floaters

Having tentatively concluded that exchange rate regimes are more flexible post-crisis (with the important exception of Malaysia), this section continues with an analysis of the standard deviations of exchange rates, interest rates and reserves but expands upon it in two ways. First, the data is split into a pre-crisis and a post-crisis sample and second, in order to benchmark the degree of exchange rate flexibility, the volatilities are compared to a set of 'known' floaters – Australia, New Zealand, Canada, UK and USA.[8]

Table 2.2 presents the standard deviations of exchange rate, interest rate and reserve differences as before for the Asian countries being examined and for the known floaters for a pre and a post-crisis sample. The pre-crisis sample is 1990:1 to 1997:3 and the post crisis sample is 1999:6 to 2004:6. A comparison of each sample confirms the conclusions of the previous section. Irrespective of how the exchange rate is expressed, its volatility after the crisis increased for Korea, Thailand and Indonesia, decreased for Malaysia and, to a much lesser extent, the Philippines. Correspondingly, interest rate and reserve volatility decreased after the crisis for the most part – although there are a few interesting exceptions. The first relates to interest rates in Indonesia.

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[8] See Calvo and Reinhart (2002).

Unlike in the other countries, they have become more variable after the crisis. Along with a post-crisis reduction in reserve volatility, this suggests that interest rates are possibly used as a policy instrument.[9] The second exception is the increase in reserve volatility in Korea. Is this an indication of some desire to continue to use reserves as an exchange rate management tool? Indeed, it is worth noting that the general reduction in reserves post-crisis for Korea and the Philippines is not as emphatic as the decrease in the volatility of interest rates. Results of this nature have led authors such as Baig (2001) and Calvo and Reinhart (2002) to hypothesise about a possible 'Fear of Floating' in some emerging market economies and this point is examined further in the next section.

As in Baig (2001) and Calvo and Reinhart (2002), this section presents a comparison of the pre and post-crisis volatilities for the Asian sample and the known floaters. In order to attempt to confirm whether central banks that say they floated after the crisis actually did so, the focus is on the post-crisis sample.

There are some exceptions but for the most part, the exchange rate variation is lower for those countries in the Asian sample than for the floaters. The interest rate volatility is lower also – suggesting the floaters are less inclined to intervene using interest rate policy. The volatility of reserves is harder to explain. It would appear that New Zealand is an outlier here and that the floaters possess less variation in reserves.

A comparison of exchange rate variation with the floaters suggests a more flexible regime post-crisis. However, a comparison of interest rate and reserve volatility indicates that the floaters did not intervene as much as the Asian sample. This is typified by the case of Indonesia where the volatility of reserves and interest rates is

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[9] Despite the high interest rate volatility, interest rate smoothing does not seem to be an objective here.

comparatively very high – suggesting possibly that Indonesia has had some trouble controlling what might appear to be excessive exchange rate movement.

2.3.3. Exchange Rate Flexibility Index

A commonly used method to assess the degree of conditional exchange rate flexibility is the intervention or exchange rate pressure index.[10] This section presents intervention indices based on previous work by Baig (2001), Bayoumi and Eichengreen (1998), Glick and Wihlborg (1997) and Calvo and Reinhart (2002) and are given by the following:

$$\textit{Index 1} = \sigma_{ER}/(\sigma_{ER}+\sigma_{NFA}) \qquad (2.1)$$

$$\textit{Index 2} = \sigma_{ER}/(\sigma_{ER}+\sigma_{IR}) \qquad (2.2)$$

$$\textit{Index 3} = \sigma_{ER}/(\sigma_{ER}+\sigma_{NFA}+\sigma_{IR}) \qquad (2.3)$$

where σ_{ER} is the annual standard deviation of monthly (log) percentage differences in the exchange rate, σ_{IR} is the annual standard deviation of monthly first differences in money market rates and σ_{NFA} is the annual standard deviation of monthly percentage differences in reserves (Net Foreign Assets/Lagged Money Base).[11] All standard deviations are calculated as in the previous sections.

The index is chosen because it is easily aligned with the discussion of the previous section about the role of interest rates and/or reserves as policy instruments.

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[10] There are many types available and there is a significant literature on these Indices. A sample is given by the following: Girton and Roper (1977), Holden, Holden and Suss (1979), Bayoumi and Eichengreen (1998), Pentecost et al (2001), Tanner (1999). An outline of the different methodologies is given in Guimãeres and Karacadag (2004).

[11] It is quite conventional to scale reserves by lagged money base. The reason is to compare the effects of reserve changes over time. However, more work needs to be done on ensuring that the valuation effects of reserves are isolated from those effects pertaining to policy. (Kim, 2003)

For instance, a low index value in this instance implies less exchange rate flexibility or a higher level of intervention. Higher reserve volatility, other things being equal, will reduce the index value due to the possibility that reserves are being employed as a monetary policy tool in order to limit exchange rate flexibility.

Baig (2001) and Bayoumi and Eichengreen (1998) are primarily concerned with an index similar to Index 1 used in this section. However, using the three indices provided allows for a more balanced understanding of the use of the policy instruments available. Index 1 measures the possible effects of reserve intervention but ignores the effects of interest rates. It must be conceded that interest rate movement contains market as well as policy determinants and, as such, the results must be interpreted with care. However, it is worth evaluating the effects of interest rate based intervention in light of the move by Asian central banks toward inflation targeting and the use of interest rate rules. Hence, Index 2 is used for that purpose. Index 3 is a generalised index capturing both reserve and interest rate intervention. By construction, each index presents values bounded by 0 and 1 and the weights attributable to each variable in the denominator of the index are equal.

As in the previous section, three measures of the exchange rate are used; local against the US dollar, local currency against the yen and the REER. The results are presented in figures 2.5a to 2.5c. Figure 2.5a shows Index 1 for each exchange rate. For each exchange rate, Figure 2.5b presents Index 2 and Figure 2.5c presents Index 3.

A general observation from each diagram is that, pre-crisis, there was a greater inclination on the part of central banks to intervene in the market for local currency against US dollar. This also seems to carry across all three indices. In other words, any desire to peg is directed towards a US dollar peg. Certainly, the degree of flexibility against the US dollar increases materially after the crisis. Such a transformation is not evident in the interventions where the local currency per yen is used. This suggests that local central banks allowed their exchange rate changes relative to the yen to be determined by the yen/US rate. There is some post-crisis increase for the REER results – these would reflect the weight of the US dollar in the currency basket.

Figure 2.5 can also be employed to analyse difference between the indices. Given that the differences in the results for the exchange rate against the US dollar are obvious and possibly more reflective of policy, the focus is on those. As expected, the flexibility index for Malaysia post crisis is zero. The others indicate a general increase in flexibility after the crisis but three exceptions emerge. The first relates to Index 1. The Philippines appear to be reverting to a US dollar peg in the post-crisis period as indicated by the downward trend in the index value for that country. After an initial burst of high flexibility, the index for Korea appears to be trending down.

The second exception is regarding Index 2 in panel 1 of Figure 2.5b where the level of flexibility for Indonesia is decreasing after the crisis. Recall that Index 2 provides information about the possible use of interest rates as a policy instrument. This is consistent with analysis above that shows that the variability of interest rates in Indonesia post-crisis is very high. It is this variability that is causing the index value to be low.

The third can be seen from the first panel in Figure 2.5c. When both interest rate and reserve intervention is considered in the index (Index 3), there is evidence to suggest that Korea and the Philippines are possibly resuming a *de facto* US dollar peg. This is an interesting development as both countries have declared themselves inflation targeters. As neither of these countries displayed high interest rate intervention but both displayed reserve intervention, there is evidence to conjecture that each may be using interest rate policy for domestic objectives (inflation) and reserves for an exchange rate objective.

2.4. Testing for the Degree of Influence of the US Dollar vs the Yen

The last section presented several forms of flexibility index measuring the extent of possible intervention in the movements of the market for local currency against the US dollar and the yen separately. One of the main results is that the extent of intervention in the US dollar has decreased for the most part but that there appears to be a reversion to a US dollar peg in some instances. The flexibility indices also show that there is little change in intervention in the exchange rate against the yen.

This section presents some formal tests of the degree to which local currencies have been and are being influenced by the US dollar and by the yen. The tests are based around the well-known work by Frankel and Wei (1994) and have been used in Baig (2001) and Beng (2000). The method essentially conducts an OLS test of the local currency on other currencies that are considered to influence the local. Each currency is expressed in terms of an 'independent' numeraire. Given that the focus in this Chapter has been on the effect of the US dollar (US) and the yen (JP) on local currencies, the tests are confined to those currencies. The equation examined is given by the following:

$$LC_t = \beta_0 + \beta_1 US_t + \beta_2 JP_t + \mu_t \qquad (2.4)$$

where LC refers to the local currency. All currencies are expressed in log differences and the numeraire currency used is the Swiss franc. As with the empirical results in the previous section, the pre-crisis sample is 1990:1 to 1997:3 and the post-crisis sample is

1999:6 to 2004:6. The data used are monthly observations and are from the IMF IFS CD as described in the previous section.

There are three sets of results. The first two are results from Frankel and Wei type regressions carried out for a pre-crisis and a post-crisis sample. Table 2.3 presents the pre and post-crisis values of β_1 and β_2 for Korea, Thailand, Indonesia and the Philippines.[12] Only the pre-crisis regressions are presented for Malaysia owing to that country's rigid fix to the US dollar. The coefficient values are interpreted as the degree of influence of the US dollar and yen, respectively, on the local currency. A value of $\beta_1 = 0.90$ suggests that a one-unit movement in the value of the US dollar leads to the local currency changing by 0.90. A higher β_1 value is suggestive of a high degree of influence of the US dollar and, hence, possible intervention in the market for that currency.

The results in Table 2.3 appear to indicate that the value of β_1 has fallen after the crisis. By and large, this confirms the results from the previous sections in that the degree of flexibility against the US dollar has increased after the crisis. Not only has the value fallen, but the level of significance has fallen as well, a refection of a reduction in the tightness of the peg to the dollar. This result is consistent with the similar study found in Baig (2001). Also of note is the increase in the degree of influence of the yen after the crisis. This is noticeable across the board. It must be noted that the significance levels are lower for the yen than for the US dollar.

Table 2.4 presents Wald Tests (F-statistic) for coefficient restrictions from the regressions in Table 2.3. There are two hypotheses tested. The first is for $\beta_1 = 1$ and examines whether the local currency was pegged one-to-one with the US dollar. The second restriction is $\beta_1 + \beta_2 = 1$. This examines the extent to which the dollar and the yen combined explained all the movement in the local currency much in the same way as

[12] When interpreting the significance levels of the coefficient estimates, the reader is asked to be aware of the existence of multicollinearity in estimated models of this type.

a (two) currency basket. A rejection of the hypothesis implies either that the peg (either to the US dollar or to both dollar and yen) is quite tight but not equal to one or the peg is sufficiently loose that it cannot be reasonably concluded that it is equal to one. A non-rejection, however, implies a one-for-one relationship. There are very few clear non-rejections – Indonesia pre and post-crisis for both hypotheses and the Philippines post-crisis for the hypothesis of $\beta_1 + \beta_2 = 1$ are the most significant. The most suitable interpretation of the rejections is that there is a high degree of influence of the US dollar and/or the yen but that this influence is not exclusive. In other words, there appears to be some residual influences on the local currencies not explained by the dollar and/or yen, possibly due to the effect of regional currencies. Regrettably, these tests do not elaborate on the source of the residual influence.

The relative degree of significance between the US dollar and the yen can be explored further by applying the Kalman Filter to the regressions. This allows for the coefficient's evolution to be tracked over the entire sample. The model used is as follows:[13]

$$LC_t = \beta_0 + \beta_{1t}US_t + \beta_{2t}JP_t + \mu_t \qquad (2.4a)$$

$$\beta_{1t} = \beta_{1t-1} + \varepsilon_{1t} \qquad (2.5)$$

$$\beta_{2t} = \beta_{2t-1} + \varepsilon_{2t} \qquad (2.6)$$

Equation (2.4a) describes the measurement equation of the system. Notice that the coefficients have time subscripts. Each coefficient is assumed to vary over time and are given by the transition equations, (2.5) and (2.6). This particular version of the Kalman

[13] Cuthbertson, Hall and Taylor (1992) discuss Kalman Filter methods in an exchange rate determination model.

Filter method applies a recursive algorithm to estimate the value of each β at each iteration. The result is that the evolution of each β can be examined for the pre-crisis and post-crisis periods without needing to split the sample.[14] One of the advantages of this technique for the Frankel-Wei type tests is that the volatility of a coefficient can be observed. This may offer us greater insight into central bank behaviour. A smooth time path of the coefficient might imply that the central bank intervenes to maintain the influence of one currency on the other. A high but erratic coefficient value possibly implies a strong correlation that is not necessarily brought about by central bank behaviour. Rather, it implies a strong correlation that occurs naturally in the market for that particular currency pair, driven by factors such as market conditions, trader behaviour and noise.

Figure 2.6 shows the one-step ahead forecasts of β_1 and β_2 (for the US dollar and the yen) at each iteration over the sample period 1990:1 to 2004:6. This is shown for Korea, Thailand, Indonesia, Malaysia and the Philippines. As with the flexibility indices in section 2.2, the crisis period is easy to detect for both the US dollar and the yen. The results lend weight to those of the previous section in that the won, baht, and rupiah are all less influenced by the US dollar after the crisis. For Korea and Thailand, the value of β_1 is more volatile post-crisis. Volatility of the coefficient values over time might possibly be interpreted as a loosening of the degree of influence of a particular currency over the local currency. As such, this is a reflection of a loosening of a peg to that currency. As expected, the β_1 coefficient for Malaysia is 1 after the crisis. Interestingly, the influence of the yen (β_2) is more volatile after the crisis for Thailand and higher in value for Korea and Indonesia. The results for the Philippines accord to those in the last

[14] The βs are assumed to follow a random walk and the covariance matrix of the measurement and the transition equation is diagonal. This is the usual practice, see Cuthbertson, Hall and Taylor (1992) for a discussion.

section. There appears to be little difference in the influence of the US dollar or the yen between the pre and post-crisis periods.

Figure 2.7 presents, for each country, the time variation of β_1 and β_2 on the same graph. It can be seen here that, in general, the influence of the US dollar has decreased after the crisis, but that the influence of the yen has increased. For Korea, there is a sizeable difference between the influence of the dollar and the influence of the yen before the crisis. After the crisis, there is evidence of convergence as β_1 decreases and β_2 increases. A similar pattern emerges for Thailand. The extent to which the baht is driven by the dollar is more erratic post-crisis and is being matched by the yen. Indonesia's coefficient for the US dollar is relatively smooth relative to the yen, suggesting a possible inclination to fix to the dollar. The results for Malaysia are as expected, if the ringgit is influenced entirely by the US dollar ($\beta_1 = 1$) then it is expected that $\beta_2 = 0$. The comparative results for the Philippines show that while the degree of influence of the US dollar may be high, it is not smooth. This is representative of a scenario where a high correlation doesn't imply a fixed exchange rate. The yen maintains a small influence over the peso.

2.5 Conclusions

This chapter has reviewed the pre and post-crisis exchange rate regimes for Korea, Thailand, Indonesia, Malaysia and the Philippines. The *de jure* regimes for Korea, Thailand and Indonesia seem to suggest that exchange rates changed from basket pegs and managed floats to floating exchange rates after the crisis. Malaysia's regime became a fully fixed exchange rate. The Philippines' regime maintained its status as having an independently floating exchange rate.

From the various measures of *de facto* regimes presented in this chapter, three points emerge. First, it appears that the pre-crisis pegs, primarily and most significantly to the US dollar, were applied much more rigidly than the official classifications would initially suggest. The degree of variability in exchange rates, reserves and interest rates suggested quite heavy intervention.

Second, there is definitely an increase in exchange rate flexibility after the crisis, Malaysia being the exception. The biggest increase in flexibility is shown up in the raw exchange rate data for local currency against the US dollar and those indices that have been calculated using the exchange rate against the US dollar. The increase in flexibility in Korea, Thailand, Indonesia and the Philippines and the US dollar fix in Malaysia is consistent with the bipolar view of exchange rate regimes and with the *de jure* classifications. It is also consistent with the recent moves by the central banks of Korea, Thailand, Indonesia and the Philippines in implementing IT regimes.

Third, there is evidence of a possible reversion to the soft pegs of before the crisis. This is shown initially by a comparison of pre and post crisis volatilities with a set of known floaters. Allowing for the outliers, there is a clear difference in the volatility of exchange rates and interest rates. Interestingly, there is less difference in reserves volatility. The evidence from the indices suggests that there is a possible reversion to a US dollar peg – especially for Korea, Indonesia and the Philippines. However, the evidence from the Frankel-Wei regressions and, in particular, the Kalman Filter, seem to suggest that, while there is still a significant degree of influence by the US dollar on local currencies after the crisis, the influence of the yen has increased materially. However, the variability of this influence has also increased. As such, it is unclear whether the increased influence of the yen is due to a deliberate choice on the part of central banks to give more weight to the yen in a basket peg arrangement, or whether it is due to conditions in the foreign exchange market resulting a higher correlation between local currencies and the yen. This is an area for future research.

Table 2.1
***De Jure* Exchange Rate Classifications**

	1990	1995	1999
Korea	Managed Float	Managed Float	Independent Float
Thailand	Basket	Basket	Independent Float
Indonesia	Managed Float	Managed Float	Independent Float
Malaysia	Basket	Basket	Peg
Philippines	Independent Float	Independent Float	Independent Float

Source: Glick (2000) and IMF Annual Report on Exchange Arrangements and Exchange Restrictions

Table 2.2
Standard Deviations Pre and Post-Crisis

	ER/US		ER/Yen		REER		Mon Mkt Rate		D(NFA/MB(-1))	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Indonesia	0.24	6.09	2.87	6.42	1.57	4.88	1.97	2.67	9.72	7.93
Korea	0.79	2.29	2.69	2.89	1.15	1.48	1.28	0.10	3.25	13.33
Philippines	2.24	2.17	3.82	3.11	2.33	2.05	5.68	0.60	6.43	5.70
Thailand	0.50	2.11	2.57	3.01	1.08	1.37	2.26	0.25	4.55	3.59
AVERAGE	**0.94**	**3.17**	**2.99**	**3.86**	**1.53**	**2.45**	**2.80**	**0.91**	**5.99**	**7.64**
Malaysia	1.25	-	2.80	2.45	1.58	1.46	0.41	0.06	9.59	8.77
Australia	2.06	3.25	3.67	3.63	2.10	2.08	0.32	0.15	3.58	7.35
Canada	1.22	1.91	2.85	4.09	1.25	1.39	0.56	0.21	4.34	3.07
New Zealand	1.57	3.55	3.20	2.94	1.43	2.15	0.71	0.16	29.62	22.53
UK	3.25	2.29	3.87	2.86	1.76	1.22	0.64	0.82	6.73	0.54
USA			2.87	2.45	1.64	1.78	0.18	0.21	3.92	0.23
AVERAGE	**2.03**	**2.75**	**3.29**	**3.19**	**1.64**	**1.73**	**0.48**	**0.31**	**9.64**	**6.74**

Source: IMF IFS and ADB-ARIC data, monthly observations.

Note: Standard deviations are calculated from percentage first differences (Exchange rates, and reserves/lagged money base), first differences (Interest rates).
ER/US (ER/JP) refers to the each local currency against the US dollar (yen), REER refers to the Real Effective Exchange Rate.
Pre sample period: 1990:1 to 1997:3
Post Crisis data: 1999:6 2004:6 (except REER for East Asian countries, 1999:6 2004:5)

Table 2.3
OLS Estimates using Frankel and Wei (1994) Methodology

Equation: $LC_t = \beta_0 + \beta_1 US_t + \beta_2 JP_t + \mu_t$

	Korea		Thailand		Indonesia		Malaysia	Philippines	
	Pre	Post	Pre	Post	Pre	Post	Pre	Pre	Post
β_0	0.00 (0.84)	-0.00 (-0.02)	0.00 (2.16)**	0.00 (0.88)	0.00 (14.78)†	0.00 (1.69)*	-0.00 (-0.55)	0.00 (0.67)	0.01 (2.61)†
β_1	0.93 (36.59)†	0.70 (4.74)†	0.84 (101.22)†	0.68 (5.23)†	0.99 (95.87)†	0.13 (0.36)	0.89 (21.27)†	1.10 (16.32)†	0.75 (5.53)†
β_2	0.11 (3.13)†	0.45 (3.80)†	0.11 (14.27)†	0.20 (1.83)*	0.02 (3.15)†	0.44 (1.64)	0.09 (1.81)*	-0.03 (-0.37)	0.06 (0.51)
R^2_{adj}	0.97	0.72	0.99	0.60	0.99	0.31	0.89	0.75	0.54
DW	1.92	1.74	2.06	1.98	1.97	2.01	1.80	1.92	2.20
Obs	87	61	87	61	97	61	87	87	61

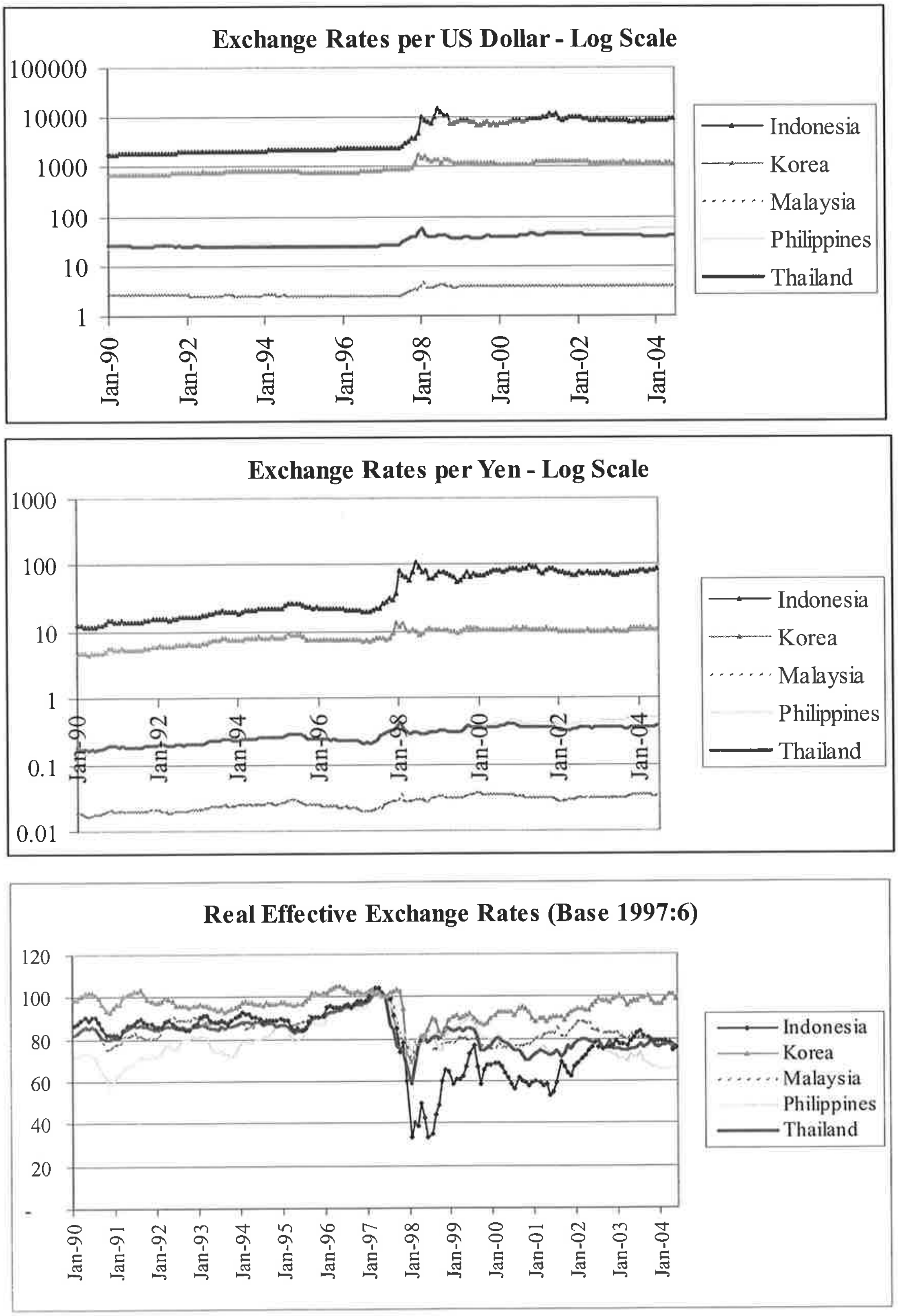
Note: *(**)(†), 10% (5%)(1%) significance levels, respectively
Malaysia post-crisis regressions not included
Korea pre-crisis results, Indonesia pre and post-crisis results contained serial correlation. To correct for this, Korea pre-crisis and Indonesia post-crisis model includes ARMA(1,1) terms and Indonesia post-crisis includes ARMA(3,3) terms

Table 2.4
Wald Test for Coefficient Restrictions.
(F-statistic shown)

	Korea		Thailand		Indonesia		Malaysia	Philippines	
	Pre	Post	Pre	Post	Pre	Post	Pre	Pre	Post
$\beta_1 = 1$	7.45 (0.01)	4.20 (0.04)	387.16 (0.00)	6.31 (0.02)	0.47 (0.50)	5.33 (0.02)	6.61 (0.01)	2.40 (0.12)	3.40 (0.07)
$\beta_1 + \beta_2 = 1$	2.84 (0.10)	2.34 (0.13)	104.95 (0.00)	3.39 (0.07)	1.28 (0.26)	5.77 (0.02)	0.10 (0.75)	1.02 (0.31)	53.48 (0.00)

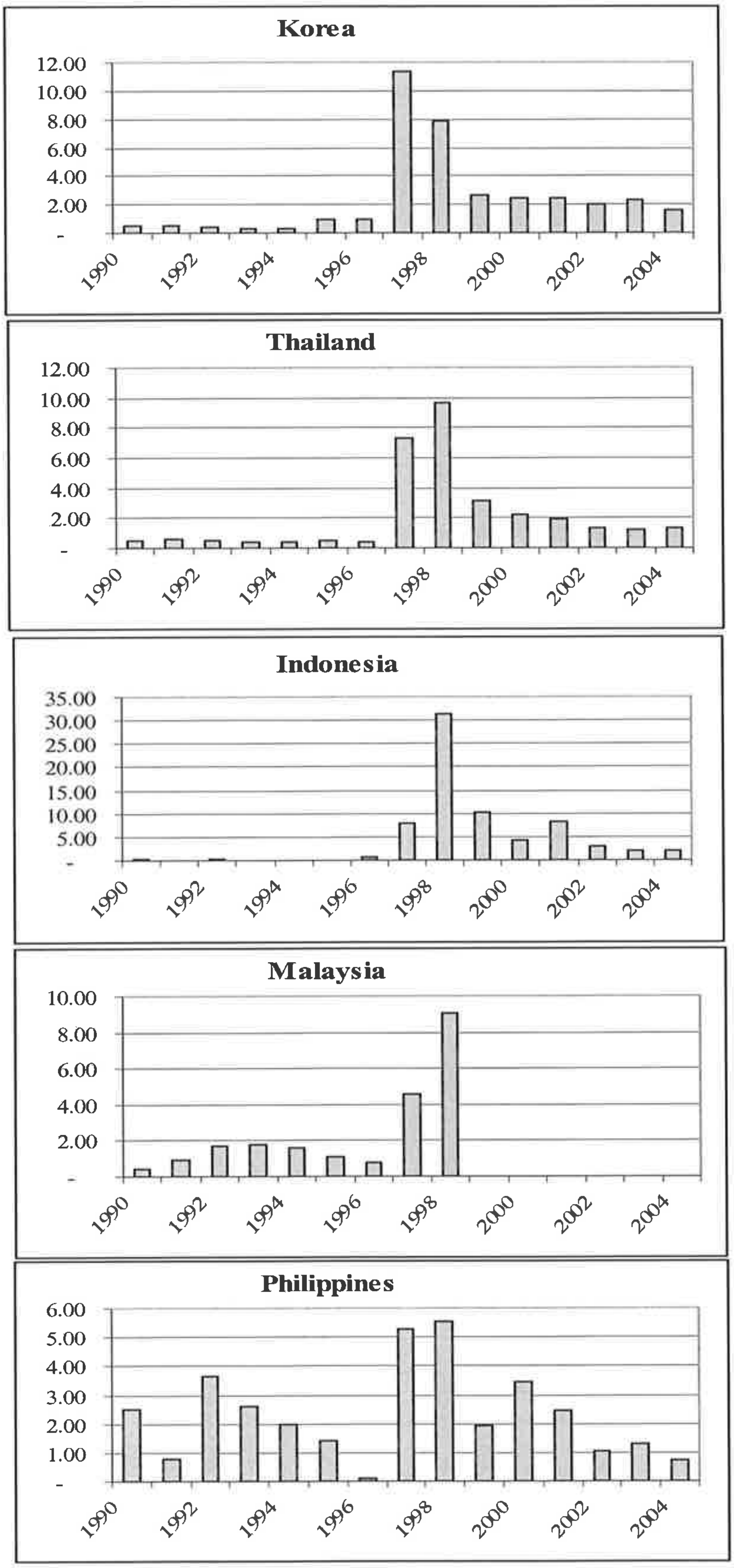
Note: Figures in parentheses are P-values.
Malaysia post-crisis regressions not included

Figure 2.1
Exchange Rates, 1990-2004



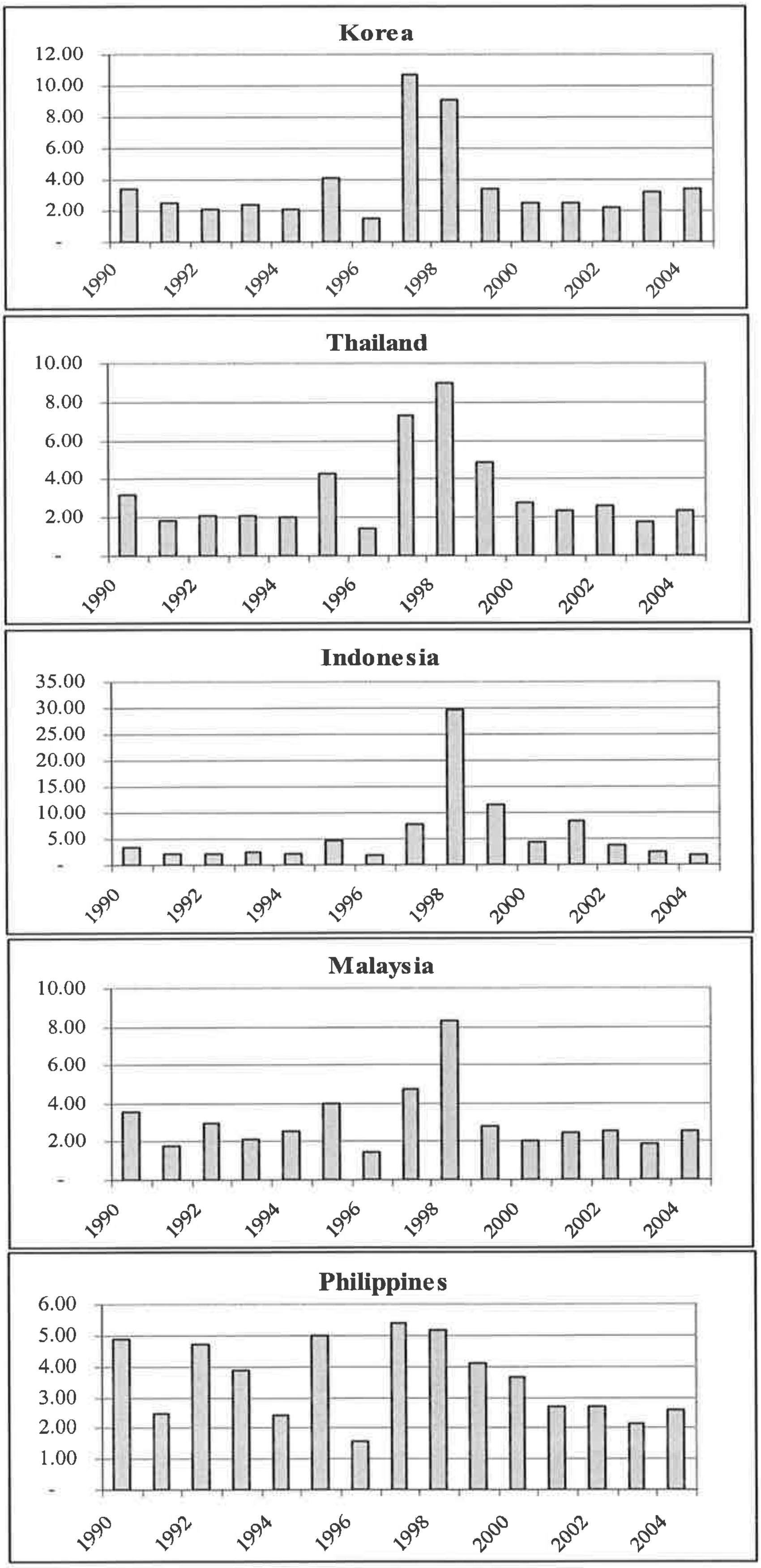
Source: IMF IFS and ADB-ARIC

Figure 2.2a
Standard Deviations, Exchange Rate /US Dollar



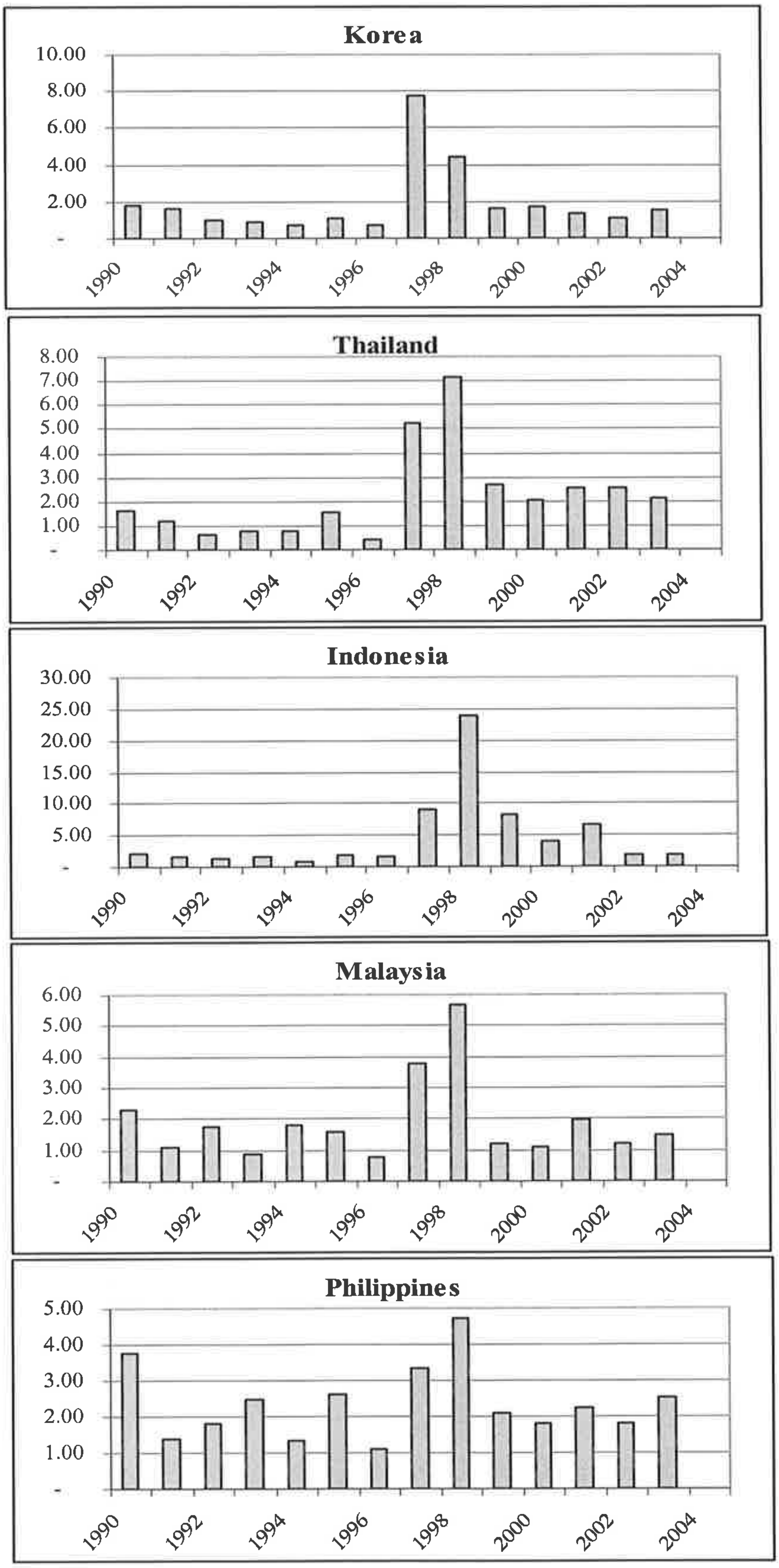
Source: IMF IFS. Calculated as calendar year standard deviations of percentage first differences (Exchange rates, and reserves/lagged money base), first differences (Interest rates).

Figure 2.2b
Standard Deviations, Exchange Rate /Yen



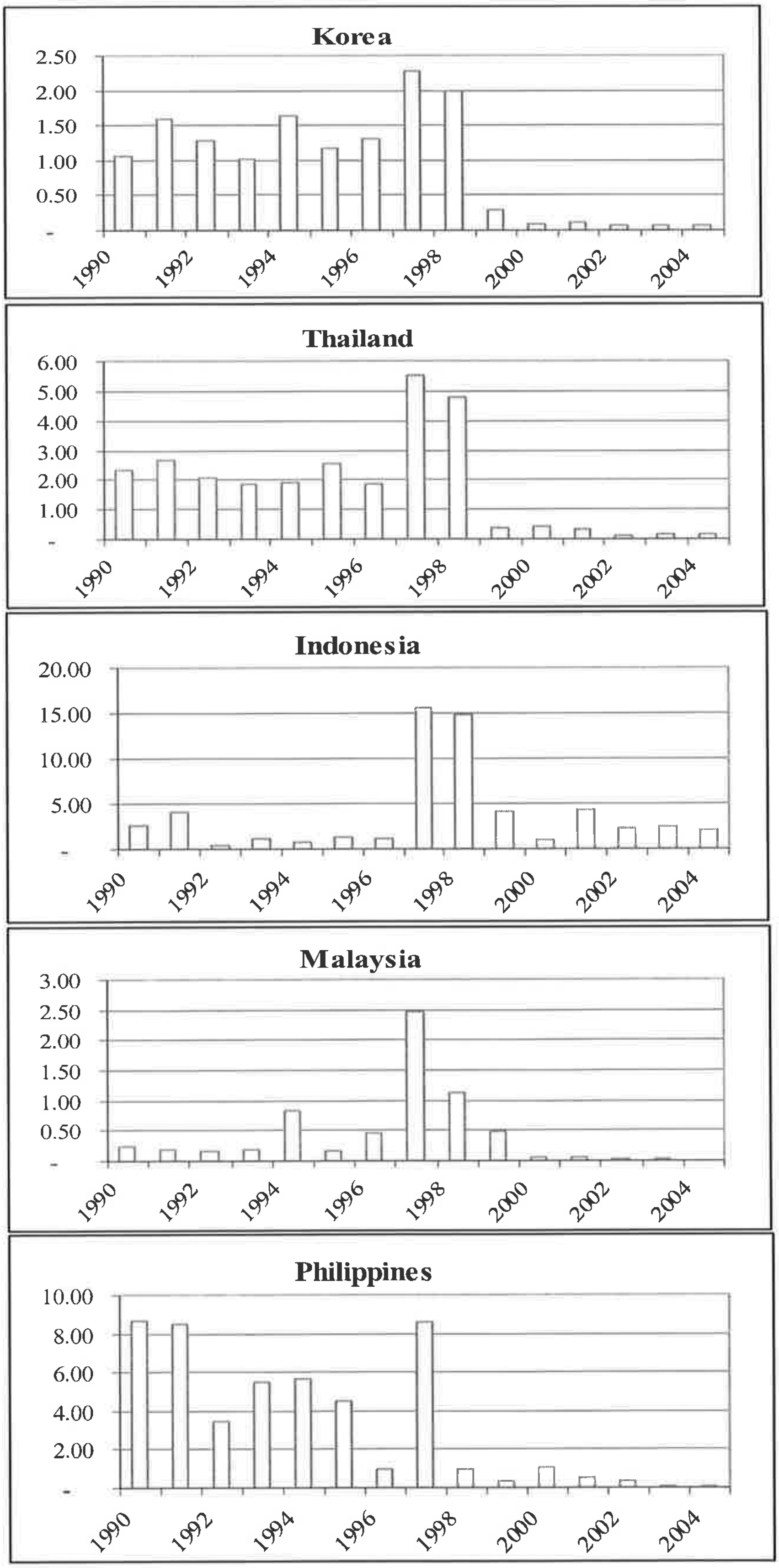
Source; IMF IFS, Calculated as per Figure 2.2a.

Figure 2.2c
Standard Deviations, REER



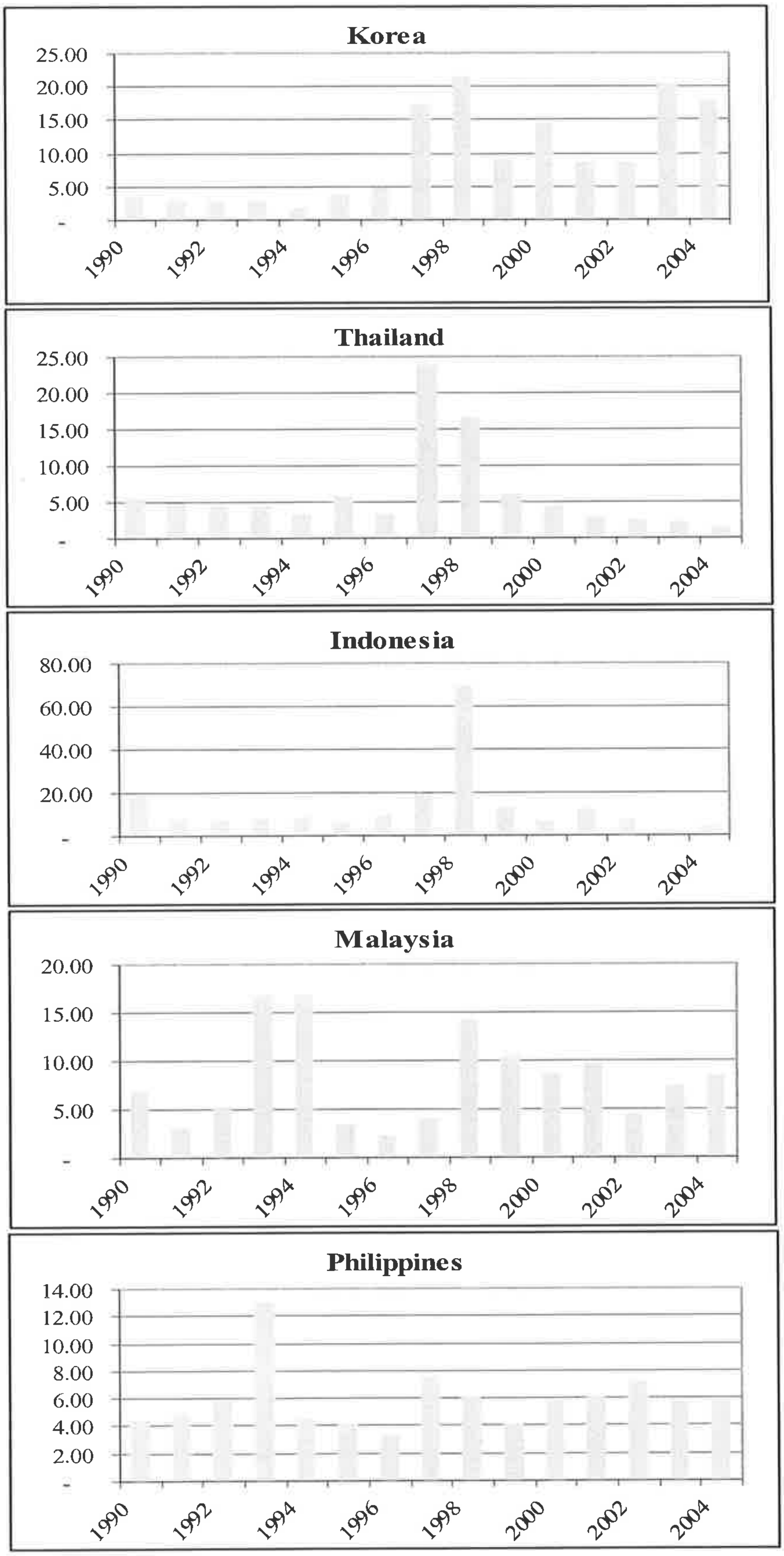
Source: ADB-ARIC. Calculated as per Figure 2.2a

Figure 2.3
Standard Deviations, Interest Rates



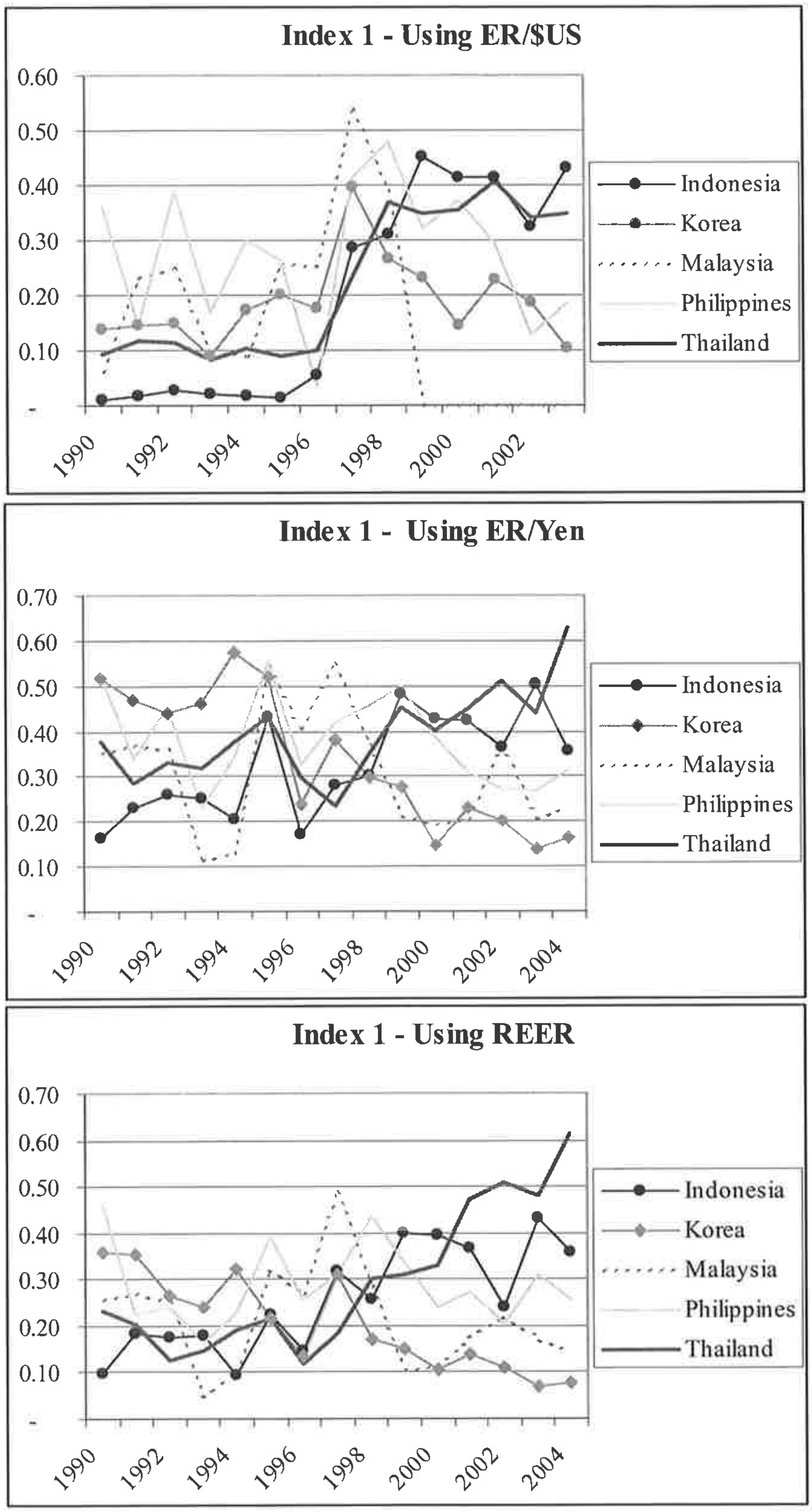
Source: IMF IFS. Calculated as the annual standard deviation of monthly first differences

Figure 2.4
Standard Deviations, Reserves/Lagged Money Base



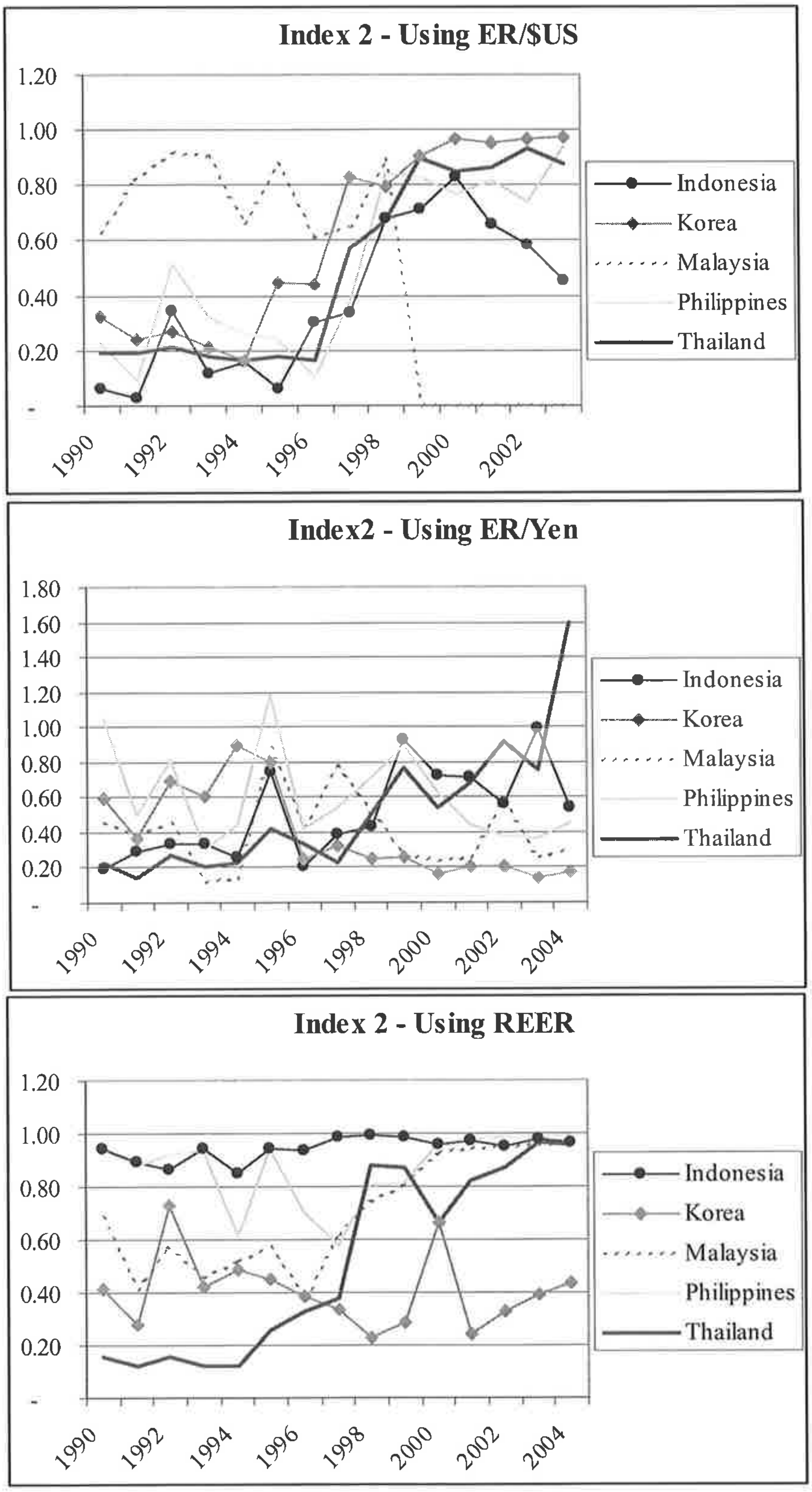
Source: IMF IFS. Calculated as annual standard deviation of percentage monthly first differences of net foreign assets, scaled by lagged base money.

Figure 2.5a
Flexibility Index #1



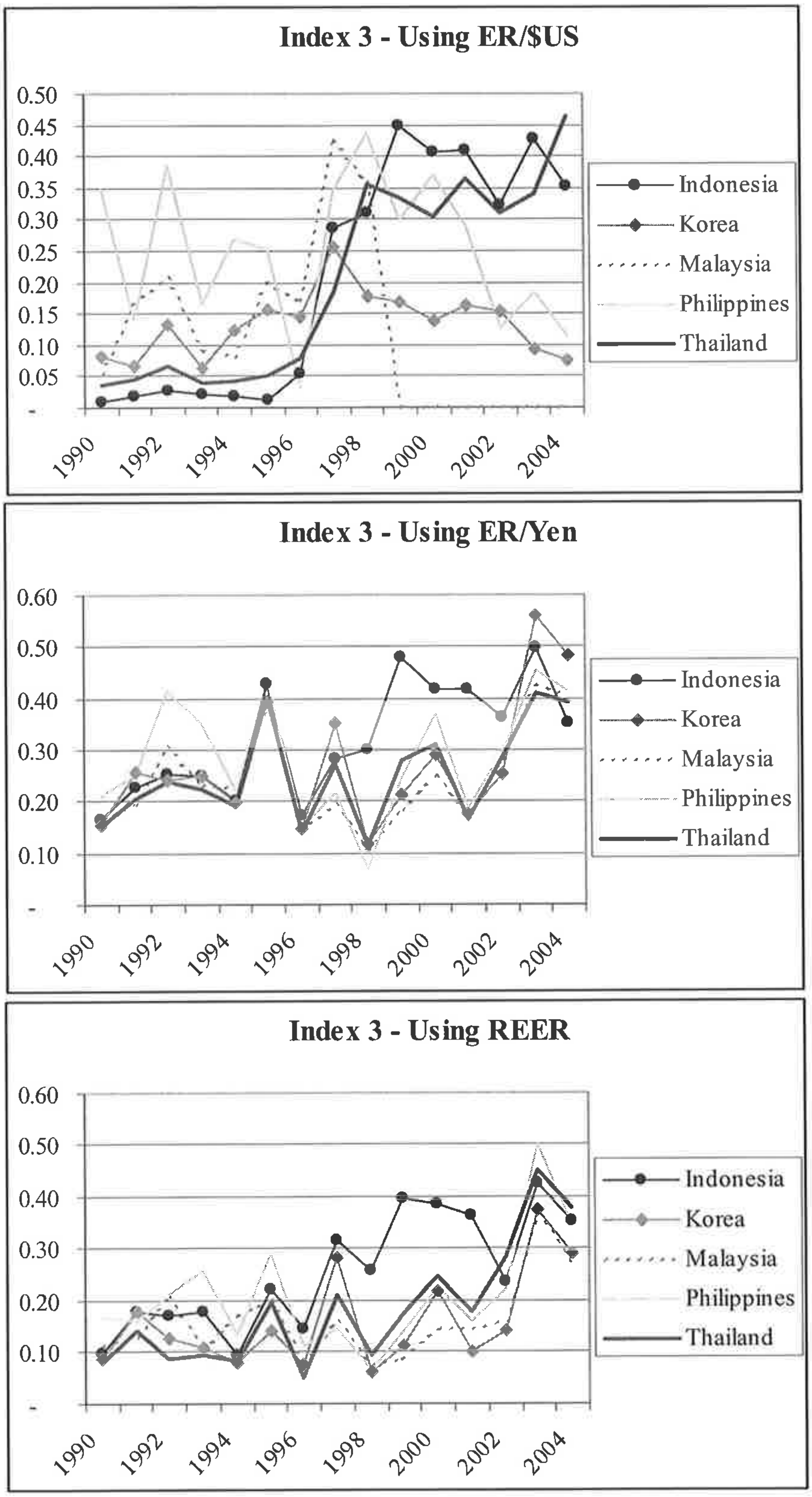
Source: IMF IFS and ADB-ARIC

Figure 2.5b
Flexibility Index 2



Source: IMF IFS and ADB-ARIC

Figure 2.5c
Flexibility Index #3



Source: IMF IFS and ADB-ARIC

Figure 2.6
Kalman Filter Results

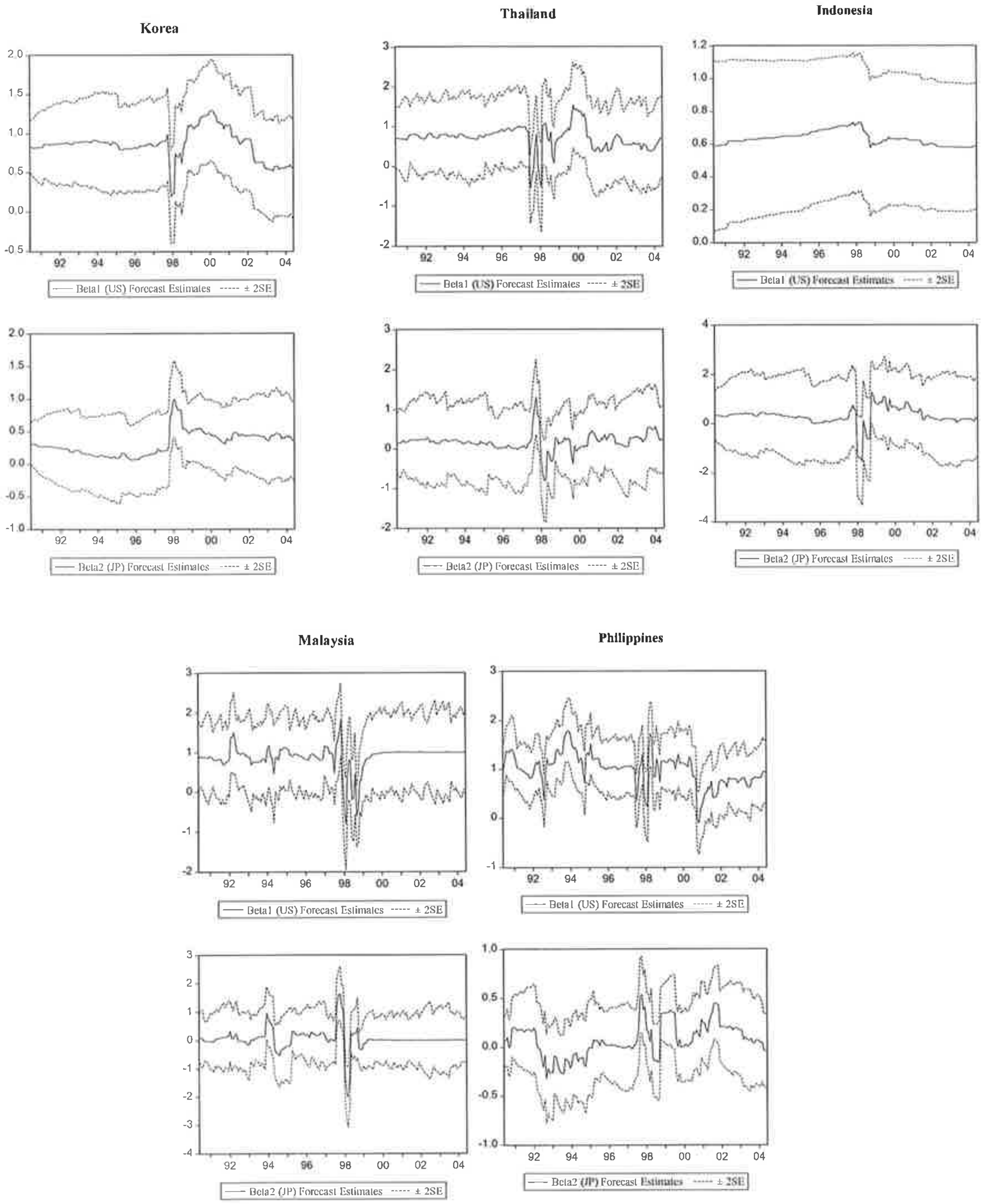
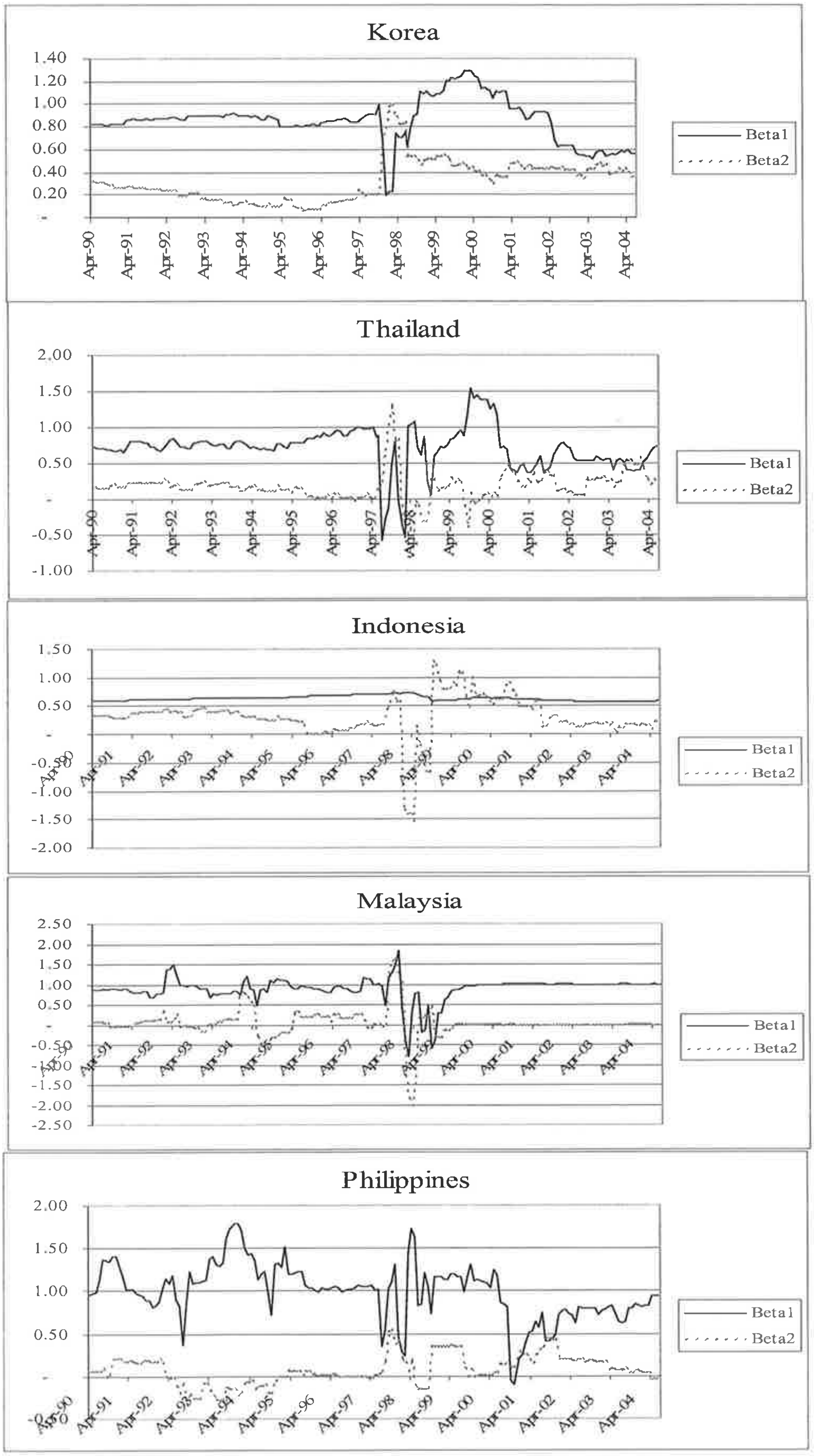


Figure 2.7
Kalman Filter Results



3
Sterilisation, Capital Mobility and Interest Rate Determination for East Asia Pre-Crisis

3.1. Introduction

Before the crisis, it is widely acknowledged that several East Asian economies experienced substantial and prolonged periods of foreign capital inflow. In the presence of largely fixed exchange rates, monetary control of these economies was achieved by the sterilisation of the reserve effects of capital inflows. In this chapter, the focus is on the impact of the reserve effects of capital inflows on the domestic interest rate. In the absence of sterilisation of these inflows, under a fixed exchange rate regime, a capital inflow should place downward pressure on interest rates. The presence of sterilisation should, if successful, reverse this effect. Full sterilisation of the reserve inflow would maintain the interest rates at levels that existed pre-inflow.

This chapter uses a simple open economy monetary style model of interest rate determination to empirically examine the monetary policy reactions of central banks in the East Asian region in the period prior to the Asian crisis. The model is based on the one used by Edwards and Khan (1985) (EK), and subsequently modified by Haque and Montiel (1991) and Dooley and Mathieson (1994). Essentially, these models were originally employed to test for the level of capital mobility in developing countries. Instead, this chapter alters the conditions for money market equilibrium to include the effects of sterilisation of capital inflows. This allows the model to assess whether sterilisation was effective in, firstly, addressing the monetary impacts of capital inflows and secondly, in placing upward pressure on domestic interest rates, thus keeping interest rates at the level that existed before the capital inflows.

A key feature of the model is the relationship between capital mobility and sterilisation.[1] The more mobile is capital, the more the domestic interest rate will be influenced by external factors such as interest rates overseas and current and expected future exchange rate changes. As capital mobility decreases, the interest rate depends more significantly on domestic variables. It is this scenario involving imperfect capital mobility that sterilisation policies might have an impact on interest rates.

The chapter is set out as follows; Section 3.2 briefly examines the nature and extent of capital inflows in East Asia prior to the crisis.[2] The resulting pressure on the exchange rate to appreciate motivated the need for central banks to sterilise. Some basic empirics are used to assess the degree of sterilisation employed by the central banks of Korea, Thailand, Indonesia, the Philippines and Malaysia. Section 3.3 formalises the relationship between sterilised intervention and capital mobility and assesses the effectiveness of sterilisation in addressing the issue of sustained capital inflow. It is shown that the presence of high capital mobility and/or the presence of full sterilisation of capital inflows neutralises the effect of the reserve inflow on the domestic interest rate. In other words, high capital mobility renders sterilisation ineffective but, where there is low to moderate levels of capital mobility, full sterilisation reverses the downward pressure on interest rates that would arise from a capital inflow episode in a fixed exchange rate regime.

Using the model as an organising framework, Section 3.4 will present some empirical estimates to investigate the extent and effectiveness of sterilisation for the East Asian region using monthly observations from 1990-97. The selection of 1990 as

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[1] The interaction between sterilisation and capital mobility is captured by the 'irrelevance hypothesis'.

[2] The pre-crisis scenario is used because there is a sufficient amount of data to assess, ex post, the extent and magnitude of the capital inflow episode and the extent of the sterilisation of the reserve inflow.

the starting point is driven mainly by the fact that many of the countries in this sample had made substantial efforts to deregulate their financial systems during the 1980s thereby reducing the necessity of modelling a structural break.[3] The paper tests for sterilisation and capital mobility separately before evaluating the effect of reserve inflow on the domestic interest rate. The results indicate that, due mainly to the presence of high capital mobility or a high degree of sterilisation, the effect of the reserves inflow on interest rates is small in magnitude. Some supplementary empirical results based on VAR analysis are derived to examine whether there are any lagged effects of sterilisation on interest rates. Section 3.5 provides some concluding comments.

3.2. Capital Inflows and Policy Responses in East Asia

3.2.1. Pre-crisis Capital Inflows in East Asia

The pre-crisis level of capital inflow in East Asia – particularly compared to the Latin American pre-crisis scenario – has received much attention.[4] It is widely regarded that inflows of capital in East Asia were significantly higher as a proportion of GDP than in Latin America. Table 3.1 presents some figures from Rajan and Siregar (2001). The average capital inflow for Indonesia, Malaysia, the Philippines and Thailand for the period 1988 to 1995 is 7.7%. This number is consistent with other studies such as Montiel and Reinhart (1999). They indicate that average capital inflow for their selection of Asian economies is 7%.[5] This compares to a sample of Latin

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[3] Interest rates are still subject to some regulation during this period but much less so than before. There is sufficient volatility in the series' to pursue an empirical investigation.

[4] In addition to the papers cited in this section, see Bond 1999, Rajan and Siregar 2001.

[5] Indonesia, Malaysia, Philippines, Sri Lanka and Thailand.

American countries whose average was around 4%.[6] The levels of capital inflow are high even when compared to an earlier time period. Bond (1999) estimates that capital inflows for East Asia for the period 1985-88 is about 1% of GDP using the same selection of countries as Montiel and Reinhart (1999).

An important factor in this analysis is the composition of capital inflow. Table 3.1 reports capital inflow by foreign direct investment (FDI), portfolio flows and other flows. With the exception of Malaysia – which had strong FDI flows pre-crisis – the largest category of inflow was 'other'. This category consists largely of bank lending along with some other smaller items. It is the bank-lending channel that creates an impetus for sterilisation in that it is said to be inflationary if not sterilised as the inflow impacts strongly on the money multiplier process.

Montiel and Reinhart (1999) also examine the volatility of the capital inflow episode. They conclude that not only did East Asia have higher inflows than other regions, but also that they were more stable. This is important in terms of the effectiveness of sterilisation in that it implies that capital flows were sustained. Under fixed exchange rates, this places more pressure on the monetary base and, hence, more pressure on central banks to engage in sustained sterilised intervention.

3.2.2. Sterilisation in Pre-Crisis East Asia

A major monetary policy arrangement in East Asia in the years preceding the crisis involved exchange rates that were largely pegged to the USD and sterilised intervention of its capital inflows. It is well known that when a country fixes its currency, it loses control of its domestic money supply. If the country experiences, say, an inflow of foreign capital, the pressure for the currency to appreciate forces the

[6] Argentina, Brazil, Chile, Colombia, Costa Rica and Mexico

central bank to buy foreign reserves which in turn increases the money base. In order to sterilise this change in the money base, the central bank constrains domestic credit.

Several Asian economies actively engaged in sterilisation activities. Generally speaking, as Fry (1993) points out, central banks in Indonesia, Korea, Malaysia, the Philippines, Taiwan and Thailand all had some success in retaining some monetary control. Specifically, the economies within the region sterilised inflows in different ways. Indonesia did it in two ways. First, Bank Indonesia (BI) employed Open Market Operations (OMOs) – issuing its own CDs called SBIs. Second, the Indonesian government managed its budgetary operations in a way that built up large deposits with Bank Indonesia (McLeod, 1998). Thailand conducted OMOs to sterilise its inflows (Warr, 1998). Kwack (1994) reports that OMOs were not used extensively in Korea and that reserve controls and discounting policies were used to dampen domestic credit. Glick and Moreno (1994) state that Korea used OMOs early but found the financing costs too high.[7]

Therefore, if the central bank maintains an exchange rate peg and it sterilises inflows fully, there should be no monetary effect. This can be shown by the following:[8]

$$\Delta M \equiv \Delta DA + \Delta FA \qquad (3.1)$$

Equation (3.1) is a simple identity for the money base, *M*. It comprises the stock of domestic assets, *DA* and the stock of foreign assets (reserves), *FA*. Therefore, a change in money is brought about either by a change in *DA* and/or a change in *FA*. Figure 3.1

[7] There are many costs of sterilisation. The one referred to above results from issuing domestic bonds that, firstly, need to be paid off and secondly, need to be serviced. These create a financing burden on the Central Bank. See Calvo (1991)

presents the (quarterly) changes in net foreign assets (NFA) and net domestic assets (NDA) for Korea, Thailand, Malaysia, Indonesia and the Philippines for 1990-97. It shows the extent to which foreign assets are offset by domestic credit and provides some graphical evidence of the extent of sterilisation. This is especially pronounced for Thailand, Malaysia and Indonesia where there appears to be quite a sustained accumulation of reserves throughout the sample period. All countries presented (especially Thailand, Philippines and Malaysia) show the same pattern of an increase in NFA in one period and an almost corresponding reduction in NDA in the next. This is strongly suggestive of a central banks desire to sterilise effect on the domestic money base.

Most empirical studies of sterilisation have centered on the following:

$$\Delta DA_t = \lambda_0 + \lambda_1 \Delta FA_t + \varepsilon_t \tag{3.2}$$

Equation (3.2) tests for the degree of sterilisation. For full sterilisation, λ_1 would be expected to be equal to -1. Glick and Hutchison (1994) and Kwack (1994) have estimated various versions of equation (3.2) for Japan and Korea respectively. Kwack (2001) also incorporates the effect of the money multiplier in his empirical tests. Glick and Hutchison (1994) tested for contemporaneous and long run sterilisation effects and found at least partial sterilisation and for some parts of the sample, could not reject full sterilisation in Japan. Kwack (1994) found that the sterilisation coefficient in Korea between 1980 and 1990 was around -0.8, an indication of partial sterilisation. Kwack (2001) found that the sterilisation parameter was significant in most cases and also found significance for the parameter representing the money multiplier. This is an

[8] It should be noted that this paper is dealing only with sterilisation through OMOs.

indication that central banks are observing the effects on broader definitions of money when carrying out sterilisation activities. A recent contribution has been to assess the dynamics of sterilised intervention. Glick and Hutchison (2000) present a model similar to that in equation (3.2) that also includes lagged terms for foreign assets and domestic credit. The idea is to capture whether monetary authorities smooth the effect of reserve changes over time rather than offset the reserve flow contemporaneously. [9] [10]

This approach is taken up here where some sterilisation equations are estimated for Korea, Thailand, Indonesia, the Philippines and Malaysia. The results are presented in Table 3.2.[11] The sterilisation coefficient is found by estimating a slight variant of equation (3.2):

$$\Delta DA_t = \lambda_0 + \lambda_1 \Delta FA_t + \lambda_2 \Delta FA_{t-1} + \varepsilon_t \tag{3.3}$$

It is clear that there is a moderate to high degree of sterilisation present and that the λ_1 parameter is significant. Indonesia sterilised a little over three-quarters of its foreign reserves accumulation. Thailand, the Philippines and Malaysia had sterilised their

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[9] See, also, Fane (2000) for a list of sterilisation coefficients for a selection of emerging market economies.

[10] see Glick and Hutchison (2000) for a discussion. They refer to gradual sterilisation being a result of imperfect asset substitution in that portfolios take time to adjust and that the authorities need to allow for an adjustment period when sterilising.

[11] Net foreign assets, money base are taken from IFS lines (11-16c) and 14 respectively. First differences are used in the regressions. Following Fane (2001), regressions with ΔDA/MB(-1) and ΔFA/MB(-1) were also tried. The results weren't substantially different. These are available upon request.

inflows more heavily, at over 90% of reserves. An interesting result is that of Korea. The coefficient implies the possibility of over-sterilisation.[12]

Turning to the lagged sterilisation terms, a possible interpretation of the sign of those parameters is that a positive sign might be taken to mean that the central bank is correcting a perceived over-sterilisation whilst a negative sign may imply that the central bank is possibly attempting to gradually sterilise a reserve inflow over two periods. Indonesia, Thailand and the Philippines have (negative) significant estimates for first-order lagged sterilisation. These countries have values of $\lambda_1+\lambda_2 < -1$. This is suggestive of a desire to mop up as much of the reserve flow as it can and, as such, could be a position taken by their central banks to use sterilisation as a contractionary monetary policy tool.

Of course, the sterilisation coefficients reported above are constant over the sample. It may be interesting to examine how sterilisation might move over time throughout the sample. Following Sasaki at al (2000) and De Koning and Straetmans (1997), Figure 3.2 presents the value of λ_1 for some rolling regressions. The sample was split into a 48-month sub-sample and an OLS regression for ΔDA was performed for a 48-month sub-sample every 3 months.[13] In other words, the first sub-sample is 1990:1 to 1993.12, the second, 1990:4 to 1994:3 and so on. Hence, each point on the x-axis in Figure 3.2 represents a 4-year time window from 1990.1 – 1993.12 to 1993.6-1997.5.

[12] A word of caution here, the analysis in the text implicitly assumes that other aspects of domestic monetary policy remain constant throughout the sample.

[13] Usually, rolling regressions are performed with much larger data sets and for high frequency data.

Figure 3.2 shows that for the most part, reserve inflow sterilisation was fairly constant for Thailand, Philippines and Malaysia. Indonesia's sterilisation policy seemed to ease from about 1993 when the coefficient shifted from around –0.8 to about –0.6. This is broadly supportive of the situation in figure 3.2 for Indonesia where it is seen that there are fewer offsetting changes to *DA* post 1993. The rolling coefficients for Korea are quite variable. Recall that the constant coefficient is –1.11. There are times, however where there is significant under and over sterilisation. This might suggest that it was an active and possibly discretionary policy in Korea, whereas it might have been a more automatic or rules based activity for the others.

3.3. Sterilisation and the Interest Rate

3.3.1 The Irrelevance Hypothesis and Interest Rates

Does sterilisation work? How might it affect the domestic interest rate? The effectiveness of sterilisation policies and the nexus between sterilisation and capital mobility has been governed in the theoretical literature by the *irrelevance hypothesis*. This stipulates that under fixed exchange rates, sufficiently high capital mobility and sufficiently high asset substitutability, sterilisation activities become ineffective. This is because no sooner has an inflow been sterilised, a subsequent inflow can occur without any of the barriers to restrain or halt that inflow. In the extreme case, under perfect capital mobility and perfect asset substitution, sterilisation is impossible (Frankel and Okongwu, 1995). Kumhof (2000) states that there is reasonable support for the irrelevance hypothesis in industrial countries. In emerging market economies, however, imperfect asset substitution should allow for at least a portion of the inflow to be offset. Relatively low capital mobility may also be a feature of emerging economies – particularly pre-liberalisation and, as such, it can be conjectured that capital mobility and asset substitutability are related. What imperfect asset substitution and relatively low capital mobility have in common is that they arise due to differences between assets in different countries and/or currencies. These differences manifest themselves as risk premia, capital controls and so on.[14] [15] These differences allow for the possibility that sterilisation policies may be effective in developing economies.

What if sterilisation is effective? A consequence of successful sterilisation is that it may actually propagate a capital inflow episode. This issue has also received significant attention in the literature. As Bond (1999, p52) states: "In particular, an attempt … to sterilise a reserve inflow [may] raise interest rates and attract more capital inflows."[16] The second part of this statement, viz the determinants of capital flows, has been the subject for research for quite some time. Some notable attempts to model capital flows are Kouri and Porter (1974), Obstfeld (1982) and an East Asian application is found in Bond (1999).

However, the effect of sterilisation policies on the domestic interest rate (or, indeed, the interest differential) has not received as much attention. Consider an episode of capital inflow where the central bank buys reserves to help preserve the value of the domestic currency. If this reserve flow is not sterilised (or only partially sterilised), the reserve flow has a net expansionary effect which will result in a decrease in domestic interest rates. If the reserve flow is sterilised fully, then the monetary impact, and therefore the effect on interest rates, is neutralised. Other things being

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[14] There is not a consensus on this point. Frankel (1983) stresses that there *is* a difference between capital mobility and asset substitution. He cites Mundell (1963) as one who infers that there is a connectivity.

[15] See McLeod (1998) for a discussion of the variety of capital controls applied to East Asian countries.

[16] Frankel and Okongwu (1995) refer to this as the simultaneity of the sterilisation and offset equations where the offset equation is one that posits that capital inflows are attracted by higher interest rates.

equal, the domestic interest rate has not changed, implying that it may have remained at pre-inflow levels.[17] If capital flows are a function of the interest differential, this may further promote capital inflows indefinitely. This is especially the case in emerging market economies where high domestic interest rates attract capital in the first instance. Montiel and Reinhart (1999) find that the volume and composition of capital inflows are sensitive to domestic policy considerations (especially sterilisation) in capital importing countries. Kumhof (2000) presents a theoretical model that emphasises the undesirable consequences of a high interest policy and concludes that lower interest rates may be a more appropriate policy response.

The question that is addressed in this paper deals with whether there is a possibility of a two-way relationship by securing some insights into the effect of reserve sterilisation on interest rates. In other words, knowing that capital flows might depend on the domestic interest rate, did the sterilisation of the reserve flows (in a fixed exchange rate regime) keep domestic interest rates sufficiently high such that they might further attract capital inflow? Figure 3.3 presents the money market interest rates (line 60B, IFS) for Korea, Thailand, Indonesia, the Philippines and Malaysia for the period 1990-97. Eyeballing Figure 3.3 suggests that interest rates did not show signs of significant reduction in response to capital inflows – although there appears to be a slight downward trend and a dip mid-sample around 1993-4 for Korea, Thailand and Indonesia. As such, the information in Figure 3.3 is somewhat inconclusive. The model developed in Section 3.3.2 will be used to address the effect of sterilisation on interest rates and this is examined empirically in Section 3.4 using pre-crisis data for Korea, Thailand, Indonesia, the Philippines and Malaysia.

3.3.2 The Interest Rate Model and Some Implications

This section derives a model based on Edwards and Khan (1985) (henceforth EK) where the effects of sterilisation are incorporated. Consider the following:

$$i_t = \psi i^*_t + (1-\psi)\tau_t, \qquad 0<\psi<1 \qquad (3.4)$$

Equation (3.4) is the structural interest rate equation from EK. It states that the domestic interest rate is a weighted average of international monetary conditions, i^*_t and domestic monetary conditions, τ_t. The parameter, ψ refers to a country's level of capital mobility. As capital mobility increases, the domestic interest rate is determined increasingly by external factors and as capital mobility decreases, the domestic interest rate is determined more by domestic monetary conditions.

The external factors, i^*_t, are measured by uncovered interest parity (UIP). This is expressed as follows:

$$i_t^* = i_t^f + (e^e_{t+1} - e_t) \qquad (3.5)$$

where i^f_t is a foreign interest rate with which to base UIP and e_t is the log of the current exchange rate expressed as the domestic price of foreign currency. e^e_{t+1} is the expected depreciation of the (log) exchange rate in the next time period. As in many studies of capital mobility based on UIP, the risk premium is not explicitly captured in the model here, but it is very much implied. This is particularly the case for developing

[17] In answering the question: Has the interest differential remained high? Frankel and Okwongu (1995) found that it was expected currency movements and not sterilisation that was the main determinant for Argentina, Chile, Mexico, the Philippines and Korea for 1987-94

economies where uncovered interest differentials (UIDs) exist (de Brouwer, 1999 and Arias, 2001).[18]

In the context of the model, τ_t is the domestic nominal interest rate that would exist if it were manipulated entirely by domestic monetary conditions.[19] Hence, τ_t is a (shadow) interest rate that captures conditions of disequilibrium arising from excess demand or supply of money. As in EK, this shadow rate can be calculated in the following way:

$$\tau_t = \rho + \pi^e{}_{t+1} + \gamma(m^d{}_t - m_t) \qquad (3.6)$$

Equation (3.6) derives the domestically determined interest rate, τ, as comprising of ρ, a full equilibrium real interest rate that is a reflection of the long run marginal product of capital, the expected inflation rate, $\pi^e{}_{t+1}$, and a term capturing monetary disequilibrium. Thus, any excess (shortfall) of log money demand (m^d) relative to its supply (m) will result in an increase (decrease) in the domestically determined interest rate.

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[18] It is worth noting here that UIP has not worked well empirically. An interesting paper by MacCallum (1994) states that including and exogenous money policy term may help UIP to hold. The analysis above is an interpretation of this theme.

[19] The interpretation of variable like τ in Edwards and Khan, Haque and Montiel and the others is that it is a 'closed economy' interest rate or shadow rate. This interpretation has to be refined in this context. In the model, τ depends on (amongst others) the sterilisation coefficient, λ. This implies that the capital account must not be completely closed for τ to be determined. An alternative definition of τ would be that is the domestic rate that would be determined entirely by domestic considerations where these considerations include the monetary policy stance taken by the central bank.

The demand for money is similar to the one given in EK with the addition of a stock adjustment term. It depends on the full equilibrium interest rate, expected inflation and income.[20]

$$m^d_t - p_t = -\alpha_1(\rho + \pi^e_{t+1}) + \alpha_2 y_t + \alpha_3 m_{t-1} \tag{3.7}$$

The effect of reserve inflow sterilisation enters through the expressions for the money stock. The supply of (base) money is the familiar identity in first differences given by equation (3.1). If sterilisation is incorporated then equation (3.1) becomes:

$$\Delta M_t = (1+\lambda)\Delta F_t, \qquad 0 \geq \lambda \geq -1 \tag{3.8}$$

which, when expressed in log differences, becomes:[21]

$$\Delta m_t = (1+\lambda)\kappa\Delta f_t \tag{3.9}$$

where: $\kappa = F_{t-1}/M_{t-1}$. The money stock can also be expressed as follows:

$$m_t = \Delta m_t + m_{t-1} \tag{3.10}$$

Substitution of (3.9) into (3.10) yields:

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[20] Interpretation of the parameters corresponding to the money demand function should be done so keeping in mind the unstable nature of money demand in recent empirical models.

[21] From equation (3.8), divide both sides by M_{t-1} and then multiply and divide both sides by F_{t-1}. Using $(X_t - X_{t-1})/X_{t-1} \approx ln(X_t) - ln(X_{t-1})$, the result is equation (3.9).

$$m_t = (1+\lambda)\kappa\Delta f_t + m_{t-1} \tag{3.11}$$

The domestic interest rate, i_t can now be calculated by substituting (3.11) and (3.7) into (3.6) to find τ_t and this can be substituted into (3.4):

$$i_t = \theta_0 + \theta_1 i^*_t - \theta_2 \Delta f_t - \theta_3 m_{t-1} + \theta_4 \pi^e_{t+1} + \theta_5 p_t + \theta_6 y_t \tag{3.12}$$

where

$\theta_0 = (1-\psi)(1-\gamma\alpha_1)\rho$

$\theta_1 = \psi$

$\theta_2 = [(1-\psi)\gamma(1+\lambda)\kappa]$

$\theta_3 = (1-\psi)(\gamma-\gamma\alpha_3)$

$\theta_4 = (1-\psi)(1-\gamma\alpha_1)$

$\theta_5 = (1-\psi)\gamma$

$\theta_6 = (1-\psi)\gamma\alpha_2$

a) Implications

What does the model imply about the behaviour of sterilisation? The parameters of most interest are the capital mobility parameter, $\theta_1 = \psi$ and the one for the reserve inflow, Δf, $\theta_2 = [(1-\psi)\gamma(1+\lambda)\kappa]$. The degree to which the sterilisation of reserve inflows are successful in maintaining an upward pressure on the domestic interest rate is driven by three factors. The first is the degree of sterilisation undertaken by the central bank, given by λ. The second is the degree of capital mobility, ψ. Note from Section 3.2 that the interaction between the two parameters is explained by the irrelevance hypothesis. As a result of the model used, there is a third factor, γ - the adjustment parameter that determines the effect of monetary disequilibrium. These are considered in turn.

The first factor influencing the effect of Δf on i_t is sterilisation. $(1+\lambda) = 0$ implies that there is complete sterilisation of reserve flows. If this is the case, the model asserts that there is no effect on the interest rate as full sterilisation removes any monetary impact of a reserve flow and, as a result, interest rates also remain constant through the liquidity effect. The downward pressure on the interest rate due to a possible capital inflow has been reversed by sterilisation and thus remains at the same level as before the inflow episode.

Assuming a given level of capital mobility that is not either perfect or zero, if the central bank engages in partial sterilisation, say $\lambda = -0.5$, then only half of the reserve inflow is being offset by a change in domestic credit and hence the stock of money. For an inflow of capital, this means that there is a net increase in the money base. Under the model, this places downward pressure on the domestic interest rate or, put more accurately, the downward pressure on interest rates brought about by the reserve inflows is not sufficiently resisted by partial sterilisation.

The second factor affecting the relationship between Δf_t and i_t is the level of capital mobility. For a given and constant $(1+\lambda)$, if the level of capital mobility, ψ increases (or $(1-\psi)$ decreases), the effect of a reserve inflow on i_t diminishes. For levels of capital mobility that are extremely high (nearing 1), the effect of capital inflows on the interest rate tends to zero – irrespective of the extent of sterilisation activity. This is because the interest rate is determined primarily by foreign interest rates and/or other external factors. In the context of this (monetary style) model that has no 'portfolio balance' type features, the capital mobility parameter may also capture characteristics more typically associated with imperfect asset substitution. These might include sluggish adjustment of returns following a shock (or sterilised intervention) and risk factors. Hence, as argued previously, the capital mobility parameter may have a more general interpretation to include any factors that, in some way, hinder convergence of the interest differential.[22]

The adjustment parameter, γ, is the third factor. It is the extent to which a monetary disequilibrium affects the domestic interest rate. This effectively represents a measure of the sensitivity of the effects of sterilisation on the interest rate. Clearly, a higher γ indicates that the domestic interest rate is more sensitive to the authorities' sterilisation activities. As above, its interaction with the other parameters is important. If capital mobility is near perfect, then the value of γ is irrelevant because domestic factors have no influence on i_t. If λ = -1, then the reserve inflow has no monetary effect, other things being equal, there should be no monetary disequilibrium and, hence, no effect on the interest rate.

In sum, for a given γ, the effectiveness of the domestic channel – and sterilisation policy – depends principally on the level of capital mobility. Sterilisation can only be effective if there exists less than perfect capital mobility. As mobility increases, the effect of domestic monetary policy on the domestic interest rate reduces. That is, as capital mobility rises, the interest rate as a transmission channel of sterilisation policy becomes less effective.

[22] In a recent paper, Hutchison (2002) believes that capital mobility (more strictly interpreted) is a stronger factor in determining the effectiveness of sterilisation than imperfect asset substitution. For imperfect asset substitution to have any meaningful effect, the relative asset quantities being moved must be enormous.

3.4. Estimating the Interest Rate Model

The empirical assessment in this paper centres around the examination of the effect of reserve sterilisation on the domestic interest rate and whether this might be responsible for the non-convergence of the interest differential. From Section 3.3, it is stated that if the reserve inflow is fully sterilised, or if capital mobility is very high, then the domestic interest rate is not strongly influenced by the reserve inflow. Using the model as an organising framework, the effect of the UIP foreign interest rate, i^* on the domestic interest rate, i is examined by estimating equation (3.12). Recognising that there may be lagged relationships between sterilisation and the domestic interest rates, the model is generalised to incorporate a lag structure using VAR analysis. This allows for coefficient restriction tests and variance decomposition tests to be performed.

3.4.1. Data and Estimation

The data is taken from the IMF IFS CD and from ADB-ARIC databases taking monthly observations from 1990:1 to 1997:5 as the sample period.[23] The sample excludes any effects of the crisis. Exchange rates are taken from lines RF, interest rates, prices and output are taken from 60B, 64 and 66 respectively For the interest rate equations, Δf is measured as [ΔFA/FA(-1)]*100 to measure the sensitivity to a percentage change in reserves and also because there were some observations of negative changes in reserves. Expected inflation is measured as [log(CPI(12))-log(CPI)]*100, m_{t-1} is log(MB(-1)), and output and CPI are measured in logs. The equations based on equation (3.12) are estimated using OLS and TSLS and include a

[23] For the sterilisation regressions, the sample ends at 1997:3 to avoid the inclusion of the rapid depletion of reserves at the onset of the crisis.

lagged dependant variable term to soak up the substantial amounts of serial correlation in the data and standard errors are estimated as Newey-West heteroskedastic-robust standard errors.[24] All estimates were subject to the Breusch-Godfrey LM test for higher order serial correlation (Godfrey, 1988), White's test for heteroskedasticity and the Engle ARCH LM test for the existence of ARCH processes (Engle, 1982). For the most part, there were no significant ARCH coefficients except for Malaysia, but the model estimated remains Least Squares due to the fact that estimation in an ARCH model does not materially alter the value of the parameters for i^* and Δf. The interest rate is estimated in levels as they are *I(0)* processes (except for Malaysia and weakly *I(0)* for Korea) over the sample. ADF tests on the residuals for Malaysia and Korea indicate that the residuals are *I(0)* and that a cointegrating relationship existed in the models as estimated (see Appendix 1).

3.4.2. Results

a) Capital Mobility

The empirical model used to estimate capital mobility is equation (3.12). The level of capital mobility is given by the parameter θ_1. Estimating this will assist in drawing inferences about the source of variation in domestic interest rates – foreign or domestic. A high θ_1 suggests that capital mobility is high and that the domestic interest rate is determined by foreign influences. A low value means that sterilisation (if there is any) has the potential to influence the domestic rate.

OLS and Two-Stage Least Squares (TSLS) results for this are presented in Table 3.3. TSLS is the preferred method for this exercise to remove the possible endogeneity of Δf arising from its relationship with domestic assets and the nominal

[24] Correlations between, and regression of, the errors and the regressors show no significant

interest rate through the monetary offset coefficient (see Frankel and Okwongu, 1995, Bond, 1999 and Mark, 2001 for a description). The instruments used in the TSLS regressions are the regressors from the OLS model, Δd – which is measured as (NDA-NDA(-1))/NDA(-1) and the trade balance as per Bond (1999) and Mark (2001).[25] The instruments form the equation that reflects the literature relating to the offset equation. The subsequent analysis is based on the TSLS results – the OLS numbers are provided merely for comparative purposes. The results are quite mixed. For the Philippines and Malaysia, there is no significant relationship between i^*_t and i_t. Korea's capital mobility coefficient is 0.39, suggesting that, when taking into account any risk factors, around 1/3rd of a foreign interest rate move is transmitted into domestic rates. Thailand records higher coefficient values at 0.83 and Indonesia's is 0.56.

What does this say about capital mobility? In contrast to much of the literature on financial integration of late (see Cavoli et al, 2003 for a survey), the above results, with the exception of Thailand, suggest quite low levels of capital mobility. There are a number of possible reasons and they relate mainly to the nature of the model. The model is built upon the UIP framework and as mentioned earlier, much of the UIP based measures of capital mobility for developing countries do not show much evidence of high integration. The reasons for this have been examined many times and include the existence of a risk premium, capital controls and endogenous monetary policy (see McCallum, 1994 and Anker, 1999).

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relationships.

[25] The trade balance is used to proxy for the current account for which monthly data is difficult to obtain for the sample used here.

b) The overall effect of reserve sterilisation on the interest rate

In the context of the model in Section 3.3, the overall effect on the domestic interest rate centres around the interaction between the degree of capital mobility and the extent of reserve sterilisation. Recall from section 3.3 that if capital mobility is very high (around 1) then internal factors such as sterilisation do not have an impact on the domestic interest rate. Sterilisation can only affect interest rates under the model if capital mobility is sufficiently low.

The parameter in equation (3.12) that captures this interaction is the sterilisation parameter, $\theta_2 = [(1-\lambda)\gamma(1-\psi)\kappa]$. Due to the γ parameter, direct estimation for inference is not possible. The results for sterilisation and capital mobility above present the estimates for the degree of sterilisation and the extent of capital mobility separately. From these, it can be safely concluded that, for the sample period examined, there was a high degree of sterilisation and a low degree of capital mobility. Under this scenario, the model would predict that the domestic interest rate can be explained by domestic factors. As mentioned, the capital mobility parameter for Korea is 0.39. This means that there is 61% of the domestic rate that can be tentatively explained by domestic factors – such as sterilisation. From above, we also know that the degree of sterilisation for Korea is –1.11. This would suggest that the sterilised intervention being undertaken should negate the downward pressure placed on the interest rate by the capital flows. As a result, the value of θ_2 should be close to zero. For those countries with a moderate degree of sterilisation and low capital mobility, θ_2 is expected to be slightly negative. The existence of over-sterilisation would suggest that θ_2 is slightly positive.

Consider the value of θ_2 in Table 3.3. The sign and size of the effect of (%) changes in f on the domestic interest rate is consistent with the discussion above in that they are close to zero. For Korea, where the sterilisation parameter is greater than –1, the effect of Δf on i_t is expected to be slightly positive and it is but it is statistically insignificant. For the other countries in the sample where sterilisation is less than complete, the sign of θ_2 should be slightly negative. This is indeed the case in Thailand. Only Indonesia's sterilisation coefficient is statistically significant to any reasonable degree. The lack of decisive results in this section motivate the analysis in the next section, which examines whether there is any lagged influence on the domestic interest rates.

c) Using a VAR to test for a lagged relationship

The model in section 3.3 and subsequent analysis looks at the contemporaneous relationships between sterilisation, capital mobility and the domestic interest rate. In this section, we investigate whether there is a lagged relationship by presenting a Vector Autoregression (VAR) model on the variables of interest, i, Δf and i^*. The VAR is of a standard form given by the following:[26]

$$i_t = a_{10} + a_{11} i_t^* + a_{12} \Delta f_t + \sum_{j=1}^{m} \gamma_{1j} i_{t-j}^* + \sum_{j=1}^{m} \beta_{1j} \Delta f_{t-j} + \sum_{j=1}^{m} \alpha_{1j} i_{t-j} + \mu_t \qquad (3.13a)$$

$$\Delta f_t = a_{20} + a_{21} i_t^* + a_{22} i_t + \sum_{j=1}^{m} \gamma_{2j} i_{t-j}^* + \sum_{j=1}^{m} \beta_{2j} \Delta f_{t-j} + \sum_{j=1}^{m} \alpha_{2j} i_{t-j} + \mu_t \qquad (3.13b)$$

$$i_t^* = a_{30} + a_{31} \Delta f_t + a_{32} i_t + \sum_{j=1}^{m} \gamma_{3j} i_{t-j}^* + \sum_{j=1}^{m} \beta_{3j} \Delta f_{t-j} + \sum_{j=1}^{m} \alpha_{3j} i_{t-j} + \mu_t \qquad (3.13c)$$

The lagged effects of foreign interest rates, reserve changes and the domestic interest rate on the current domestic interest rate can be analysed by way of coefficient

[26] The exogenous variables in equation (3.12) are left out of the VAR mainly to help with model identification. In order to identify the model, the Choleski decomposition is imposed, $a_{22}=a_{31}=a_{32}=0$. The restriction of $a_{22}=0$ corresponds to the 'instrument' equation in the TSLS regression and, as such, addresses the endogeneity issues as in the static model.

restrictions tests.[27] Since the primary interest is what determines the domestic interest rate, the focus is on the coefficients affecting i_t, equation (3.13a). Equation (3.13b) and (3.13c) are essential in the construction of a VAR and the subsequent results because they determine the current and future values of Δf and i^* - which, in turn, impact on subsequent values of i. Table 3.4 reports the χ^2 statistics of the Wald Test for coefficient restrictions for the VAR model. Three lag structures of the model are examined; m = 12, 6, 3 months. For each structure, the Wald Test is performed for each set of m parameters for γ_l, β_l and α_l. The aim of the test is to ascertain whether the lagged effects of i^*, Δf and the domestic interest rate, i are significant in explaining the current value of i.

Let's look firstly at the results regarding the significance of restricting the coefficients of the lagged i^* terms (the γ_l terms). Generally, the omission of the γ_l terms has little effect – regardless of the lag structure of the model. The main exception is Korea, where the results are statistically significant for m=6, 3 and has a reasonably high χ^2 value for the 12 month lag. Hence, for Korea, there is strong evidence that the external influences on the domestic interest rate are sustained over a period of time. For Thailand and Indonesia, recall from Table 3.3 that there is a significant contemporaneous relationship between i^* and i. From Table 3.4, it can be seen that the effect appears to be limited to the same time period and not be carried over as a lagged effect. The weak lagged results for the Philippines and Malaysia seem to back up the weak contemporaneous results from Table 3.3.

The second set of results relate to the effect of restricting the β coefficients. In other words, the test examines whether a change in reserves, one that may arise from

[27] A Wald test for restrictions on γ and β are similar tests to the Granger Causality test for a selection of lag lengths.

sterilisation, influences the domestic interest rate in the future. The results of the Wald Tests are quite mixed. For the most part, a significant relationship is detected for Malaysia, Indonesia and Thailand. In contrast to the results for i^*, Korea, and to a lesser extent, the Philippines are the exceptions due to the weakness of its results. This is not a strange result if one thinks about the time it may take for a reserve flow to affect the money market rate. In fact, a delayed interest rate response to a reserve change is consistent with the weak contemporaneous results from Table 3.3.

The strongest Wald Test results by far are those testing for the effect of the lagged domestic interest rate. The exceptions here are the Philippines with a 3-month and 6-month lag structure and Indonesia at 12 months. This is expected as there is always going to be persistence in monetary variables. It is important to include the effect of the lagged dependent variable as it is an indication of the effect of domestic vs external variables. The more significant the effect of lagged i, the less likely it is that external determinants and, thus, capital mobility, play a material part in determining the domestic interest rate.

To further assess the relative importance of lagged i, i^* and Δf in determining i, the standard VAR is used to analyse some variance decompositions. The lag length chosen for the decompositions is 12 months. Its selection may seem somewhat arbitrary but it is an attempt to balance the competing model selection criteria, AIC and BIC. The AIC criteria generally favours long lag lengths, even beyond 24 months, while BIC generally favours fewer than 3 lags. An important consideration here is to capture as much of the variation as is feasible. Figure 3.4 presents the variance decompositions for each country up to a 24 month forecast horizon. Each graph shows how a random innovation to i, i^* and Δf – in relative terms – affects the variation of the domestic interest rate in the model. The ordering used is (i^*, Δf, i).[28]

The advantage of reporting the effect of an innovation in i is that it addresses the amount of persistence in the model. The domestic interest rate is significantly driven by its own innovations. In fact, with the exception of Indonesia, the line corresponding to i never crosses the i^* or the Δf line. In other words, the effect of the domestic interest rate innovations on the domestic interest rate is generally stronger than the effect of the foreign interest rate and reserve changes for most countries tested. An exception is Thailand where the reserve and foreign interest rate effects cross at around 12 months, and Indonesia, where the effect of reserve changes is stronger than the effect of the domestic interest rate after about 14 months – ultimately explaining over 50% of the variation in the domestic interest rate. This supports the Wald Test results that suggest a strong effect in the intermediate months (6 and 12). Over this period, it can be conjectured that reserve sterilisation may have some effect on domestic interest rates in Indonesia.

In Malaysia, for the later parts of the forecast horizon, the effects of innovations in reserves and the domestic interest rate seem to influence the domestic interest rate in almost equal proportions. For the other countries, the relative effect is not as high, with the innovations to i^* and Δf each ultimately explaining a smaller proportion of the variation in i. This is an indication, first, that there is some dynamic relationship between reserves and the interest differential but not an overly strong one and, second, it indicates the strength of the persistence of the domestic interest rate.

[28] The ordering is based on a Choleski decomposition on the VAR model as specified above. The decomposition is such that the contemporaneous effect of i^* and Δf is maintained as it is in equation (2.12). The value of Δf is determined contemporaneously by i^* but not i, and the value of i^* not determined contemporaneously by either Δf or i. The results, in fact, are very robust to a change of ordering.

3.5. Concluding Remarks

Motivated principally by the large and persistent capital inflows into East Asia before the crisis, this chapter has presented a theoretical model that examines the link between the central banks desire to sterilise capital inflows and the domestic interest rate in a fixed exchange rate regime. Under the model, the success of sterilisation depends substantially on the level of capital mobility. If capital mobility is perfectly high, domestic rates are determined entirely by foreign influences and, therefore, sterilisation is ineffective (irrelevance hypothesis). As such, the paper has investigated the possible connection between a central bank's desire to sterilise and the domestic interest rate.

The interaction of sterilisation and capital mobility is also investigated empirically. The paper estimates the sterilisation and capital mobility coefficients individually from the structural equations in the model. These are then used to assess the overall effect on the domestic interest rate. The results presented show that, sterilisation is mostly very high, with possible over-sterilisation for Korea.

The model is generalised in order to show some lagged relationships between sterilisation, capital mobility and the interest rates. Wald coefficient restriction tests show that lagged relationships exist strongly for Malaysia and, to a lesser extent, Thailand and Indonesia but not so for other countries. Variance decomposition tests indicate that there is some relationship between reserve changes and interest rates but that interest rate shocks are highly persistent.

What do the results above imply about the effectiveness of sterilisation and about the determinants of the interest rate non-convergence? There is evidence of imperfect capital mobility in most countries. This suggests that sterilisation policies designed to maintain the interest rate at pre-inflow levels should have some effect. Their effect is mitigated by the extent of capital mobility (ψ) and also the extent of monetary disequilibrium (γ). Thus, aside from persistence of the domestic interest rate, the principal determinant of the domestic interest rate is the foreign channel – the foreign interest rate, expected devaluation of the currency and a possible risk premium – and these drive the level of capital mobility. Given that the period examined was a time of quite rigid exchange rates, it follows that the foreign (US) interest rate can be isolated as a main determinant.

Table 3.1
Capital Inflows as a percentage of GDP, 1988-95

	INDONESIA	MALAYSIA	PHILIPPINES	THAILAND
FDI flows	1.7	7.2	1.8	1.6
Portfolio flows	0.5	0.0	0.2	1.4
Other	3.0	2.9	2.1	8.5
Total	5.1	10.2	4.1	11.5
Δ Reserves*	-1.7	-5.1	-1.8	-4.3

Source: Rajan and Siregar (2001) and International Monetary Fund
Note: Negative sign means increase in reserves

Table 3.2
Sterilisation

Dependent Variable: Change in Domestic Assets, *ΔDA*

	KOREA	THAILAND	INDONESIA	MALAYSIA	PHILIPPINES
Constant	85.29 (0.50)	5.95 (3.01)†	334.30 (3.15)†	691.77 (2.21)**	3.15 (2.44)**
Net Foreign Assets (t)	-1.11 (-3.81)†	-0.91 (-8.15)†	-0.76 (-7.07)†	-0.94 (-12.70)†	-0.97 (-10.24)†
Net Foreign Assets (t-1)	0.07 (0.28)	-0.56 (-4.96)†	-0.39 (-2.88)†	-0.05 (-0.41)	-0.33 (-2.39)**
Adj R^2	0.26	0.58	0.61	0.36	0.47
DW	2.20	1.98	2.03	1.99	1.99
Obs	86	85	85	86	86

*(**)(†), 10% (5%)(1%) significance levels, respectively

Table 3.3
Interest Rate Model – Capital Mobility and Domestic Influences

Dependent Variable: Money market Rate, i_t,

	KOREA		THAILAND		INDONESIA		MALAYSIA		PHILIPPINES	
	OLS	**TSLS**	**OLS**	**TSLS**	**OLS**	**TSLS**	**OLS**	**TSLS**	**OLS**	**TSLS**
Const	19.17 $(2.67)^{\dagger}$	14.99 (0.96)	-65.86 (-1.34)	-12.32 (-0.27)	-16.97 (-1.11)	-21.71 (-1.10)	0.82 (0.19)	5.17 (0.51)	90.77 $(2.56)^{**}$	101.89 $(2.72)^{\dagger}$
i^*	0.34 $(2.65)^{\dagger}$	0.39 $(1.95)^{*}$	0.59 $(2.35)^{**}$	0.83 $(2.77)^{\dagger}$	0.36 $(2.38)^{**}$	0.56 $(1.66)^{*}$	0.03 (0.82)	-0.13 (-0.59)	-0.15 (-0.21)	-0.12 (-0.17)
Δf_t	-0.06 $(-2.08)^{**}$	0.02 (0.10)	0.05 (0.44)	-0.03 (-0.20)	0.03 (0.97)	0.27 (1.75)	-0.03 $(-3.68)^{\dagger}$	-0.11 (-0.92)	-0.001 (-0.52)	-0.01 (-0.94)
m_{t-1}	-6.47 $(-4.70)^{\dagger}$	-6.37 $(-4.71)^{\dagger}$	-8.75 (-1.43)	-3.53 (-0.62)	1.92 (0.62)	7.98 (1.58)	-0.17 (-0.70)	-0.81 (-1.00)	3.41 (0.51)	3.83 (0.55)
π^e_{t+1}	-0.40 $(-4.40)^{\dagger}$	-0.37 $(-2.95)^{\dagger}$	0.44 $(2.03)^{**}$	0.33 (1.34)	-1.52 (-0.59)	-7.72 $(-1.96)^{**}$	-0.002 (-0.10)	-0.05 (-0.58)	-0.55 $(-1.91)^{*}$	-0.60 $(-1.84)^{*}$
p_t	13.22 $(3.22)^{\dagger}$	14.94 $(2.12)^{**}$	24.83 (1.40)	6.25 (0.37)	-3.96 (-0.52)	-16.84 (-1.43)	-0.17 (-0.12)	-0.76 (-0.31)	-24.25 (-1.16)	-30.46 (-1.40)
y_t	-2.23 (-1.03)	-3.38 (-0.76)	0.43 (0.06)	0.70 (0.09)	3.94 (0.89)	5.17 (1.11)	0.35 (0.79)	1.60 (0.91)	4.17 (0.43)	7.64 (0.80)
Adj R^2	0.78	0.76	0.60	0.52	0.68	0.42	0.95	0.88	0.09	0.02
DW	1.76	1.77	1.73	1.82	1.94	1.59	2.14	2.16	1.98	1.91
Obs	89	89	88	77*	89	88	89	89	89	89

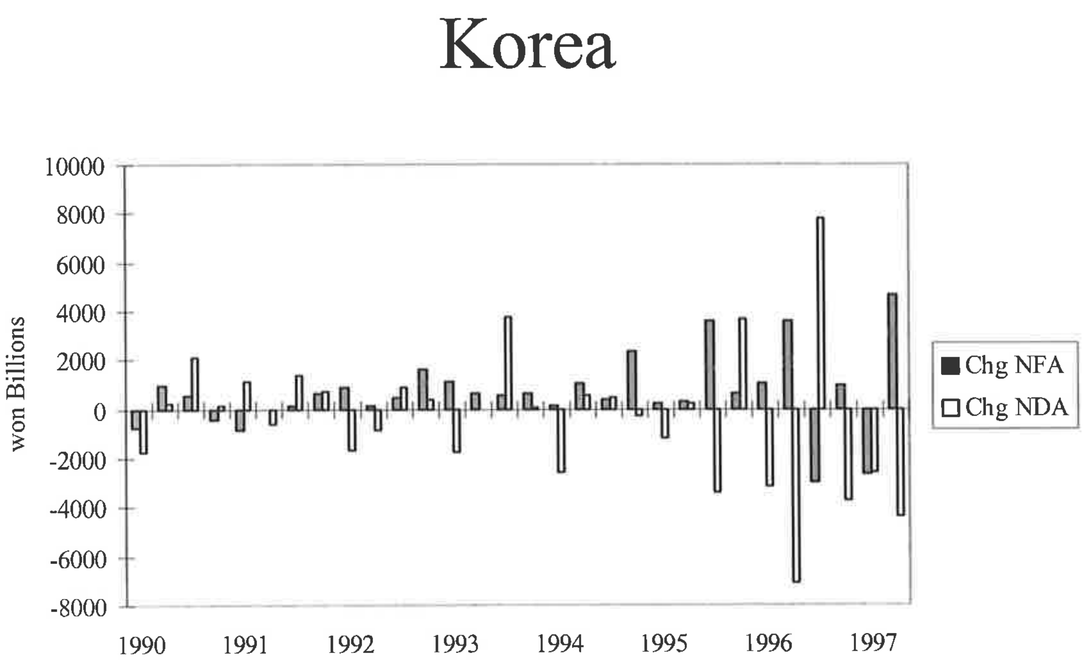
*(**)(†), 10% (5%)(1%) significance levels, respectively

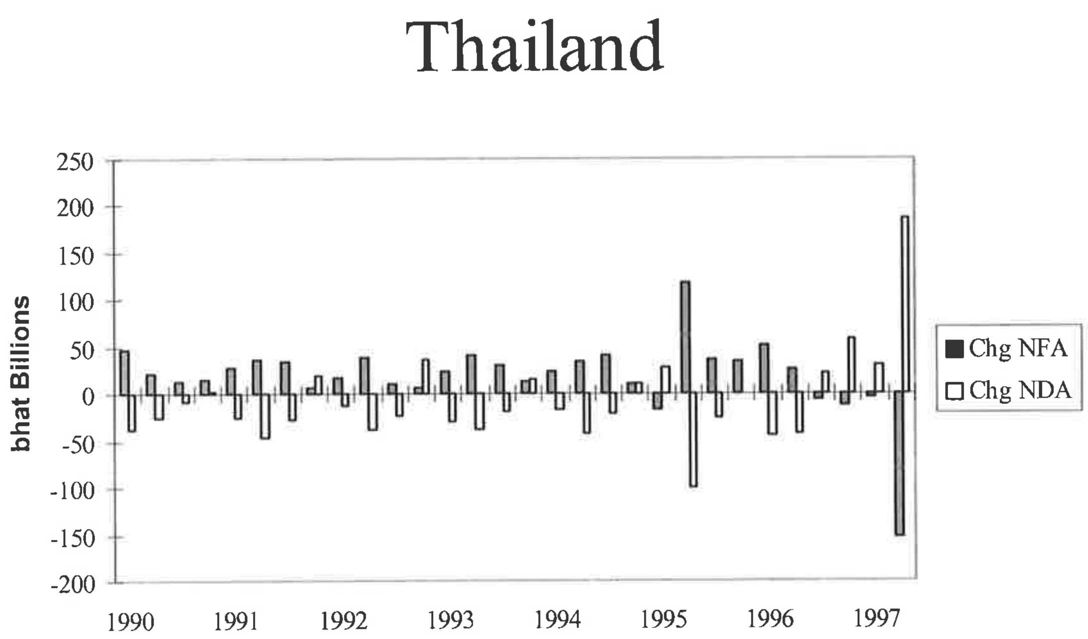
Table 3.4
Test for Lagged Effects using VAR Model.
Wald Test for Coefficient Restrictions

	Effect of Lagged i^*		**Effect of Lagged Δf**		**Effect of Lagged i**	
	χ^2	**Prob**	χ^2	**Prob**	χ^2	**Prob**
KOREA						
12 lags	17.11	0.15	9.33	0.67	90.23	0.00
6 lags	14.04	0.03	5.12	0.53	153.30	0.00
3 lags	6.58	0.09	4.07	0.25	166.12	0.00
THAILAND						
12 lags	6.93	0.86	11.77	0.46	13.42	0.34
6 lags	11.14	0.08	10.70	0.10	22.95	0.00
3 lags	2.84	0.42	12.20	0.01	23.50	0.00
INDONESIA						
12 lags	11.73	0.47	35.04	0.00	30.48	0.00
6 lags	7.72	0.26	28.73	0.00	51.91	0.00
3 lags	3.04	0.38	0.65	0.88	42.14	0.00
MALAYSIA						
12 lags	10.42	0.58	16.97	0.15	231.25	0.00
6 lags	5.70	0.46	24.05	0.00	568.81	0.00
3 lags	1.87	0.60	17.19	0.00	915.37	0.00
PHILIPPINES						
12 lags	19.68	0.07	23.21	0.03	17.70	0.12
6 lags	4.26	0.64	6.94	0.32	8.44	0.21
3 lags	1.04	0.79	2.19	0.53	4.30	0.23

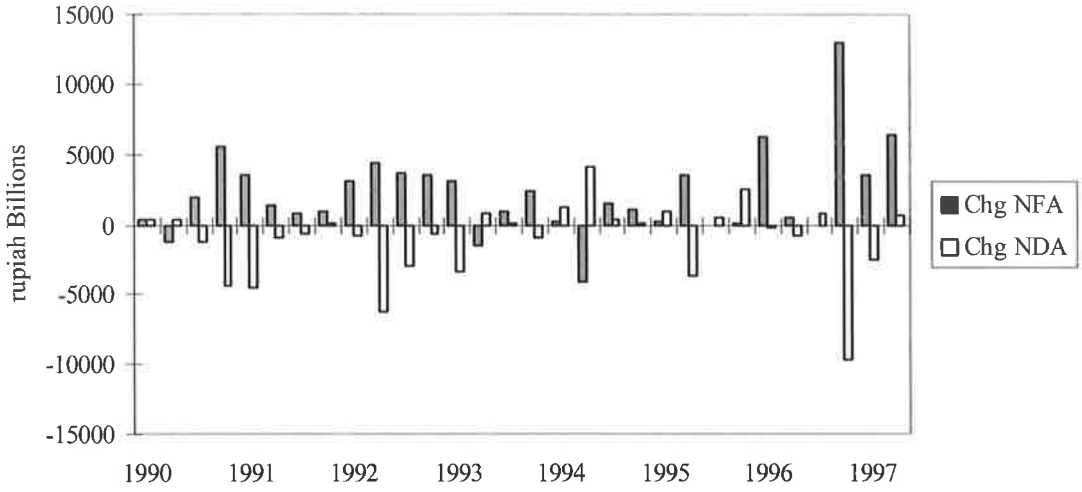
Note: Based on the VAR model for i, Δf and i^* in equation (3.13). The sample is 1990:1 to 1997:5

Figure 3.1: Reserve Sterilisation

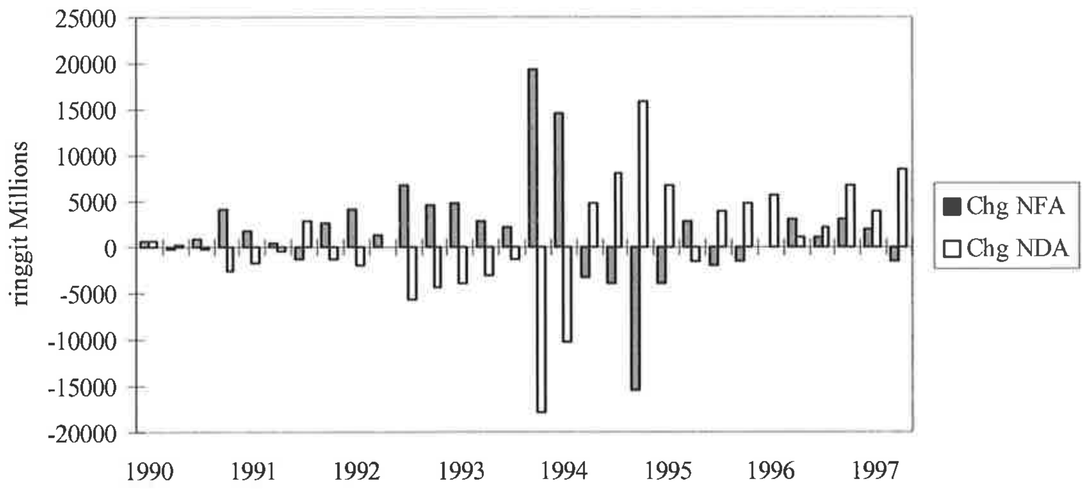




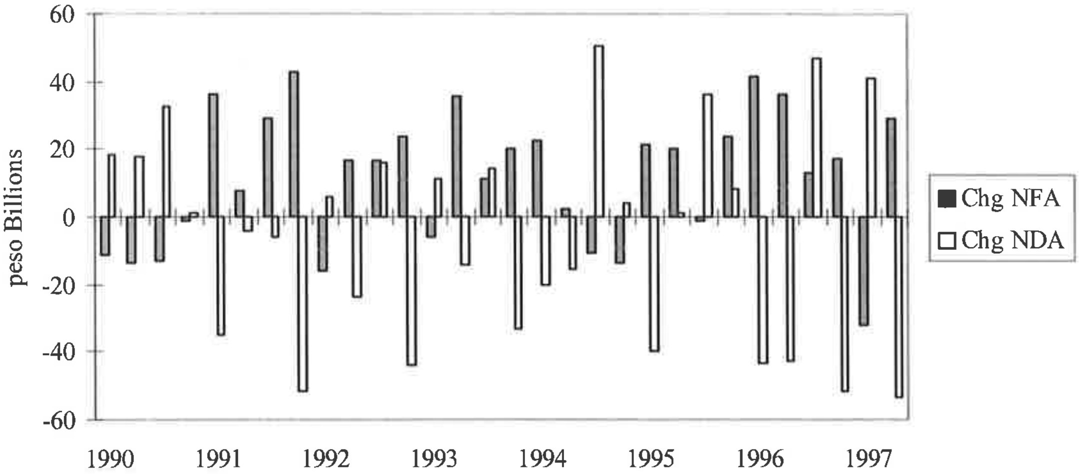
Indonesia



Malaysia



Philippines



Source; International Financial Services

Figure 3.2
Rolling Regressions – Sterilisation

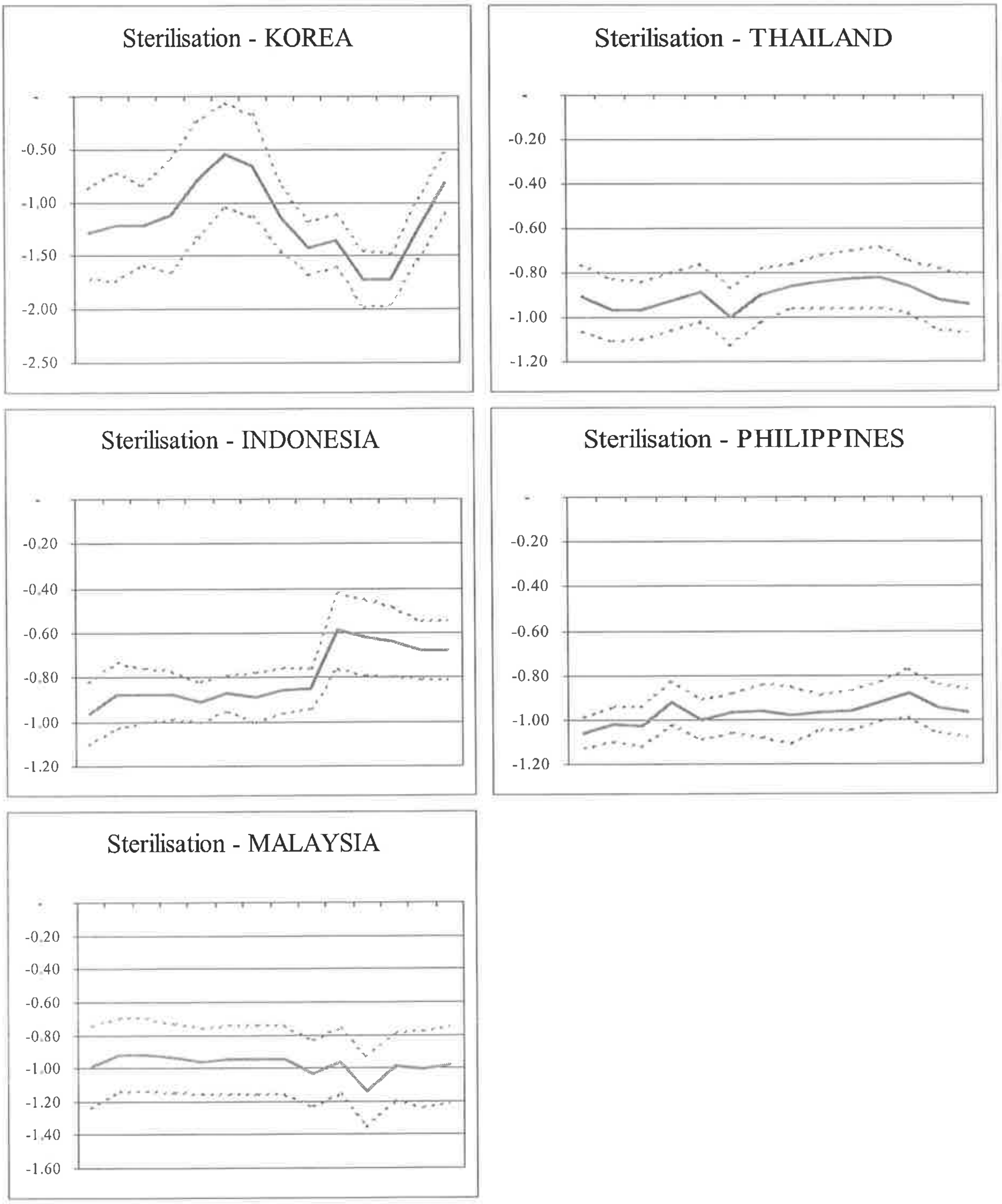
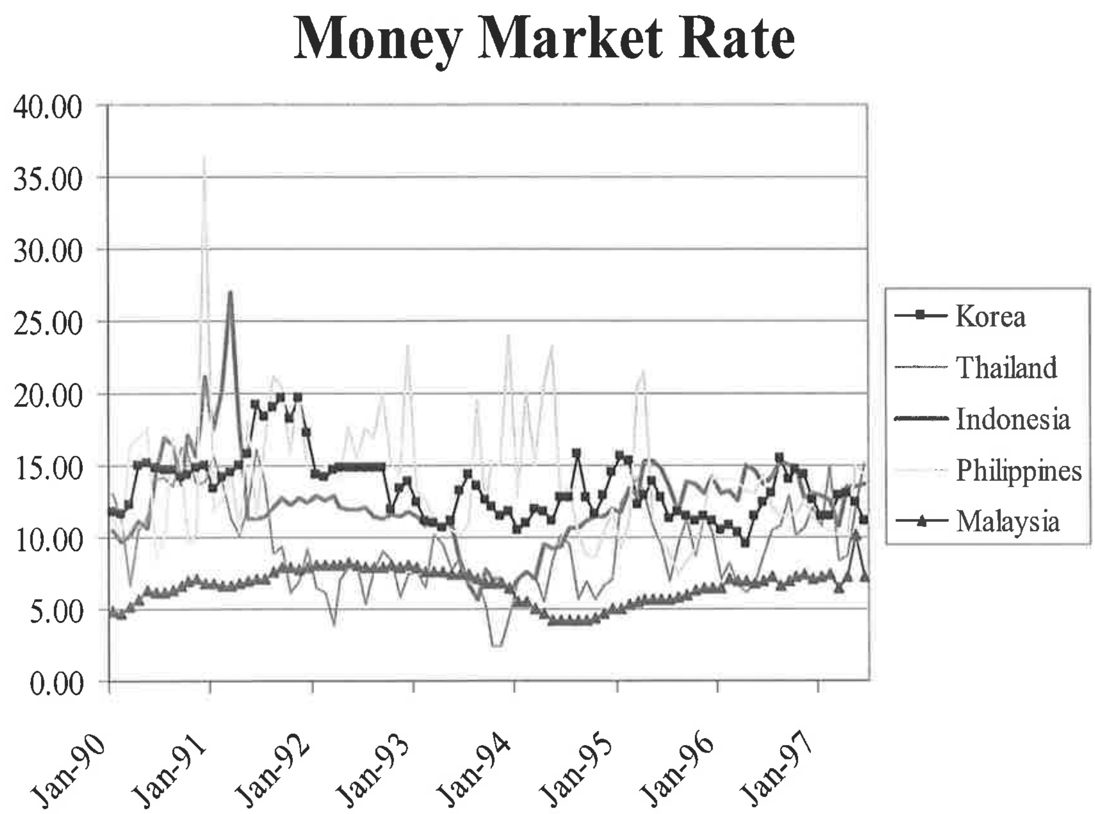
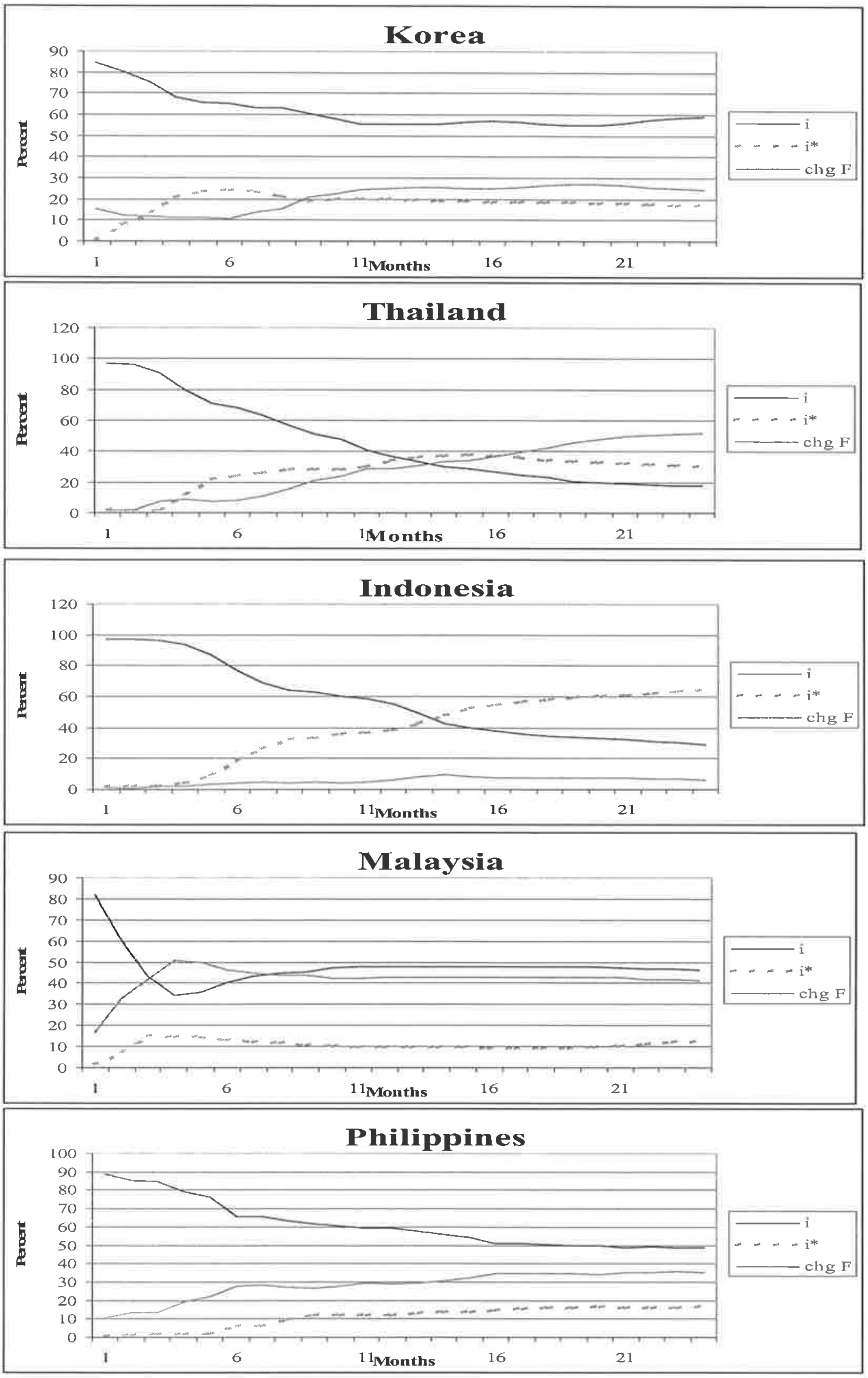


Figure 3.3
Interest Rate Time Series, 1990-7



Source": IMF IFS

Figure 3.4
Variance Decomposition of *i*



4

Inflation Targeting and Monetary Policy Rules in East Asia Post-Crisis: With Particular Reference to Thailand

4.1. Introduction

This chapter examines the effects of an open economy inflation targeting (IT) regime in an East Asian context. This is motivated largely by what appears to be the stated preferences of the central banks of four of the crisis-hit economies in East Asia – Thailand, Korea, Indonesia and the Philippines. Since the East Asian crisis, each of these countries implemented formal arrangements promoting and supporting IT style monetary policy systems.

IT regimes typically comprise the following elements: transparent monetary policy operations, instrument independence but with central bank accountability, an interest rate monetary policy rule (MPR) and a commitment to an inflation objective. The literature on IT has expanded significantly from the early work of Taylor (1993), Ball (1997), Debelle (1997) and Masson et al (1997) and has become a vast body of knowledge. That said, it is only recently that it has extended to the open economy and then to emerging market economies through Bharucha and Kent (1998), Ball (1999), Svensson (2000), Leitemo and Söderström (2001), Morón and Winkelried (2003), Collins and Siklos (forthcoming) and many others.

The literature on IT in East Asia is relatively new. The contributions thus far, such as Debelle (2001), McCauley (2001), Ho and McCauley (2003), Ito and Hayashi (2004) have been largely descriptive and/or have focused on the institutional aspects of IT regimes in East Asia. To date, there appears to be very little in the way of analytical work on the effect of IT regimes in East Asia.

Using a simple, small open economy macro model, this chapter investigates the performance of a range of different IT based policy rules. Some rules are optimal rules, those that are derived from the minimisation of a central bank loss function. Optimal policy under commitment and under discretion is assessed. Simple MPRs are also examined. These MPRs are determined exogenously and therefore do not reveal direct information about central bank preferences. However, MPRs are possibly reflective of how a central bank might behave by how it uses its policy instrument.

The model parameters are selected in the same manner as Bharucha and Kent (1998), Ball (1999), Svensson (2000) and others but are calibrated to Thailand. Thailand is chosen as it is one of the countries that has formally adopted IT as a policy framework and, as such, is the East Asian 'representative' for the purposes of this study.

The next section reviews the legal and institutional aspects of inflation targeting that have been introduced in East Asia after the crisis. The post-crisis monetary policy arrangements in many Asian countries provide a suitable context for analyzing the overall success, thus far, of an open economy IT regime. It offers some observations about Thailand's monetary policy actions and the possible role the exchange rate might play in implementing monetary policy in that country and the other inflation targeters in the region. Section 4.3 presents the model, describes the policy types and outlines the solution methods and numerical techniques used to assess the policies. The results presented in Section 4.4 indicate that many of the characteristics that appear in simulated models of industrial economies also show up in this parameterisation of the model. These characteristics include the tradeoffs between inflation and output and between inflation and the exchange rate in setting policy. Furthermore, as with models of industrial economies, the results show that the performance of any particular policy depends on the nature of the shocks to the economy. An important point of departure between the model presented here and others is the effect of possible contractionary depreciation/devaluation. This is especially a problem for those rules where the instrument of policy reacts to the real exchange rate. Two technical appendices accompany the main-text (Appendix 2 and 3). Section 4.5 concludes.

4.2. Inflation Targeting in East Asia

Buoyed by the apparent success of IT in industrial countries in the early 1990s, it has been advocated by the IMF and other commentators as a viable policy option for emerging economies in Asia and elsewhere. Since the Asian financial crisis of 1997-98, four of the five crisis-hit countries – Korea, Indonesia, Thailand and the Philippines – have instituted monetary policy arrangements fashioned around an inflation objective[1]. Each of these countries have made into law their respective IT arrangements (Table 4.1)[2]. These legislations so passed provide for many facets of the new monetary policy regime, including the appointment of key personnel and their tenure (five year terms in Korea and four years each in Indonesia and Thailand), the independence and autonomy of the monetary authority, the stated objectives of monetary policy, and the responsibilities and accountability with respect to the achievement of those objectives.[3]

The Bank of Korea Act was passed in December 1997. The Act presents conditions allowing monetary policy to be conducted independently. For example, Article 3 of the bank of Korea Act states that "monetary and credit policies of the Bank of Korea shall be formulated neutrally and implemented autonomously and [its] independence ... shall be respected", while Article 6 provides conditions for the setting of the price stability target (www.bok.or.kr). The inflation rate that is to be targeted is a

[1] Malaysia shifted to a rigid US dollar peg in September 1998 (Rajan, 2002b).
[2] The revised Bank of Korea Act was passed in December 1997 (and revised in April 1998), the new Bank Indonesia Act was passed in May 1999, and the Bank of Thailand Act was passed in May 2000 (Table 1).
[3] The subsequent discussion in this section draws on Ito and Hayashi (2004)

measure of core CPI that excludes volatile items relating to agriculture and energy. The time horizon is indefinite. Accountability measures are not well developed up to this point but the governor is appointed for five-year terms. An inflation report is published regularly and monetary policy meetings are published.

Indonesia began targeting inflation following the Bank Indonesia Act in May 1999 with the single policy objective to "pursue and maintain the value of the rupiah" (www.bi.go.id).[4] It currently targets headline CPI inflation at 1 to 2 year horizons. The Central bank governor is appointed to a four-year term. Like Korea, the Bank Indonesia has few accountability measures but does have objective-setting autonomy. Bank Indonesia produces a quarterly inflation report and an annual report to the public.

The Philippines began to employ an IT arrangement in December 2001. Until very recently (February 2004), the Bangko Sentral ng Pilipinas targeted headline CPI inflation but reverted to core CPI inflation. The central bank sets the objective and, if a breach occurs, must provide an explanation to the public regarding the nature of the breach and what it intends to do to address it. As with the others, it produces a quarterly inflation report and publishes its policy meetings.

As mentioned, the model in the following sections has been calibrated to Thailand. The Bank of Thailand Act was passed in April 2000. The rate of inflation that is targeted is core CPI inflation and the target horizon is indefinite – although Hataiseree (1999) hints at a forecast horizon of 1-2 years. Ito and Hayashi (2004) report that the core CPI inflation measure used retains around three-quarters of the price information of the CPI basket. The governor is appointed to a four-year term and accountability measures include having to explain breaches and actions to the public if and when they occur. The central bank does not have full autonomy over goal-setting, it does this in conjunction with the government of the day. The Bank of Thailand

[4] See Alamsyah et al (2001) for an interpretation of this statement

produces an inflation report and also publishes the models it uses to forecast inflation and set its policy to. The policy instrument for Thailand – as for most IT countries – is a short-term interest rate, namely the 14-day repurchase rate.

Monetary policy in Thailand is conducted with inflation as its primary objective. Any conflict that may arise between the inflation objective and other objectives such as output or the exchange rate is managed by the central bank by giving first priority to inflation (Hataiseree, 1999). The idea of presenting a clear order of pursuing the policy objectives is widely acknowledged as the most sensible way to manage multiple monetary policy goals (see Miskin, 2000).

The monetary policy landscape in Thailand reflects of the experiences in industrial countries in terms of how the instrument of policy leads to changes in inflation in an IT regime. This is reflected in Figure 4.1. The short-term interest rate affects the cost of borrowing through the financial system. This, in turn affects expenditure – particularly on durables and capital goods, which influences the level of aggregate demand. Eventually, the effect is realized through inflation. It is estimated that the process takes about 2 years.

Figure 4.1 effectively summarises the Bank of Thailand model (publically available: ww.bot.or.th). It is a sectoral model comprising OLS equations over 4 main sectors: First, the real sector containing expressions for consumption, investment, capacity utilization, exports and imports. Second, the government budget constraint. Third, there is an external sector with identities for balance of payments and exchange rate equations. The fourth is a monetary sector capturing interest rate and monetary aggregates. The model in section 4.3.1 captures the salient characteristics of the type of monetary policy and the transmission mechanism applicable in the Thai context.

Despite the formal adherence to a conventional IT regime, Hataiseree (1999) and Ito and Hayashi (2004) both state that the Bank of Thailand takes into account the exchange rate in implementing monetary policy. This is a strong indication that central banks in the region concern themselves with exchange rate movements. The normative literature on IT in developing economies typically suggests that such a regime should be accompanied by freely floating exchange rates (in particular, see Masson et al. 1997). Officially, Indonesia, Korea, the Philippines and Thailand have all declared that their currencies have floated post-crisis (Carare and Stone 2003). In contrast to the *de jure* exchange rate classifications, observations of the *de facto* regimes seem to suggest a reversion to US dollar pegs, albeit ones not as tightly as before the crisis. Several studies have argued this to be the case (for instance, see Baig, 2001, Calvo and Reinhart, 2002, McKinnon, 2001, Rajan 2002 and Chapter 2 of this dissertation). Ito and Hayashi (2004), Ho and McCauley (2003) and Debelle (2001) point out a number of reasons as to why the exchange rate is important in these countries. Such reasons include the degree of openness, exchange rate pass-through and the extent of financial vulnerability leading to contractionary devaluation and are pursued in Chapter 5 of this dissertation. [5]

How have these countries performed since implementing IT regimes?[6] The inflation performances of these new regimes against their stated targets are provided in Table 4.2[7]. Figure 4.2 shows the inflation rates relative to the crisis and pre-crisis periods and against when IT regimes were introduced in each country. At a superficial level, the performances have thus far been commendable, with Thailand, Korea and the Philippines for the most part being within target. Indonesia has struggled to keep its inflation within its target range, while Korea also surpassed its 2001 and 2002 targets.

[5] In addition to the exchange rate issues, Masson et al (1997) provide other factors that inhibit the success of IT in emerging market economies, these include an inability to establish independence due to fiscal dominance and seigniorage issues.
[6] For a recent review on IT in East Asia, see Ito and Hayashi (2004)
[7] Each of these monetary authorities defines inflation a little differently to each other. Indonesia excludes the effect of government prices and incomes policy. Korea uses CPI excluding petrol and some farm products. Thailand excludes raw food and energy prices (see McCauley, 2001

Figure 4.2 shows, at least circumstantially, that the introduction of IT may have had some effect in reducing inflation for Korea, Thailand and the Philippines – although factors such as the contractionary effects of the crisis were also important. The situation for Indonesia is not altogether clear, but this may be a reflection of the ambiguity of its monetary policy objective with respect to inflation.

What can we conclude from this? Central banks in the region have enacted IT policies and procedures that essentially target CPI inflation and that have appeared to enjoy moderate success. It can also be concluded that there has been some increase in the volatility of exchange rate post-crisis and there is some evidence of exchange rate management (see Chapter 2 of this thesis). Thus, any analysis of the effectiveness of IT policies in the region must contain some reference to how the exchange rate may be employed in the construction of monetary policy.

4.3. Open Economy Inflation Targeting (IT)

What exactly is IT? While more complete definitions can be found in Taylor (1999b), Bernanke and Mishkin (1997) and others, a brief synopsis is given here. Inflation targeting is generally thought of as a framework for the coordination of monetary policy. As with any framework, it has a number of elements or building blocks.[8] Mishkin (2000) identifies five elements: the announcement of a medium term target for inflation, an institutional commitment of price stability as the primary objective of the IT system, the use of as much information as possible to set the policy instrument; transparency of policy actions to the public and accountability of the central bank. Debelle (2001) identifies four (not dissimilar to Mishkin's) features of an IT

and Table 1).

[8] The points that follow appear in many papers on IT, including Bernanke and Mishkin (1997), Mishkin (2000), Debelle (2001), McCallum (1999), Khan (2002), Cecchetti (2000), Masson et al (1997) and Agenor (2000).

regime: the primacy of the inflation objective, instrument independence, transparency and accountability.

Masson et al (1997) state that the popularity of IT in the early 1990's owes much to the consensus regarding four main features of monetary policy. The first is the long run neutrality of money. Changes in money affect only the price level in the long run. The second relates to the costliness of inflation. The third pertains to the non-neutrality of money in the short term and its possible ambiguous effects. The fourth is the uncertainty of the length of transmission lags of policy – thus making inflation difficult to control on a year-to-year basis.

An important component in an IT system is the monetary policy rule (MPR). In general terms, the MPR is one element of a strategy employed by the monetary authority as part of its overall monetary policy. The MPR specifies how the instrument of monetary policy is to be changed given the characteristics of the economy and the policy objectives of the monetary authority. It implicitly assumes that the instrument of monetary policy will always react strongly to inflation (or some forecast of future inflation). The MPR provides a guide to the policymaker as to how to manipulate the instrument of monetary policy; the inflation target simply makes a statement of what the instrument is ultimately being used for.

For much of this last decade, the literature on IT and MPRs developed in a closed economy context (see, for instance, Ball, 1997 and Svensson, 1997). In this context, when calculating optimal policy, the primary objectives have been inflation and output (deviations). As a result, this has become the conventional stance of monetary policy under an IT system. It is only recently, when IT has been suggested as a serious policy option for small and open emerging economies that research has begun to focus on rules in open economy models and consequently, the role of the exchange rate. For instance, Fischer (2001) notes that "in most countries, even those with floating exchange rate regimes, monetary policy is likely to respond to some extent to movements in the exchange rate" (p.13)[9]. It is appropriate, then, that the analysis of IT policies in an East Asian setting include the possibility of a role for the exchange rate and is something that is pursued below.

4.3.1 Small Open Economy Macro Model

In order to investigate and attempt to clarify the role of the exchange rate in the setting of the MPR, consider a simple, small open economy IS-LM type model introduced by Ball (1999), but with the addition of some forward-looking behavior and foreign conditions[10]. The principal motivation for keeping the model simple is to facilitate its calibration to Thailand (see Section 4.4).

Consider the following:

$$y_t = \beta_1 y_{t-1} - \beta_2(i_{t-1} - \pi_{t|t-1}) + \beta_3 q_{t-1} + \beta_4 q_{t-2} + \beta_5 y^*_{t-1} + \varepsilon^y_t \quad (4.1)$$

$$\pi_t = [\alpha_1 \pi_{t-1} + (1-\alpha_1)\pi_{t+1|t}] + \alpha_2 y_{t-1} + \alpha_3 q_{t-1} + \alpha_4 q_{t-2} + \varepsilon^\pi_t \quad (4.2)$$

$$e_{t+1|t} = e_t + i_t - i^*_t - \upsilon_t \quad (4.3)$$

$$q_t = e_t + p^*_t - p_t \quad (4.4)$$

$$\upsilon_t = \theta_\upsilon \upsilon_{t-1} + \eta^\upsilon_t \quad (4.5)$$

$$y^*_t = \theta_y y^*_{t-1} + \eta^y_t \quad (4.6)$$

$$\pi^*_t = \theta_\pi \pi^*_{t-1} + \eta^\pi_t \quad (4.7)$$

$$i^*_t = g_\pi \pi^*_t + g_y y^*_t \quad (4.8)$$

where: y_t is the output gap at time t, i_t is the nominal interest rate, π_t is CPI inflation, $e_t(q_t)$ represents the nominal (real) exchange rate, v_t is a risk premium, p_t represents CPI

[9] This issue has been examined by Ball (1999), Svensson (2000) and Taylor (2001).

[10] This has become the workhorse model (see Bharucha and Kent, 1998, Svensson, 2000, Leitemo and Söderström, 2001 and Morón and Winkelried, 2003).

prices and those terms with superscripted stars are the foreign counterparts of output, inflation and the nominal interest rate. All variables (except the nominal interest rates and inflation) are in logs and expressed as deviations from steady state values and $x_{t+n|t}$ refers to the expectation at time t of x in n periods time.

Equation (4.1) is the Aggregate Demand (AD) function. Here, the output gap (y_t) depends on its own lag, the real interest rate, the real exchange rate and the lagged foreign output gap. ε^y_t is a zero-mean demand shock. The AD function is essentially backward looking, as in Ball (1999) and the first two models in Bharucha and Kent (1998).

Equation (4.2) is a CPI Phillips Curve. It is common in open economy models of this type for the Phillips equation to be an expression for domestic or non-traded inflation and for there to be a separate equation for CPI inflation. Equation (4.2) allows the examination of the same issues as models with separate equations for non-traded and traded inflation in an open economy, that is, persistence, some forward looking price-setting behavior, exchange rate pass-through and the effect of output on inflation – in a model where these issues are embedded in the CPI equation.[11] As such, when assessing IT, we are focusing on CPI IT only[12]. Recall Section 4.2, this is appropriate in that it also corresponds to how IT is formally being pursued in East Asia. ε^π_t is a zero-mean inflation or supply shock.

Equations (4.3) and (4.4) are the conventional expressions for uncovered interest parity (UIP) and purchasing power parity (PPP) respectively. The exchange rate

[11] See Walsh (2003), p308 for how a CPI inflation expression can be derived from a non-traded inflation equation and using $\pi^c_t = p^c_t - p^c_{t-1}$. The result is a forward-looking version of an expression similar to equation (2).

[12] There is still some debate as to whether CPI IT is preferred to domestic IT in open economies (see Debelle and Wilkinson, 2002, Bharucha and Kent, 1998 for instance). However, for the most part, open economies pursue a policy of targeting headline CPI inflation or a measure of core CPI inflation that adjusts for volatile items. Debelle and Wilkinson (2002) examine optimal policy tradeoffs for CPI IT and domestic IT for Australia, and find little difference

is given by the domestic price of foreign currency (US dollar). The risk premium is given by v_t and it is assumed to follow an AR(1) process, as described by Equation (4.5). η^v_t is a risk premium shock. Equations (4.6) to (4.8) are expressions for foreign output, foreign inflation and a foreign Taylor Rule, respectively. η^y_t and η^π_t are foreign demand and inflation shocks, respectively.

The model can also be expressed in a state space form. Substitute (4.4) into (4.3) and using (4.7) and (4.8) to yield:

$$q_{t+1|t} = q_t + i_t - \pi_{t+1|t} + (\theta_\pi - g_\pi)\pi^*_t - g_y y^*_t - v_t \tag{4.9}$$

Expressing (4.2) in terms of $\pi_{t+2|t}$ and using the following:

$$\pi_{t+1} = \pi_{t+1|t} + \varepsilon^\pi_{t+1} \tag{4.10}$$

we obtain:

$$\pi_{t+2|t} = (1/1-\alpha_1)[\ \pi_{t+1|t} - \alpha_1\pi_t - \alpha_2 y_t - \alpha_3 q_t - \alpha_4 q_{t-1}] \tag{4.11}$$

These, along with (4.1) and (4.5) to (4.7) constitute the state space system:

$$X_{t+1} = AX_t + Bi_t + \xi_{t+1} \tag{4.12}$$

where:

$X_t = [x_{1t}, x_{2t}]'$, $x_{1t} = [\pi_t, y_t, v_t, i_{t-1}, \pi^*_t, y^*_t, q_{t-1}]'$, $x_{2t} = [q_t, \pi_{t+1|t}]'$

between them.

$\xi_{t+1} = [\varepsilon^{y}_{t+1}, \varepsilon^{\pi}_{t+1}, \eta^{\upsilon}_{t+1}, 0, \eta^{y}_{t+1}, \eta^{\pi}_{t+1}, 0, 0, 0]'$

x_{1t} = (n_1x1) vector of predetermined state variables,

x_{2t} = (n_2x1) vector of forward-looking variables, and

$n = n_1 + n_2$.

As detailed in Svensson (2000) and Taylor (2000, 2001), a key result of the model is that monetary policy affects inflation directly through the price effects of currency movements, as well as indirectly via output (which in turn is impacted by both interest and exchange rate changes). The direct effect takes place contemporaneously, while the lag structure of the model implies that indirect effects on inflation via output occur after two periods. The more open the economy the stronger the pass through effects of exchange rate changes on consumer prices, i.e. a larger coefficient on the q_{t-1} in Equation (4.2) and an increased effect of the exchange rate on goods demand in Equation (4.1).

4.3.2 Simple versus Optimal Monetary Policy Rules (MPRs)

a) Simple MPRs

The MPR that we propose to investigate here is given by a variant of the Taylor Rule (*a la* Taylor, 1993, 2000, 2001):

$$i_t = f_\pi \pi_t + f_y y_t + f_{q1} q_t + f_{q2} q_{t-1} \tag{4.13}$$

Generally speaking, the MPR can be derived in two ways. The first is to specify a simple MPR for the instrument that provides guidance for the monetary authority in setting monetary policy. This is the basic philosophy behind the Taylor rule. The f coefficients are selected to reflect the central bank's preferences in relation to its monetary policy target. As such, the central bank preferences are implied by the coefficients to the rule. While these simple rules may be ad hoc, their virtue lies in the fact that since the exact structure of the economy is not known with certainty, a model that is robust across all model structures might be desirable. Moreover, simple MPRs are useful because they provide a direct assessment of the behaviour of the central bank.

b) Optimal MPRs

The second way is to explicitly specify a central bank loss function and derive the MPR as part of the first order conditions for minimizing a simple quadratic loss function such as:

$$\min E_0 \sum_{t=0}^{\infty} \delta^t [\mu_\pi \pi_t^2 + \mu_y y_t^2 + \mu_i i_t^2 + \mu_{\Delta i}(i_t - i_{t-1})^2 + \mu_q q_t^2] \qquad (4.14)$$

where δ is a discount factor representing the central bank's rate of time preference, μ_π, μ_y, μ_i, μ_n *and* μ_q are policy parameters that relate to inflation (π), output (y), interest rate (i) volatility and smoothing, and the exchange rate (q) respectively.

The objectives of the monetary authority are principally inflation and output and also include an interest rate smoothing term. For our purposes, we assume that μ_i, and μ_q both equal to zero[13]. This is the specification of a loss function most often used in the literature on IT, where the primary objectives are inflation and output, and this will be reflected in the positive values given to μ_π and μ_y. For a strict IT regime, only inflation appears in the loss function. Often, a central bank may wish to achieve the inflation target over a longer time horizon so as to minimise adverse output variation. In doing so, output enters the loss function with a smaller weight than that for inflation and the regime is then referred to as flexible IT. Nominal income targeting, interest rate stabilisation policies, even exchange rate stabilisation policies can be defined by how they appear in the loss function. In practice central banks are also keen on preventing sharp fluctuations in the interest rate (i.e. "optimal inertia") given its repercussions on macroeconomic stability and asset prices. It is for this reason that $\mu_{\Delta i} > 0$ (Lowe and Ellis, 1997 and Sack and Weiland, 1999)[14].

Once the loss function is minimised, an optimal MPR similar to the one given in Equation (4.13) can be derived. Even if μ_q is zero, the optimal rule is expected to contain non-zero values of f_{q1} and f_{q2}. This essentially reflects the fact that it is optimal for the instrument of policy to respond to exchange rate changes (indeed any variable) in the pursuit of its inflation and output objectives. [15] Optimal policy rules are very much dependent on the structure of the model. In addition, they offer *direct* insight into central bank *preferences*, something simple MPRs are not able to do – in simple MPRs, preferences can only be guessed at by observing the rule.

The optimal policy rules are derived for the cases of commitment and discretion. This is quite standard in the inflation targeting literature. Optimal policy under commitment occurs when a loss-minimizing central bank derives an optimal rule, sticks to it, and agents' expectations adapt to this rule. In the discretion case, the policymaker re-optimises every period after taking into account the evolution of the variables in the model (see Walsh, 2003 for details).

c) Comparisons

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[13] If μ_y is also set at zero, Mervyn King (1996) terms such an optimising monetary authority an "inflation nutter".

[14] It bears noting that even those who strongly advocate that the IT monetary authority should react to asset prices in the course of policy making, are clear that asset prices ought not to be included in the objective function (see Cecchetti, et al., 2000 and Cecchetti et al., 2002 for clear statements on this). Some of the general issues of clarity of objectives and transparency versus the benefits of discretion outlined in Section 4 are of particular relevance to this debate.

[15] Note that under the solution methods employed in this paper, the optimal coefficient for the current real exchange rate, f_{q1}, cannot be derived as q is a jump variable. The optimal policy

The aim of the numerical investigations is to compare conventional optimal monetary policy under IT with various manifestations of a simple, exogenously determined MPR for two main reasons. The first is to ascertain how effective optimal policy is in a model with parameters that might be representative of an Asian inflation targeting economy. The second reason is to compare the optimal policies with simple MPRs in order to investigate the importance of the exchange rate in the rule. The simple MPRs that are examined differ in how much the real exchange rate is represented in the rule. As such, the focus is on the values the f parameters should take on.

The original Taylor rule for a large and relatively closed economy like the US is one where $f_{\pi}, f_y > 0$ (specifically 1.5 and 0.5 respectively) and $f_{q1} = f_{q2} = 0$. For a small and open economy, the exchange rate should enter the MPR with a non-zero coefficient.[16] In particular, f_{q1} must be greater than zero and f_{q2} must be less than or equal to zero. This is so as an appreciation (decrease) of the domestic currency induces a relaxation of monetary policy, i.e. currency appreciation tends to be deflationary. A positive f_{q2} represents a partial adjustment. The idea of the partial adjustment relates mainly to the direct effect of the exchange rate on inflation. Consider some positive shock to inflation. The subsequent increase in the interest rate appreciates the currency, which, in an open economy, may be met with an interest rate reduction. In the context of the original shock, this could possibly be seen as premature easing. A partial adjustment decreases the magnitude of the interest rate reduction, therefore offsetting some of the premature easing. Recent work by Taylor reviews Ball (1999), Svensson (2000) and Taylor (1999a) and the monetary policy rules derived as optimal for each of

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rules derived in Section 3.2 for the control variable, i_t, is a function of the pre-determined variables in the system. See Svensson (2000)

[16] There are similarities between rules of this type and monetary conditions indices (MCI) that have previously been employed in New Zealand and Canada. For an analytical discussion see Ball (1999,2001), for a discussion of its use in New Zealand see Dennis (1997).

those models. He finds that the exchange rate coefficients for those optimal rules are quite small. The weights presented in Ball are $c_1 = 0.37$, $c_2 = -0.17$, for Svensson, $c_1 = 0.45$, $c_2 = -0.45$ and a similar rule in Taylor (1999a) used $c_1 = 0.25$, $c_2 = -0.15$ (Table 4.3).

The next section contains some numerical experiments with a view to assessing the nature of exchange rate involvement in MPRs. Optimal policy, under commitment and under discretion, is compared to different specifications of a simple rule for a calibration of the model presented above.

4.4. Model Parameterisation, Empirical Analysis and Results

4.4.1 Model Parameterisation

In assessing the impact of different policy types, the model is calibrated to represent a small and open Asian economy, Thailand. For this, we have used simple OLS estimates for Thailand as it was the first country impacted by the Asian financial crisis and among the first to adopt an IT regime. The selection of parameters conforms to current practices in this literature in that the structural parameters for the output gap and inflation equations and the exogenous processes are chosen (see Ball 1999, Bharucha and Kent, 1998, Leitemo and Söderström, 2001, Morón and Winkelried, 2003 and Svensson, 2000). OLS and VAR estimates for Thailand for the last 10 years are used to assist in selecting these parameters. The structural parameters are presented in Table 4.4 and are based on the following:

$$y_t = \underset{(3.50)}{2.85} + \underset{(6.27)}{0.60y_{t-1}} - \underset{(0.07^*)}{0.36r_{t-1}} - \underset{(-2.35)}{0.09q_{t-1}} - \underset{(-1.07)}{0.05q_{t-2}} + \underset{(0.09)}{0.01y^*_{t-1}} \tag{4.15}$$

$R^2_{adj} = 0.89$, n = 38, DW = 2.08
* P-value for Wald Test

$$\pi_t = \underset{(-1.97)}{-0.60} + \underset{(21.60)}{0.94\pi_{t-1}} + \underset{(3.68)}{0.15y_{t-1}} + \underset{(3.00)}{0.04q_{t-1}} + \underset{(1.06)}{0.02q_{t-2}} \tag{4.16}$$

$R^2_{adj} = 0.91$, $n = 38$, $DW = 1.50$

The above OLS results leading to the calibrated model are derived using the techniques in Beechey et al. (2000), Debelle and Wilkinson (2002) and Morón and Winkelried (2003). The equations were estimated separately as the correlation of the residuals is sufficiently low (-0.07) for systems based estimation not to be deemed necessary. Correlations between residuals and RHS variables were also not significant for endogeneity to be an issue. Serial correlation was tested using the Breusch-Godfrey LM Test and heteroskedasticity and the existence of ARCH terms were tested using White's Test and the Engle ARCH LM Test respectively. The inflation equation showed some higher order serial correlation. The inclusion of a MA(4) term is sufficient to absorb most of it but its inclusion had no significant effect on the coefficient values – although its omission understates the coefficient for lagged inflation by about 0.06. The coefficient value was left at 0.94 to allow the simulations to explore some forward-looking behavior in inflation. It is fair say that, either way, inflation in this sample is highly persistent.

The object is to derive the lag structure of the empirical model such that it captures the essence of the theoretical model for calibration purposes. Hence, in the output equation, only the first-order lagged output is taken because this is supposed to capture persistence in the model. However, in the empirical model, an attempt is made to capture as much of the lagged effect of the real interest rate – measured as a money market rate (IFS line 60B) minus current inflation – as is deemed necessary to reflect a realistic transmission of monetary policy. Following Beechey et al (2000), 6 (quarterly) lags are used. These are tested jointly for significance using the Wald Test for the restriction that all parameters for the real interest rate = 0.

All variables (except interest rates) are in percentage growth rates, (log X_t - log X_{t-4})*100. The variables are not demeaned (even though the model expresses variables as deviations from a long run mean) because as growth rates, the variables are mostly stationary and subtracting a constant mean, while affecting the constant in a regression, doesn't affect the parameter values. The data used are quarterly observations from the IMF IFS CD-ROM for the period 1994:1 to 2003:4. Oddly, in testing for a structural break using a time dummy (intercept and slope), the crisis period did not seem to affect the parameter values in any material way. For output, GDP 95 (line 99B) is used, CPI (line 64) is used for inflation, the end of period nominal exchange rate per US dollar (line AE) is used to calculate the real exchange rate as defined in equation (4.5). Foreign output, inflation and nominal interest rate are proxied by US IP (line 66), CPI (line 64) and Treasury Bill Rate (line 60C) respectively. The risk premium is calculated as in equation (4) using the ex post value of next period's exchange rate. The variance of the shocks to the model, the ε's and η's are taken from the diagonals of the error covariance matrix of an unrestricted VAR model for 4 lags – thus allowing for the serial correlation mentioned above – and the covariance terms are all assumed to be zero.

If one compares the parameters with those chosen in Ball (1999) or Leitemo and Söderström (2001), it becomes apparent where the primary differences are and how these relate to emerging economies like Thailand. The real exchange rate (RER) coefficients in the output equation, β_3 = -0.09 and β_4 = -0.05, are of opposite sign to most of the previous work done in this literature (cited above). Hence devaluations/depreciations in Thailand appear to be contractionary (Bird and Rajan, 2004 and Rajan and Shen, 2003). Eichengreen (2001) discusses the issue of IT in the context of the "liability dollarization" problem in developing countries and we will take up this issue in more detail later in this chapter and, again in Chapter 5 to follow.

4.4.2 Stochastic and Dynamic Results

Using the solution techniques described in Söderlind (1999) and Söderström (2003), this section presents and evaluates the stochastic and dynamic behavior of the model where the MPR is: (i) initially derived as an optimal policy under commitment and under discretion; and (ii) exogenously determined as a simple rule[17].

The policy configurations for optimal and simple MPRs are summarized in Table 4.5. The first 4 rows are the optimal policy settings for strict IT and flexible IT under *commitment* and *discretion* respectively. The loss function weight on inflation, μ_π, is set at 1 for all optimal rules. The output weight, μ_y, is set at 0 for strict IT and 0.5 for flexible IT.[18] A weight of 0.01 is assigned to $\mu_{\Delta i}$ to capture a central bank's desire for instrument stability. Rows 5-8 in Table 4.5 are simple arbitrary MPRs (Rules 1 to 4). The first simple rule is a strict IT rule where the interest rate reacts only to inflation. The second adds output as well (i.e. flexible IT). The parameters, $f_\pi = 1.5$ and $f_y = 0.5$, are those from the Taylor Rule. Simple rule 3 is the Taylor rule with some weight given to the current and lagged real exchange rate to capture partial adjustment. The values of 0.4 and –0.2 are selected such that we can compare the rule with some of those in Table 4.3. The final rule is a Taylor Rule with $f_{q1} = 0.5$. This rule is added to evaluate the effect of a stronger reaction to the exchange rate. It is, in a sense, a simple "fear of floating" rule.

The coefficients for the simple rules in Table 4.5 can be contrasted to the coefficients for the optimal rules in Table 4.6. As expected, the coefficient value for inflation is higher for the strict IT policies than for the flexible IT policies. The most

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[17] The MATLAB code for the model solutions is adapted from the code of Paul Söderlind. His webpage is: http://home.tiscalinet.ch/paulsoderlind/. I appreciate him making the codes publicly available.

[18] This definition of strict and flexible IT is fairly standard in the IT literature. See Ball (1997) and Svensson (1997, 1999).

interesting result here is the magnitude of the reaction of inflation and output to the optimal rules compared to the simple MPRs. Furthermore, if these coefficient values are compared to different parameterisations of the model, such as Svensson (2000) and Morón and Winkelried (2003), the coefficient values to the rule are also much higher under the set of parameter values employed in this model.

The remainder of this section investigates the conventional optimal IT under commitment and discretion and the variations of the simple fixed MPRs. The objective is to compare the suitability of simple MPRs with those rules that have been derived as optimal IT given the basic structure of the model as calibrated for Thailand. Will the general philosophy behind IT be suitable for developing economies in Asia? Are some rules better than others?

a) Unconditional Standard Deviations

The first set of results is unconditional standard deviations of the model for each policy configuration. These are presented in Table 4.7. As expected, there is a trade off between inflation and output volatility for strict versus flexible IT. This is observed for both the optimal policies and the simple MPRs. The most appropriate way to assess the performance of the policy is to evaluate it against the importance a central bank might place on the various goal variables. If, for instance, inflation variation is the only objective, then policy under commitment is preferable. If the volatility of the other variables is of concern, it seems that strict IT under discretion is more efficient. This reflects the added flexibility in discretionary policy, when the central bank re-optimises, it takes into its information set the evolution of those variables that impact on the inflation target.

As expected, regardless of whether optimal policy is conducted under commitment or discretion, the choice between strict and flexible IT involves a tradeoff between output and inflation volatility. This tradeoff is also seen in Figure 4.3, which presents the output volatility/inflation volatility frontier for the optimal rules and the output volatility/inflation volatility points for the simple MPRs. The frontier is calculated by simulating the model under different values of μ_y in equation (4.14). The values of μ_y vary from 0.0 to 1.0 where μ_y = 0.0 is strict IT, μ_y = 0.1 represents the output objective being a tenth as important as inflation (μ_π remains at 1.0) and so on. At a general level, it is fair to say that, under this model, the points on the discretion frontier dominate those for commitment. There is a significant difference in the slope of each frontier. A central bank pursuing a policy under commitment, effectively locking in an IT rule can expect far less variability around inflation than a discretionary central bank.

Consider next the simple rules. From Table 4.7, as with the optimal rules, there is a tradeoff between inflation and output volatility when selecting between strict IT (rule 1) and flexible IT (rule 2) policy. There is also a tradeoff between rule 1 and the flexible IT plus RER rule (rule 4) in relation to inflation and real exchange rate volatility. This is not an unexpected result in that it reflects the difficulty in managing domestic versus external objectives. The partial adjustment rule provides better inflation but inferior real exchange rate results because it prevents the central bank from pursuing overly easy policy (in the event of an inflation shock) but in doing so encourages more currency variation than rule 4. An observation of the column containing the interest volatility reveals that an increase in the reaction to the exchange rate in the rule induces greater volatility of the interest rate. This is an expected, but important result in that it suggests a trade off between added exchange rate intervention and possible instrument instability. This, coupled with the tradeoff between inflation and the exchange rate, is a possible reflection that monetary/exchange rate policies need not be a choice between two mutually exclusive corners but a choice in a continuum between fixed and flexible exchange rates.

b) Impulse Response Functions (IRFs)

The next set of results that are generated are impulse (dynamic) responses to various (1 standard deviation) shocks to the goal variables in the model. Following Eichengreen (2001), three main types of shock are considered, a positive domestic demand shock, a foreign financial shock like a risk premium shock and a negative terms of trade shock. We observe the responses to these shocks of inflation, output and the real exchange rate (RER). The impulse reaction functions (IRFs) are presented in Figures 4.4 to 4.7.

A positive demand shock is a shock to ε^{y}_{t} and the IRFs are in Figures 4.4a to 4.4d. Such a shock affects y_t in Equation (4.1) directly, which in turn threatens to impact future inflation (from Equation 4.2). The policy response in terms of inflation in this case is to increase i_t to the extent given by the (optimal or simple) coefficient, f_π, in the rule in Equation (4.13). This is in turn leads to a real appreciation (decrease in q) of the currency (Equation 4.3). However, in the next period, if the coefficient on f_{q1} has a positive value, part of the interest rate increase will be reversed in response to the appreciation. Clearly, in the case of a domestic demand shock, there is a trade-off between the goal of maintaining a stable exchange rate, on the one hand, and that of keeping inflation under control, on the other. The trade-off can be observed in the IRFs in that the optimal rules – which are primarily inflation driven – lead to convergence quite rapidly. Those simple rules with exchange rate terms take longer to converge, although if one observes the real exchange rate response to the demand shock, the initial effect of the shock is not as high. From the point of view of faster convergence, it would appear that those rules with a smaller reaction to the exchange rate (rule 1 and 2) are better in this case.

The lack of convergence of output can possibly be explained by the contractionary devaluation nature of the model. Consider a demand shock that reduces output. In this case, the response is to lower interest rates in an expansionary monetary policy. The effect of lower interest rates is a depreciation of the exchange rate. This, therefore, implies that output will reduce further to the extent of the contractionary devaluation. Those rules that react to the real exchange rate will raise interest rates in response to the depreciation, thereby reducing output further.

Figure 4.5 shows the IRFs to an inflation shock. There does not appear to be too much difference in the policy types here owing to the lack of ambiguity of the inflation objective and the primacy of the inflation target in most policy types.

Next consider the case of a negative financial shock such as a rise in the risk premium (ν_t) – a pure portfolio disturbance shock. In the model a risk premium shock is modelled as a shock to η^{ν}_t and is presented in Figure 4.6. A risk premium shock causes a real exchange rate depreciation with consequent inflationary effects via pass through (Equation 4.2). In the competitive devaluation case, the currency depreciation ought to have positive output effects via the competitiveness channel, which in turn will have inflationary effects via the Phillips curve relation (Equation 4.1). In this case, in view of the unambiguous inflationary effects of this shock, the IT monetary authority will raise interest rates.[19]

However, in the current parameterisation of the model, there exists a contractionary devaluation effect in the case of a financial shock. Here, the direct effect of an interest rate increase on output (0.36) is greater than the indirect effect through currency appreciation (0.09) – resulting in a net output contraction from the interest rate hike. As with a demand shock, the effect of the output contraction is seen in the

[19] While this monetary policy response is optimal from an inflation perspective, it may be mistakenly interpreted as a "fear of floating" (i.e. exchange rate stability is viewed as an end in itself). (See Eichengreen, 2001)

response to output. The flexible IT rules clearly dominate the strict IT rules. The response of the strict policy under commitment reflects the inflation-only nature of the rule. Looking at the responses to RER and the interest rate, we see that the flexible IT policies result in some over and undershooting due to the weight placed on output and the trade-off occurring between output and inflation. Initially, the interest rate decreases and the currency then depreciates in response to output, but thereafter the interest rate increases (and currency appreciates) to respond to inflation.

Foreign shocks are not only of the financial variety. As noted by Eichengreen (2001), a MPR is harder to use where the foreign shock involves a terms-of-trade/external demand shock – so-called “Prebisch shock”. Consider the negative Prebisch shock (shock to η^{y}_{t}) and presented in Figure 4.7. In this case, an interest rate hike would merely exacerbate the decline in aggregate demand. Insofar as the inflationary effects via the aggregate demand channel outweighs the direct price or passthrough effect, the appropriate interest rates response would be to lower interest rates. While this would be at odds with the policy that may be advocated by a “fear of floating” monetary authority, it is consistent with received wisdom which suggests that the more variable the terms of trade, the more flexible ought to be the exchange rate regime. This seems to be reflected in the IRFs, where the policies with less exchange rate intervention appear to dominate.

But what happens if a country is financially vulnerable in the sense that a depreciation might be contractionary? In this event an interest rate reduction will exacerbate the deflationary effects, thus suggesting the need for an interest rate hike. The policy response to a negative shock that reduces export demand and depresses output will be appreciated exchange rate, not a depreciated one. Here, an appreciation has a positive effect on output because its favorable financial effects (that promote a contractionary devaluation) dominate the competitiveness effects. Ignoring this effect means that the authorities are not raising interest rates to address the output contraction.[20]

Some support of this asymmetry between large and small exchange rate shocks is provided by Lahiri and Vegh (2001) and Moron and Winkelried (2003). They find that in the case of a "financially vulnerable country" a case can be made for a non-linear MPR. The non-linearity arises from the fact that the authority should defend the exchange rate in the "turbulent times" but allow the exchange rate to float in tranquil times.

4.5. Concluding Remarks

The stated policy of the central banks of Korea, Indonesia, the Philippines and Thailand since the Asian crisis strongly indicate that the monetary policy regime of choice is inflation targeting (IT). IT essentially involves the manipulation of a policy instrument, usually the nominal interest rate, to react to a set of important variables in the model in such a way that achieves the (primary) objective of inflation.

This chapter investigates the effectiveness of inflation targeting policies in an East Asian context by using a small open economy macro model in the style of Ball (1999), Bharucha and Kent (1998) and Svensson (2000). The policies relate to strict vs flexible IT and optimal IT under commitment and under discretion. In addition to inflation and output, it is entirely possible that the exchange rate is, in some way, an objective of policy. As such, this chapter analysed the effect of some simple MPRs

[20] Eichengreen (2001) suggests a possible reconciliation; when the exchange rate depreciates by a large amount, the adverse balance-sheet effects dominate, but when it depreciates by a small amount, the favorable competitiveness effects dominate. Large depreciations cause severe financial distress because they confront banks and firms with asset prices for which they are unprepared, while doing little to enhance competitiveness because of the speed with which they are passed through into inflation. For small depreciations, the balance of effects is the opposite; small depreciations are more likely therefore to satisfy the conditions for an expansionary devaluation. See, also, Krugman (1999) and Rajan and Shen (2003) for an elaboration of these thresholds effects of devaluation in emerging economies.

where some differed in the degree to which the instrument of policy reacted to the (real) exchange rate. The model is solved numerically and some stochastic (unconditional standard deviations) and dynamic (impulse responses) properties are produced for each policy type.

The results in section 4.4.2 can be summarized as follows: Firstly, from Figure 4.2, it can be seen that optimal IT under discretion dominates optimal IT under commitment and that, as expected, optimal rules perform better than the simple MPRs. The stochastic results seem to indicate that those simple rules that react to some extent to the real exchange rate are inferior to the strict IT and flexible IT MPRs. It would appear that adding the exchange rate to the rule offered no benefits to inflation, output, or indeed the real exchange rate.

As with much of the recent literature regarding IT in industrial economies, the effectiveness of various rules is dependent on the source of the shock to the model.[21] In this paper, this is shown using dynamic responses. Here, there is some evidence of a trade-off between inflation and the exchange rate in terms of how these variables converge after a shock. But the more interesting result in this paper lies in the possible implications of a contractionary devaluation effect present in the model. This arises from the negative coefficients of the real exchange rate on output from the simple OLS test. The contractionary devaluation scenario effectively creates a difficulty because in an open economy, the exchange rate plays an important part in the transmission of monetary policy. As a result, the effect of an interest rate reduction, for example, is diluted as the corresponding currency depreciation does not stimulate demand and

[21] The shocks that are examined here are quite stylized and assumed to be reasonable persistent as given by the theta parameters in the model. If the shocks were transitory (lower thetas), the policy responses presented would remain broadly intact, but the instrument response would be a little smaller. This is because price and output effects have inertial components and tend to be longer lasting. See equation (4.1) and (4.2).

hence inflation as it would in a competitive devaluation case. This shows up predominantly in the impulse responses.

It is worth pointing out at this point that the results relate to a calibrated version of a simple model for Thailand. Many of the papers referred to above, and the analysis in this paper, point out how important the parameter values are in the construction of the most suitable policy rule. As such, a plausible next step for further research is to estimate models, with richer empirics, for the other inflation targeters in the region and possibly to compare with some of their industrial country neighbours such as Australia and New Zealand who have been using IT now for over a decade.

Table 4.1
Highlights of Inflation Targeting Regimes in Selected Asian Economies

Country	Date	Target price index	Target Width	Target horizon	Escape Clauses	Accountability	Target set by	Publication and accountability
Indonesia	May 1999	Headline CPI	Table 2	1-2 years	none	None, but parliament can request reports at any time	Central Bank	Quarterly Inflation report, Annual report to public
Philippines	Dec 2001	Headline CPI (Core CPI measure introduced Feb 2004)	Table 2	2 years	Yes, in the event of oil price shocks, food supply shocks	Public explanation of the nature of the breach and steps to address it	Central Bank	Quarterly inflation report, publication of monetary policy meetings
Thailand	Apr 2000	Core CPI (excluding food and energy)	Table 2	Indefinite	None	Public explanation of breach and steps taken to address it	Central Bank in consultation with Government	Inflation Report, inflation forecasts and publication of models used
Korea	Jan 1998	Core CPI (excluding non-cereal agricultural products and petroleum products)	Table 2	indefinite	Changes caused by major force	None	Central Bank in consultation with Government	Inflation report and submission to parliament, publication of monetary policy meetings

Source: Compiled from Bank of Korea, Bank Indonesia, Bank of Thailand, Bangko Sentral ng Pilipinas websites

Table 4.2
Actual Headline (Core) versus Targeted Inflation Rates (in percent): Korea, Indonesia, Thailand, the Philippines

	1999		2000		2001		2002		2003	
	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual
Kor	3.0	0.8	2.5	1.8	2.5	3.6 (3.2)	2.5	3.7 (3.1)	2.5	3.4 (2.7)
Ind			3-5	9.4	3-5	12.5	3-5	10.0	9.0	5.1
Thai			<3.5	1.4 (0.8)	<3.5	0.8 (1.2)	<3.5	1.6 (0.3)	<3.5	1.8 (0.2)
Phil					6-7	6.1	5.0*	3.1	5.0*	3.1 (3.4)

Notes: * plus/minus half percentage point
Core inflation in brackets
Sources: Bank of Korea, Bank Indonesia, Bank of Thailand, Bangko Sentral ng Pilipinas websites

Table 4.3
Simulated Coefficient Estimates of Exchange Rate Variables

	f_{q1}	f_{q2}
Ball (1999)	-0.37	0.17
Svensson (2000)	-0.45	0.45
Taylor (1999)	-0.25	0.15

Table 4.4
Model Parameters

Aggregate Demand	Phillips Curve	Foreign Conditions	Shocks
$\beta_1 = 0.60$	$\alpha_1 = 0.94$	$\theta_v = 0.85$	$\sigma_y = 1.39$
$\beta_2 = 0.36$	$\alpha_2 = 0.15$	$\theta_y = 0.80$	$\sigma_\pi = 0.14$
$\beta_3 = -0.09$	$\alpha_3 = 0.04$	$\theta_\pi = 0.80$	$\sigma_v = 1.70$
$\beta_4 = -0.05$	$\alpha_4 = 0.02$	$g_\pi = 1.50$	$\sigma_{y*} = 0.71$
$\beta_5 = 0.02$	$\delta = 0.99$	$g_y = 0.50$	$\sigma_{\pi*} = 0.71$

Table 4.5
Policy Configurations

Optimal Policy Rule under Commitment: Strict Inflation Targeting	$\mu_\pi = 1$, $\mu_y = 0.0$, $\mu_{\Delta I} = 0.01$
Optimal Policy Rule under Commitment: Flexible Inflation Targeting	$\mu_\pi = 1$, $\mu_y = 0.5$, $\mu_{\Delta I} = 0.01$
Optimal Policy Rule under Discretion: Strict Inflation Targeting	$\mu_\pi = 1$, $\mu_y = 0.0$, $\mu_{\Delta I} = 0.01$
Optimal Policy Rule under Discretion: Flexible Inflation Targeting	$\mu_\pi = 1$, $\mu_y = 0.5$, $\mu_{\Delta I} = 0.01$
Simple Monetary Policy Rule #1: Strict Inflation Targeting	$f_\pi = 1.5, f_y = 0, f_{q1} = 0, f_{q2} = 0$
Simple Monetary Policy Rule #2: Flexible Inflation Targeting (Taylor Rule)	$f_\pi = 1.5, f_y = 0.5, f_{q1} = 0, f_{q2} = 0$
Simple Monetary Policy Rule #3: Flexible Inflation Targeting with Partial Adjustment (PA)	$f_\pi = 1.5, f_y = 0.5, f_{q1} = 0.4, f_{q2} = -0.2$
Simple Monetary Policy Rule #4: Flexible Inflation Targeting plus Real Exchange Rate (RER)	$f_\pi = 1.5, f_y = 0.5, f_{q1} = 0.5, f_{q2} = 0$

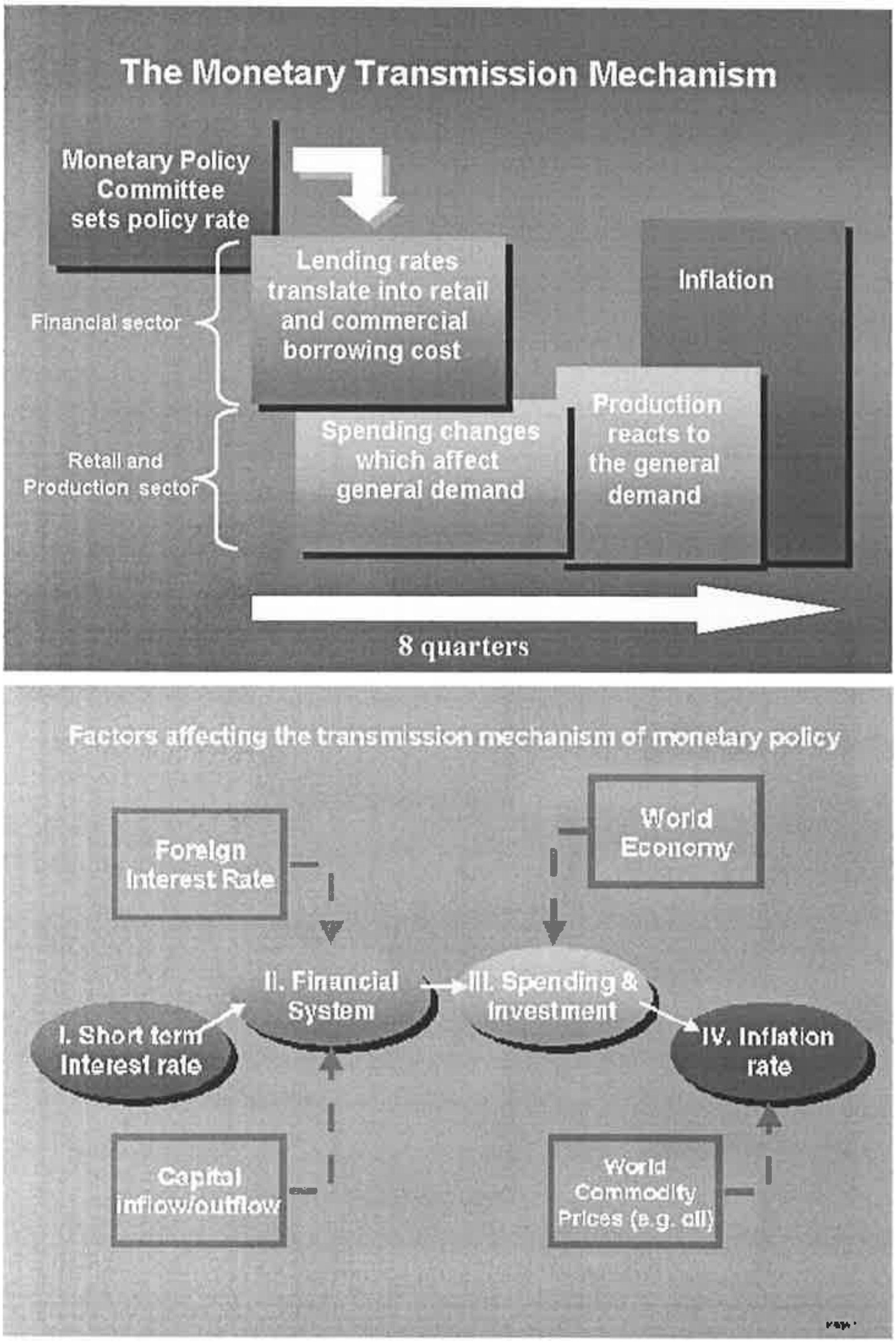
Table 4.6
Coefficients to Optimal Rules

	π_t	y_t	v_t	i_{t-1}	π^*_t	y^*_t	q_{t-1}
Strict IT under Commitment	2.34	0.35	1.35	0.50	0.82	0.56	0.05
Flex IT under Commitment	2.21	1.90	-1.09	0.10	-0.59	-0.38	-0.08
Strict IT under Discretion	3.61	1.08	0.39	0.24	0.26	0.20	0.03
Flex IT under Discretion	2.28	1.99	-1.05	0.09	-0.07	-0.45	-0.08

Table 4.7
Unconditional Standard Deviations

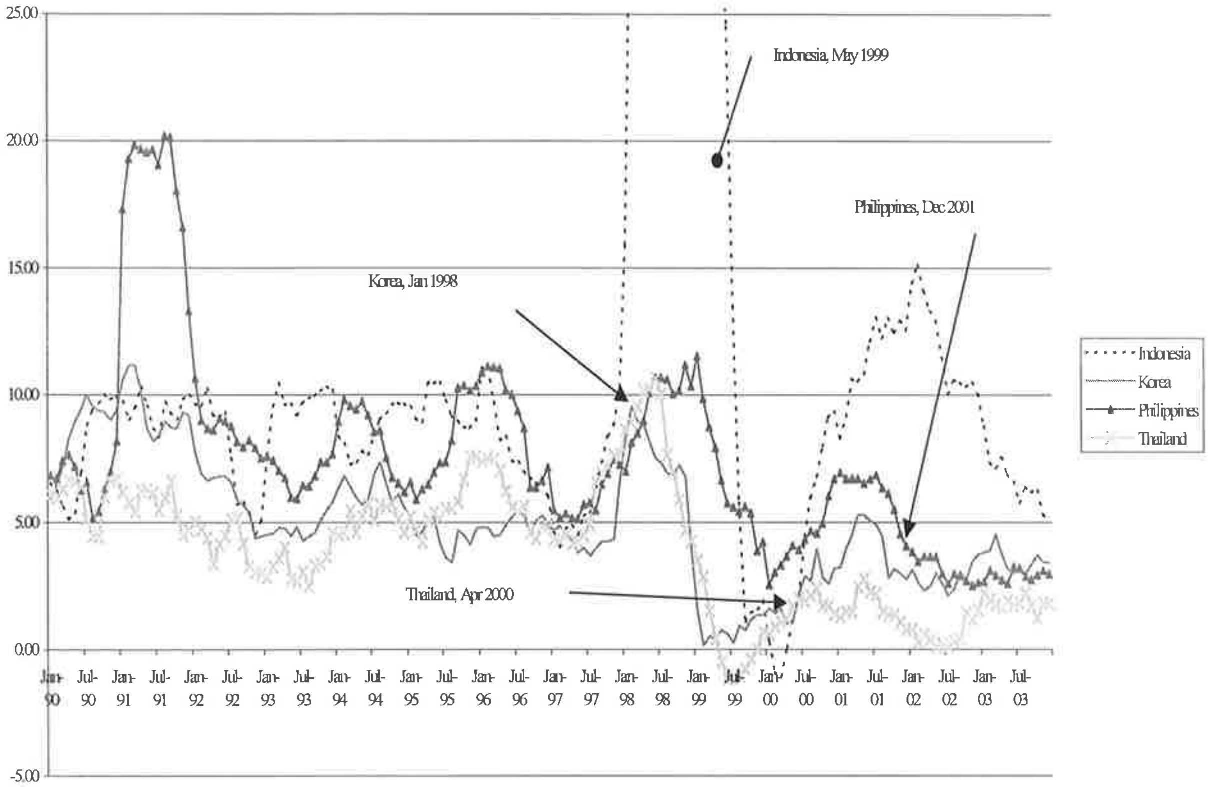
Policy	Standard Deviation of Inflation	Standard Deviation of Output	Standard Deviation of Real Exchange Rate (RER)	Standard Deviation of Nominal Interest Rate
Strict IT under Commitment	0.36	13.76	34.08	7.38
Flexible IT under Commitment	2.47	2.26	12.88	5.54
Strict IT under Discretion	0.79	3.33	8.89	2.66
Flexible IT under Discretion	2.36	1.42	11.25	5.12
Rule 1: Strict IT	2.19	5.58	15.44	3.29
Rule 2: Flexible IT	3.10	4.16	16.61	3.29
Rule 3: Flexible IT with PA	2.15	7.88	20.81	4.21
Rule 4: Flexible IT plus RER	5.79	6.42	13.56	6.46

Figure 4.1
Diagrammatic Representation of Thailand's Monetary Policy Transmission



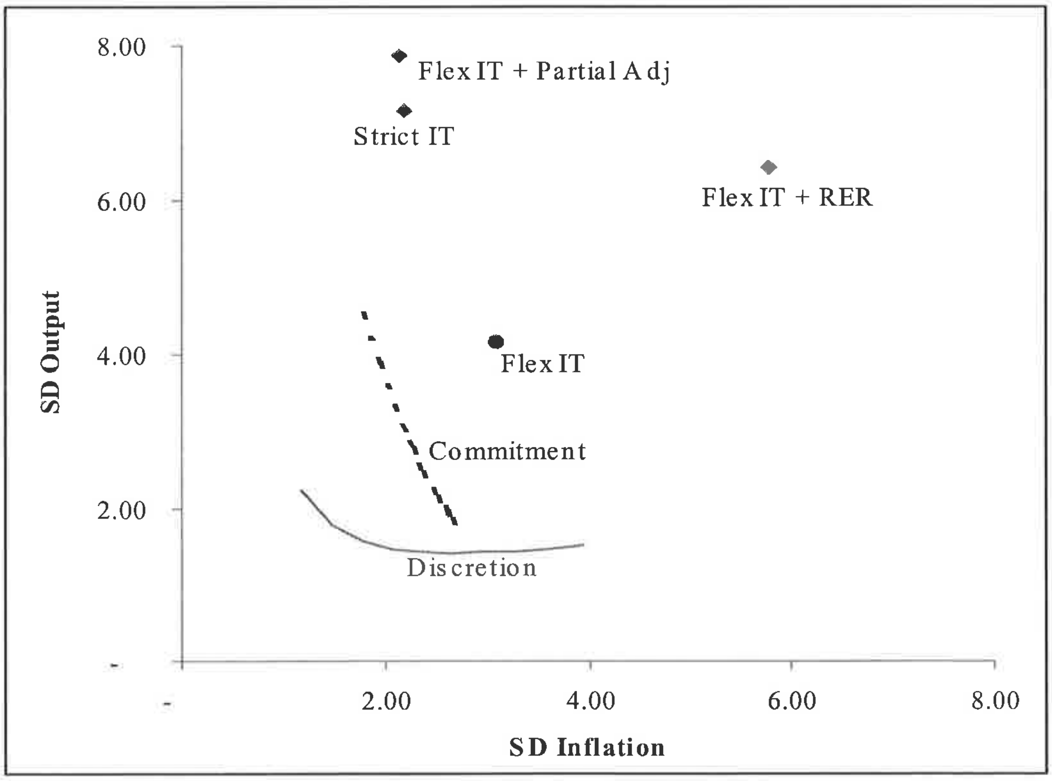
Source: Bank of Thailand, (www.bot.or.th)

Figure 4.2
Inflation Rates



Source: IFS

Figure 4.3
Output/Inflation volatility tradeoffs



Impulse Responses

Figure 4.4

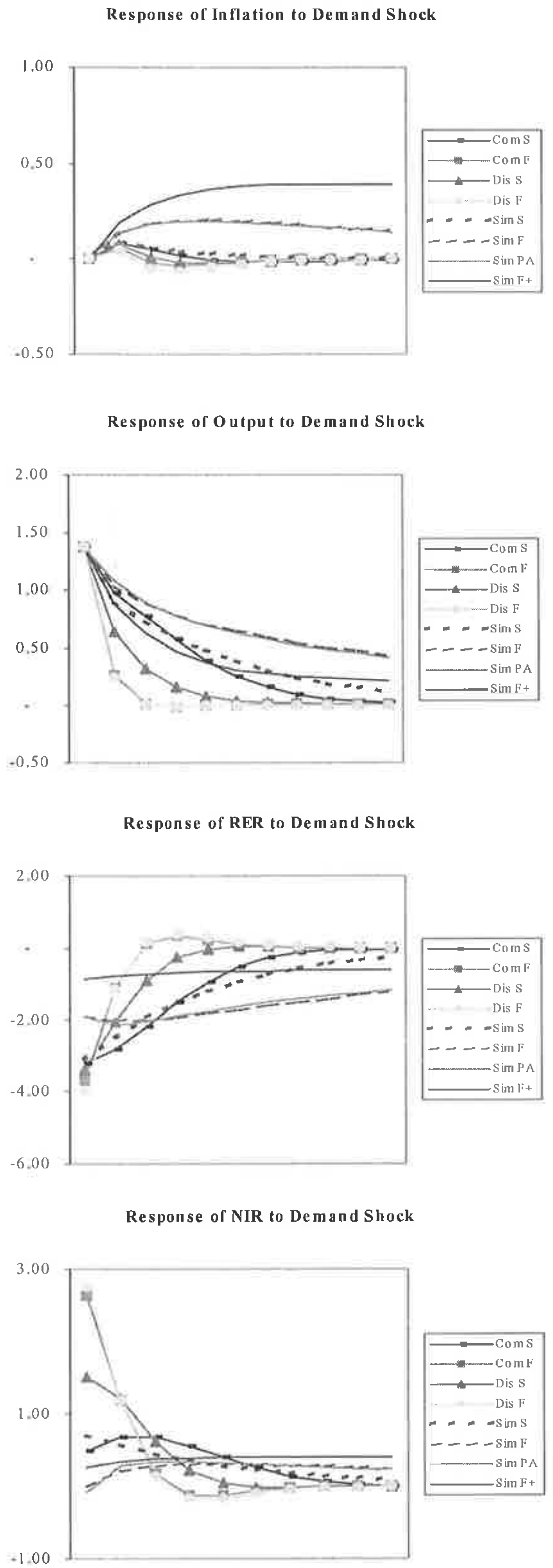
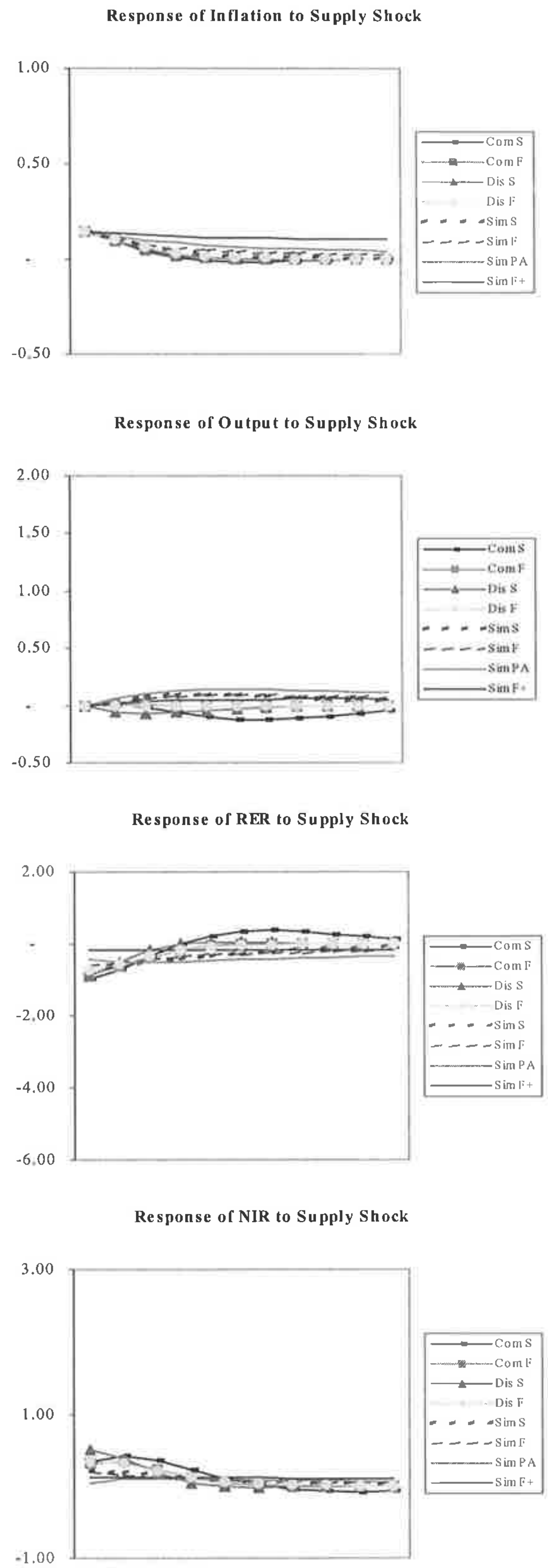


Figure 4.5



Impulse Responses

Figure 4.6

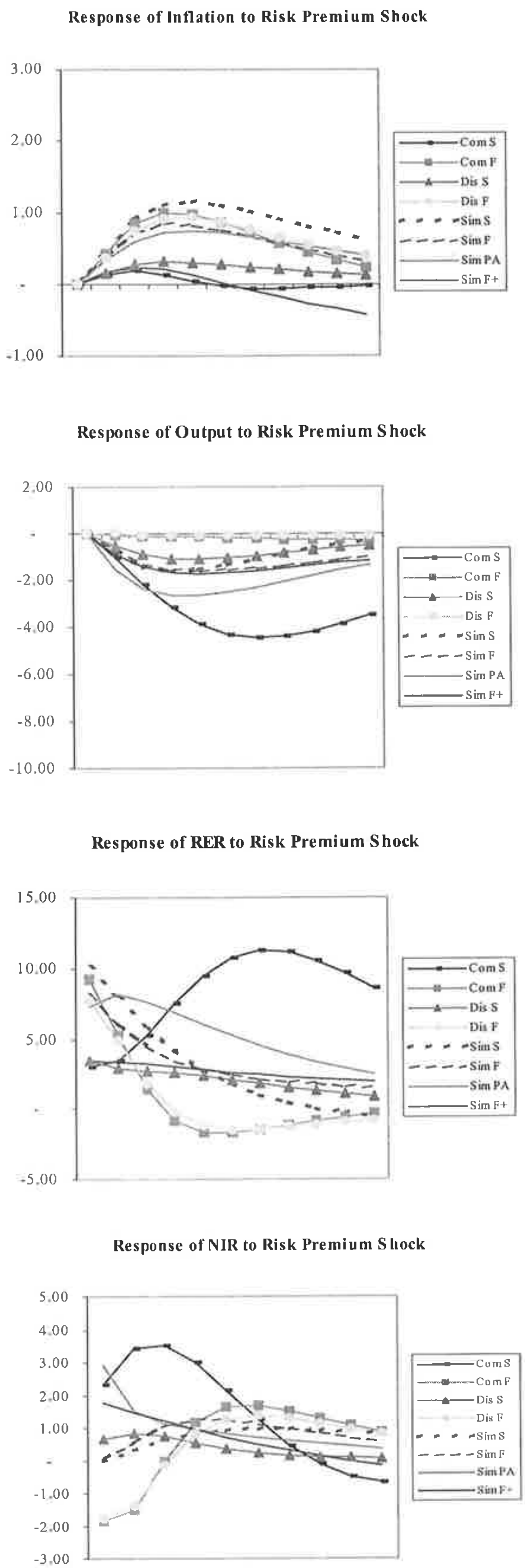
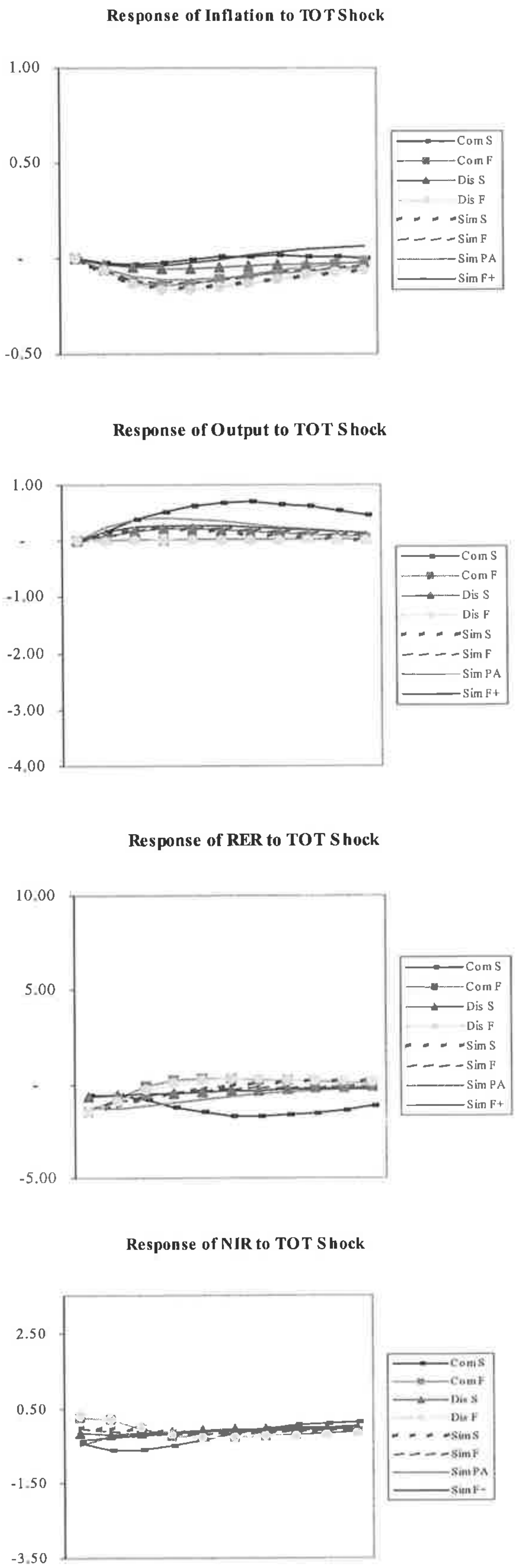


Figure 4.7



5

Fear of Floating and Optimal Monetary Policy: With Particular Reference to East Asia

5.1. Introduction

Since the East Asian crisis in 1997-8, several countries – Korea, Thailand, Indonesia and the Philippines – have seemingly opted for inflation targeting style arrangements where the major target of monetary policy is the rate of inflation and the secondary objective is output and is achieved through the manipulation of a short-term interest rate as the policy instrument. In these regimes, the conventional role for the exchange rate is for it to float freely such that it does not compromise policy in effectively achieving its domestic objectives.

However, are the exchange rates allowed to float? Quite a large literature has developed on evaluating the revealed preferences of central banks regarding monetary and exchange rate policies. Much of these indicate that there is a general reluctance of emerging market countries to allow their currencies to float freely. In an East Asian context, Baig (2001) and Chapter 2 of this dissertation examine the pre-crisis and post-crisis period and both find that exchange rate intervention is lower after the crisis than before but higher than during the crisis and that exchange rate intervention is lower in a sample of industrial countries than in East Asia. There are several papers that have articulated possible reasons or justifications for fear of floating in emerging market economies (EMEs).[1]

The desire to manage exchange rate volatility presents some interesting implications for monetary policy and the use of policy rules. The exchange rate may

[1] In particular Eichengreen (2001), Calvo and Reinhart (2002), Reinhart (2002), Willet (2002), Fischer (2001), Mussa et al (2000), Goldstein (2002)

become the third objective of monetary policy – or at least an operating target or significant referral point. But is this achievable? Can a central bank conduct monetary policy with some form of price stabilisation objective and also manage movements in its currency? This implies something of a departure from the corner solutions prescribed by the impossible trinity of fixed exchange rates, independent monetary policy and perfect capital mobility. Assuming momentarily that capital mobility is high, thus focusing on the choice between fixed exchange rates and independent monetary policy, a movement away from the corners would imply that if there is some scope for currency movements, there is also some scope for domestic monetary policy and the use of monetary policy rules. This idea is promoted in Debelle (2001) and Williamson (2001). Debelle (2001) argues that an inflation targeting regime can possibly work in those countries that still harbour some desire to regulate movements in the exchange rate because the exchange rate has "important first order effects on economic activity and in the minds of central bankers". He uses Chile and Israel as examples of countries that simultaneously pursue targets for inflation and the exchange rate where the currency regime of choice is a crawling peg. [2]

This chapter expands on some of the recent work in open economy monetary and exchange rate policy by examining what an emerging market central bank with a fear of floating might do if it is implementing optimal monetary policy.[3] It examines some of the issues/scenarios that may justify or result in fear of floating behaviour by central banks in EMEs and in East Asia in particular. It does this by applying to each scenario, a range of optimally derived monetary policy options that essentially differ in the degree

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[2] This point is made in Debelle (2001) in the context of each country moving from a peg to an IT regime.

of exchange rate involvement in each policy option. In contrast to much of the recent literature, some of the policies examined here are those that, through the specification of the central bank loss function, bear some resemblance to intermediate exchange rate policies. The idea of modelling such policies has received recent support. As Chang and Velasco (2000) point out:

> "In short, the evaluation of exchange rate policy should move away from the 'fix vs flex' dichotomy, and toward the characterization of optimal monetary policy in well specified analytical frameworks." (p75)

Moreover, Edwards (2002) states:

> "Indeed, it is perfectly possible that the optimal policy, that is, policy that minimizes a well-defined loss function is one where the central bank intervenes from time to time." (p248)

The aim is to answer the question of whether the policy choices that involve greater exchange rate management are more desirable than those that do not under different model conditions regarding openness, exchange rate pass-through and balance sheet considerations.

Section 5.2 looks at the role of the exchange rate in the construction of such regimes and examines the issue of fear of floating. It also outlines some of the possible reasons (scenarios) for fear of floating that have been highlighted by recent work – openness, pass-through and balance sheet effects – that will be examined in numerical exercises in later sections. It provides some evidence to suggest that EMEs are more concerned about the fear of floating scenarios than industrial countries by examining the case for some East Asian countries. Section 5.3 details the basic model, the scenarios and the monetary policy options that will be analysed as well as the solution of the model and the nature of the numerical exercises. Section 5.4 presents the results of the simulation exercises and section 5.5 concludes.

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[3] Recent contributions on similar themes include: Svensson (2000), Eichengreen (2001), Leitemo and Soderstrtom (2001), Moron and Winkelried (2003), Parrado (2004), Cespedes,

5.2. Reasons for Fear of Floating[4]

5.2.1. Trade Patterns and Trade Openness

What is the justification for fear of floating? Why do some countries resist flexible exchange rates? One main reason, particularly for emerging market economies, is the effect of currency volatility on trade patterns and the fear that excess volatility will discourage other countries in engaging in trade.[5] The empirical literature on this issue is however quite mixed.[6] Wei (1999) provides empirical evidence suggesting that exchange rate volatility has a much more detrimental effect on trade between country pairs than is suggested by previous studies. More generally, in a comprehensive survey of the literature on the impact of exchange rate volatility on trade flows, McKenzie (1999) concludes that the recent empirical studies have had "greater success in deriving a statistically significant relationship between volatility and trade" (p.100). Calvo and Reinhart (2000a) review a more limited set of such studies and draw a similar conclusion. In an empirical study using data from Korea, Singapore and Malaysia, Wilson (2000, 2001) find that trade patterns are not influenced by movements in the real exchange rate for Singapore and Malaysia but finds some relationship under particular

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Chang and Velasco (2000a),(2000b) and Devereaux and Lane (2003).

[4] There is an alternative school of thought explaining the behaviour of central banks regarding exchange rates. The Mercantilist or export-led growth school maintains that exchange rate policy is driven by the need to maintain the value of the currency at a level that is 'competitive' such that it promotes trade in exports. The primary concern appears to be with the *level* of the exchange rate. The fear of floating hypothesis, as has been developed up to this point, emphasizes exchange rate volatility as the primary concern for central bankers. While not in any way discounting the role of Mercantilst attitudes, this chapter is primarily concerned with fear of floating and the optimal policies developed in later sections are based on central bank loss functions with terms representing exchange rate volatility.

[5] Lahiri and Vegh (2001), for instance, claim that there is an output cost to excessive exchange rate fluctuations.

[6] Two recent papers highlight the differences and complexities inherent in this issue. Bacchetta and van Wincoop (2000) present a theoretical analysis concluding that lower exchange rate variability doesn't necessarily mean higher trade. Barkouas et al (2002), using micro data, show that there is a negative relationship between exchange rate uncertainty and trade flows.

circumstances for Korea. Another recent set of empirics based on gravity models using both cross-sectional and time series data suggests institutionally fixed exchange regimes (i.e. common currency, currency boards or dollarization) stimulates trade, which in turn boosts income (see Frankel and Rose, 2002, Glick and Rose, 2002 and Rose, 2000). As is common knowledge, proponents of the European Monetary Union (EMU) have used such an argument extensively in support of a single regional currency. In an important study, Bénassy-Quéré (1999) shows that exchange rate volatility can also have a detrimental impact on foreign direct investment, comparable to the distortions created by currency misalignments.

A country's vulnerability of trade flows to exchange rate fluctuations is a manifestation of its openness to trade. There are many studies that have examined the issue of openness and compared industrial and developing countries. Table 5.1 presents some openness ratios, ([exports + imports]/GDP), that have been taken from some recent literature, for some East Asian countries compared to some developed countries.[7] For the most part, it is clear that the East Asian economies in the sample are more open by this measure than industrial countries.

5.2.2. Exchange Rate Pass-through

Related to openness is that fear of floating might also be due to higher pass-through of exchange rate changes to prices. Pass-through refers to the situation where changes in import prices due to movements in the exchange rate are passed through to the CPI. The available empirical evidence suggests that this occurs faster in emerging countries than in industrial ones. Table 5.1 presents the results of two recent studies in

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[7] For Malaysia and Singapore, a substantial amount of these exports are re-exports.

pass-through, Choudri and Hakura (2001) and Hausmann et al (2000).[8] For each metric used, there is a clear distinction between the pass-through coefficient for the East Asian sample and the group of industrial countries.

Ho and McCauley (2003) have listed the possible determinants of higher pass-through in EMEs. The first is that EMEs tend to be more open and there is a clear theoretical relationship with openness (if openness is measured by the share of the traded goods in the price index). However, Ho and McCauley (2003), using simple regressions, do not conclusively establish the existence of this relationship. The second is that an EME's history of high inflation has made the public aware and sensitive to the effect of import prices on the CPI. Choudri and Hakura (2001) have included a variable to represent inflation history in their pass- through regressions and have found it to have a significant effect.

What are the implications of pass-through for monetary policy? At an intuitive level, high pass-through heightens the connection between inflation and the exchange rate. Thus, reacting to the exchange rate before it has an opportunity to affect import prices seems an appropriate policy response for an inflation fighting central bank of an open, high pass-through country. Eichengreen (2001) maintains that the appropriate policy response depends on the source of shocks. Clearly, there is no need to react to the exchange rate if the shock is not being transmitted through the exchange rate.[9]

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[8] Passthrough is measured by either regressing (Δlog) import prices on the (Δlog) exchange rate (Campa and Goldberg, 2002) or regressing the (Δlog) CPI on the (Δlog) exchange rate as is done in papers such as Choudri and Hakura (2001). In estimations such as the latter, the coefficient contains information on both pass-through and openness. Recall that openness can be depicted by the share of traded goods in the CPI and, as such estimations such as the latter don't allow openness and pass-through to be analysed separately. By using equations such as equation (6) in Campa and Goldberg, we can differentiate between the two in simulations and examine their interaction closely. Also, see the notes to Table 1 for a more information about the procedures used for each study.

[9] A related strand of the literature examines the issue of pass-through in terms of local currency pricing (LCP) and producer currency pricing (PCP). PCP refers to goods being priced in the currency of the producer. Any exchange rate movement will imply an expenditure-switching

Devereux and Lane (2003) provide some simulation results (standard deviations) of the difference between non-traded IT, CPI IT and an exchange rate peg in a model with high and low pass-through. The presence of high pass-through creates a trade-off between inflation and the exchange rate on one hand, and output on the other. If exchange rate volatility is an issue, their simulations would suggest CPI IT to be the more desirable, if output variability is of concern, then non-traded IT is preferable. For lower levels of pass-through, the connection between inflation and the currency weakens. As such, the trade off is less acute. In summary, CPI IT provides possibly the best balance.

5.2.3. Balance Sheet Effects

Fear of floating might also be due to balance sheet effects brought about by currency mismatches. These currency mismatches refer mainly to those loans in corporate or bank balance sheets that are denominated in foreign currency. As a result, any changes to the exchange rate impacts directly on the value of these loans. In the event of a depreciation, for example, a firm's exposure to these loans increases, resulting in greater potential losses in the form of bankruptcies, unemployment etc. These losses may outweigh any competitive effects of a currency depreciation. Indeed, the banking crises and contractionary effects that occurred in East Asia following speculative attacks are possibly due to this balance sheet effect (See Bird and Rajan, 2002 and Rajan and Shen, 2003).

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role by either making the good more or less expensive for the importer, ie pass-through is high. LCP basically means that goods can be priced in the currency of the purchaser to reflect the conditions in that market. Here, an exchange rate change will have no impact on the price of imported goods – pass-though is low. Devereux and Engel (2002) state that there is a two-way relationship between pass-through and exchange rate volatility. This is an issue not dealt with here.

Ho and McCauley (2003), Eichengreen and Hausmann (1999), and Hausmann (1999) identify two possible reasons for the currency mismatch problem. The first is moral hazard. The existence of implicit guarantees such as a pegged exchange rate encourages agents to borrow unhedged in foreign currency under the (eventually) mistaken belief that the guarantee will protect the value of the loan.

The second relates to when borrowers simply cannot borrow in domestic currency. Unlike industrial countries, many emerging economies are unable to borrow overseas in their domestic currencies, leading to an accumulation of foreign currency debt liabilities that are primarily US dollar denominated and unhedged (i.e. "liability dollarization" henceforth, LD)[10]. In the presence of a degree of LD, exchange rate fluctuations could alter the net worth of corporate and financial institutions with consequent real sector dislocations. In addition, in a flexible regime, households, fearing the cost of currency fluctuations on their individual net worth, may shy away from holding domestic financial assets (asset denominated in domestic currencies), or from doing so within the domestic financial system, hence hindering the development of domestic financial markets.

Table 5.1 presents some evidence of the existence of LD for a sample of East Asian countries and, for comparison, a sample of industrial economies. The first two metrics measure the degree of domestic currency debt and bank loans as a proportion of total debt issued by each country. It clearly shows that, for the East Asian sample, the ability to borrow in its own currency is significantly lower than its industrial counterparts. The empirical literature on LD and balance sheet effects also tend to confirm the output effect of a devaluation in a liability dollarised economy (Cespedes,

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[10] This is commonly referred to as the "original sin" hypothesis, a term attributed to Hausmann (1999) and Hausmann et al. (2000).

Chang and Velasco, 2000a, Eichengreen and Hausmann, 2000, Cavallo and Ghironi, 2001).

Does the existence of LD affect the conduct of monetary policy? Can it induce fear of floating behaviour on the part of the monetary authority? There is a significant literature on the effects of monetary policies on financially vulnerable economies. The list includes Cespedes, Chang and Velasco (2000a,b), Bernanke, Gertler and Gilchrist (2003) and Devereaux and Lane (2003). Essentially, these models incorporate a 'capitalists' or 'entrepreneurs' sector of the economy that have access to global capital markets and borrow in foreign currency in order to acquire capital and invest in production activities at home. However, foreign borrowing is subject to agency and informational problems and such frictions give rise to the incurrence of a risk premium. The risk premium is an inverse function of the ratio of the capitalists' investment to their net worth – implying that the more the firm borrows, the higher the risk premium. The firm's net worth is, in turn, a function, *inter alia*, of the real exchange rate. A real depreciation will reduce net worth and increase the risk premium.

It is this relationship specifically that is the focus here. Cespedes, Chang and Velasco (2000a,b) – or CCV – and Morón and Winkelried (2003) specify risk premia that have other arguments but it is the effect of the real exchange rate on the risk premium that drives the distinction between a "financially robust" and "financially vulnerable" economy. Consider the following from CCV:

$$\nu_t = \gamma q_{t-1}, \qquad \text{where: } \gamma = \mu[\psi - (1-\lambda)/\lambda] \tag{5.1}$$

where ν is the risk premium and γ is the real exchange rate elasticity. μ is a positive constant, ψ is the ratio of FX debt to investment, λ is a composite of structural parameters in CCV's model. The important consideration here is that a combination of the risk premium expression above and an inverse relationship between the risk premium and output (through, say, an AD equation) will give rise to a contractionary devaluation scenario. A real devaluation raises the risk premium through the balance sheet channel, which lowers output. This contrasts with the usual hypothesis of a competitive devaluation scenario that takes place through the net exports channel.[11]

5.3. Model and Solution

5.3.1 Small Open Macro-model

The model is based on the previous work of, Svensson (2000), Leitemo and Söderström (2001) and Morón and Winkelried (2003). It is a basic open economy IS/LM structure based on the New Keynesian style and is used extensively in this literature.[12]

Consider the following:

$$y_{t+1} = \beta_1 y_t - \beta_2(i_t - \pi_{t+1|t}) + \beta_3 q_{t+1|t} + \beta_4 v_{t+1|t} + \beta_5 y^*_{t+1|t} + \varepsilon^y_{t+1} \qquad (5.2)$$

Equation (5.2) is an aggregate demand (AD) equation. Here, the output gap depends on its own lag, the real interest rate, the real exchange rate and the foreign output gap. ε^y_t is a zero-mean demand shock. The key inclusion in this expression is the risk premium, v_t (see Morón and Winkelried, 2003 and CCV). As argued previously,

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[11] Eichengreen (2001) examines contractionary devaluation directly through an aggregate demand function. Consider $y_t = -\alpha r_t + \gamma q_t$. A contractionary devaluation involves $\gamma < 0$ and his analysis is one of comparing the effect of $-\gamma$ versus α. If $-\gamma > \alpha$, then the contractionary effect of a devaluation outweighs the expansionary effect of an interest rate reduction.

[12] For a description of these models and their micro-foundations, see Clarida, Gali and Gertler (1998), Gali and Monacelli (2002) and Svensson (2000)

this allows for the examination of the policy effects of a contractionary devaluation scenario arising from the balance sheets of firms.

$$\pi^N_{t+1} = [\alpha_1\pi^N_t + (1-\alpha_1)\pi^N_{t+2|t}] + \alpha_2 y_{t+1|t} + \alpha_3 q_{t+1|t} + \varepsilon^\pi_{t+1} \tag{5.3}$$

Equation (5.3) is a Phillips Curve for non-traded inflation that allows for both forward-looking behaviour in terms of inflation expectations and inflation persistence. ε^π_t is a zero-mean inflation or supply shock. The model assumes that there are two goods in the economy – traded and non-traded (or domestic). As a result, a CPI inflation term can be specified as follows:

$$\pi^C_t = (1-\lambda)\pi^N_t + \lambda\pi^T_t \tag{5.4}$$

Equation (5.4) is an expression for CPI inflation where λ is the weight of the traded goods in the consumption basket. This parameter is investigated in more detail below when looking at the effects of higher openness.

$$\pi^T_t = (1-\kappa)\pi^T_{t-1} + \kappa(\pi^*_t + \Delta e_t) \tag{5.5}$$

Equation (5.5) represents traded inflation where κ is the degree of contemporaneous exchange rate pass-through. Full (complete) pass through is represented by κ=1.[13] Any value less than unity depicts incomplete or delayed pass-through in the model. As in

[13] This is effectively a deviation from the Law of one Price (LOOP). LOOP is captured as follows: $\pi^T_t = \Delta e_t + \pi^*_t$ which is equivalent to equation (5.5) where κ=1.

Leitemo and Söderström (2001), for convenience, the delay in pass-through is captured by an AR(1) term.

$$e_t = e_{t+1|t} - i_t + i^*_t + v_t \tag{5.6}$$

$$q_t = e_t + p^*_t - p_t \tag{5.7}$$

Equations (5.6) and (5.7) are conventional expressions for UIP and PPP respectively. The exchange rate is given by the domestic price of foreign currency (USD).

$$v_{t+1} = \theta_\upsilon v_t + \gamma_q q_t + \eta^\upsilon_{t+1} \tag{5.8}$$

The risk premium in equation (5.8) is given by υ_t and it is assumed to follow an AR(1) process in addition to the parameter representing the real exchange rate effect as discussed in section 5.2. As in section 5.2, the analysis is stylised but sufficiently represents the behaviour of an economy with adverse balance sheet effects in the numerical exercises that follow. η^υ_t is a risk premium shock.

$$y^*_{t+1} = \theta_y y^*_t + \eta^y_{t+1} \tag{5.9}$$

$$\pi^*_{t+1} = \theta_\pi \pi^*_t + \eta^\pi_{t+1} \tag{5.10}$$

$$i^*_t = g_\pi \pi^*_t + g_y y^*_t + \eta^i_t \tag{5.11}$$

Equations (5.9) to (5.11) are expressions for foreign output, foreign inflation and a foreign Taylor rule, respectively. η^y_t ,η^π_t and η^i_t are foreign demand, inflation and interest rate shocks, respectively. Central bank preferences guiding the optimal monetary policy is represented by:

$$\min E_0 \sum_{j=0}^{\infty} \delta^j [\mu_\pi^N \pi_t^2 + \mu_\pi^c \pi_t^2 + \mu_y y_t^2 + \mu_i i_t^2 + \mu_{is}(i_t - i_{t-1}) + \mu_q q_t^2] \qquad (5.12)$$

The policy parameters (μ's) in equation (5.12) represent objectives regarding inflation, output and the nominal interest rate deviations, interest rate smoothing and real exchange rate deviations. All variables (except the nominal interest rates and inflation) are in logs and expressed as deviations from steady state values.

The model can be expressed in a state space form along the lines of the class of forward-looking Rational Expectations macro models found in Söderlind (1999) and Söderström (2003).

$$X_{t+1} = AX_t + Bi_t + \xi_{t+1} \qquad (5.13)$$

$$Y_t = C_x X_t + C_i i_t. \qquad (5.14)$$

$$L_t = Y_t' K Y_t. \qquad (5.15)$$

where $X_t = [x_{1t}, x_{2t}]'$, $x_{1t} = (n_1 \text{ x } 1)$ vector of predetermined state variables, $x_{2t} = (n_2 \text{ x } 1)$ vector of forward-looking variables and $n = n_1 + n_2$. A is a (n x n) matrix of coefficients and B is a (n x 1) vector. The variable i_t is a scalar and is the control variable in the system representing the monetary policy instrument, the nominal interest rate. Y_t represent the goal variables and are those on the right hand side of the loss function, equation (12). There are n_3 goal variables, $C_x = (n_3 \text{ x } n)$, $C_i = (n_3 \text{ x } 1)$. $K = (n_3 \text{ x } n_3)$ matrix of loss function coefficients where the diagonal comprises of those parameters in equation (5.12). For details of the state space representation, see Appendix 3A.

5.3.2 Fear of Floating Scenarios and Monetary Policy Options

This section describes numerical analyses to be conducted to ascertain the effect of different policy options under different model scenarios. The model is solved for optimal policy under discretion. Here, the policy maker re-optimises every period, thus taking into account the evolution of the model over time and expectations are taken as given every period. Discretion is used principally in models where there is uncertainty and also, discretion seems to produce better performing rules than commitment.

The combinations of optimal policies are given in Table 5.2. The underlying theme in the selection of policy types in this analysis is the role of the exchange rate. Hence policy types chosen are increasing in the degree of exchange rate intervention as reflected by the weights in the loss function. The first is flexible domestic inflation targeting (FDIT).[14] FDIT has a minimal reaction to the exchange rate as the policy maker is principally concerned about non-traded inflation. As such, this policy can be regarded as a floating exchange rate policy. The next is a flexible CPI IT regime (FCIT) where the central bank targets mainly CPI inflation. CPI inflation contains a strong exchange rate influence due to the degree of openness, λ, and pass-through, κ. If $\lambda=\kappa=0$, then CPI IT would be equal to domestic IT. The third is a type of flexible CPI IT cum real exchange rate targeting regime (FCRT) of a type found in Cespedes, Change and Velasco (2000b), is used to calculate a welfare metric in Parrado (2004) and a policy of this type is also considered in Debelle (2001). Here the CPI inflation parameter, μ_c, is set at 1.0 and the real exchange rate parameter, μ_q, is set at 0.5. This is designed to capture the desire of the central bank to regulate movements in the exchange rate but where CPI is still regarded as the primary objective of monetary policy. It is, in essence

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[14] Flexible IT policies also target output as a secondary objective. The inflation/output tradeoff in the IT literature is well covered and is not explicitly dealt with in this paper. (see Ball, 1997, Svensson,1997). In the numerical exercises that follow, output is assumed to be a subordinate objective to either inflation or the real exchange rate.

a CPI inflation targeting regime with a fear of floating characteristic. The final policy is a flexible real exchange rate targeting based system (RER/IT) where μ_q, is set at 1.0 and μ_c is set at 0.5. In this case the real exchange rate objective can be seen as being more important as the inflation (and output) objective.

The final two policy types are important in the context of examining optimal policies that might be considered 'intermediate' in nature. If the central bank has allocated a weight to q in the loss function, then we can make the claim it represents a fear of floating and the optimal rules that can be derived from the optimisation problem can be seen as fear of floating rules.

Following Svensson (2000) and Leitemo and Söderström (2001), there is some weight (0.01) given to the change in the nominal interest rate in the loss function. This is a reflection of some preference by central banks for interest rate smoothing and to prevent instrument instability.

Each of the above policy types will be examined for four model specifications. The first is the baseline specification. The baseline parameters to the model are taken from selected papers in the inflation targeting literature – namely Svensson (2000), Leitemo and Söderström (2001) and Bharucha and Kent (1998). There appears to be some consensus about the general value of most of the model parameters and about how they reflect a small, reasonably open industrial economy. The parameters are given in Table 5.3.

The other scenarios are extensions to the baseline model and are presented in Table 5.4. Each scenario represents a justification for fear of floating that has been highlighted in the recent literature and discussed in Section 2. The first represents the degree of openness. The baseline value of 0.35 is increased to 0.80 to capture greater openness in terms of domestic consumption of traded goods. The second scenario looks at incomplete, or delayed, pass-through and as captured by $\kappa = 0.5$. The final scenario represents the balance sheet effects brought about by liability dollarisation and is indirect effect through the risk premium as examined by Morón and Winkelried (2003) and CCV (2000 a,b). The scenarios outlined above are quite stylised but are able to capture the basic structural elements that may induce fear of floating behaviour in central banks.

For each policy type and for each model scenario, the model is solved using the dynamic programming methods as explained in Söderlind (1999) and outlined in Appendix 3B[15]. The optimal policy rule coefficients, the unconditional standard deviations of the important variables in the model and the impulse responses of these variables to various shocks in the model are calculated and are detailed in the next section.

5.4. Results

5.4.1. Coefficients to the optimal interest rate rules

The main advantage of specifying the model in an optimal control context is that an instrument of monetary policy can be specified. In this analysis, the nominal interest rate is the instrument and this is in keeping with the recent literature on monetary policy in both an open and closed economy context. The optimal coefficients are presented in Table 5.5.

The coefficients are reported for the predetermined state variables of the model and, as such, the nature of the optimal interest rate rule is highly dependent on the specification of the model. In this model, the real exchange rate and the current expectation of future inflation are forward-looking variables (as in Morón and

[15] This paper adapts Soderlind's MATLAB algorithms for the model solution for optimal policy under discretion. These are found at http://home.tiscalinet.ch/paulsoderlind/. I thank him for making them available.

Winkelried, 2003 and Leitemo and Söderström, 2001) and, thus, do not appear in the optimal rule. This is also the case for CPI inflation – as it is a goal variable. Since the variables such as the real exchange rate and CPI inflation are a linear function of the predetermined state variables, it is possible to draw some conclusions about how the instrument might react to those variables though their relationship with the state variables (see Svensson, 1998)

A number of observations can be made from the coefficients in Table 5.5. The first is, as expected, the reaction to inflation is much stronger for FCIT – irrespective of the model scenario. As the exchange rate weight in the central bank loss function increases, the reaction to domestic inflation weakens. An interesting result involves the negative coefficient values for domestic inflation and output for the flexible CPI inflation targeting (FCIT) rule. This is found in other studies that simulate the effect of CPI IT policies such as Svensson (2000) and it can be conjectured that it reflects the relationship between CPI inflation and the state variables in the model. In other words, in order to stabilise CPI inflation, the nominal interest rate must react to the state variables in the manner depicted in Table 5.5. The interest rate reactions for the CPI based policies in the more open economy scenario are smaller than for the baseline case, which, in turn is lower that the incomplete pass-through case. This reinforces the argument that domestic inflation and output are less important and the real exchange rate (current and lagged) becomes more important in a more open economy.

A second relates to the magnitude of the coefficient value of output in the financial vulnerability case. Note that it is much lower than for the other model scenarios. This is a result also found in Morón and Winkelried (2003) for its parameterisation of a vulnerable economy using flexible CPI IT. The effect applies for most policy types but is most pronounced in the domestic IT policies. Of note, also, is that the optimal IT policies react more strongly to the risk premium under this scenario. This is not a surprising result given that the risk premium has a significant effect on output and hence on domestic and CPI inflation.

5.4.2. Stochastic Properties

Table 5.6 reports the unconditional standard deviations of the four policy choices within each of the four model scenarios. The unconditional standard deviations are calculated by taking the solution to the model as given in Appendix 3B using all of the σ^2 terms. From equation (A2.16), the covariance matrix for x_1 is given by:

$$\Sigma_{x1} = M\,\Sigma_{x1}M' + \Sigma\varepsilon \tag{5.16}$$

From equation (A2.18), the covariance matrix is given by

$$\Sigma_{x2} = C\,\Sigma_{x1}C' \tag{5.17}$$

Σ_{x1} is calculated by iterating on equation (5.16) until it converges.

As expected, the volatility of the real exchange rate is smaller for FCRT and RER/IT than it is for FDIT and FCIT. This would imply that the fear of floating policies, FCRT and RER/IT appear to be successful in reducing real exchange rate volatility – at the expense of some inflation volatility. Perhaps surprisingly, the real exchange rate standard deviation is larger for FCIT than it is for FDIT. This might be due to the policy instrument in the FCIT case reacting to the exchange rate when there may be no need to – thereby inducing a further exchange rate movement. Another interesting result is that, in this model, the fear of floating policies, FCRT and RER/IT, reduce the volatility of the exchange rate quite substantially and with what might appear to be relatively little cost to inflation. This is the case for all model scenarios. The exchange rate standard deviation is around 5-7 for FDIT and FCIT but less than 1 for FCRT and RER/IT.

Interestingly, for the most part, there is little trade-off between non-traded and CPI inflation volatility. With the exception of the financial vulnerability case, CPI inflation and non-traded inflation are both smaller for FCIT than for FDIT. A possible explanation is that CPI inflation reacts twice to a change in the real exchange rate. The first is the exchange rate effect directed through traded prices by equation (5.5) and the second is through non-traded inflation in the following period. But the reductions are not similar in magnitude. Notice that the reduction in CPI inflation is much higher than that of domestic inflation for FCIT. This is not unusual, targeting CPI inflation involves some targeting of non-traded inflation but not necessarily vice versa.

The more open the economy, the larger the decrease in the variation of CPI inflation as the policies become more exchange rate oriented. This is most apparent in the high openness case where the standard deviation of CPI inflation reduced from 4.36 for FDIT to 0.45 for FCIT and 1.45 and 1.60 for FCRT and RER/IT respectively. This is expected as a more open economy implies a greater connection between the exchange rate and CPI inflation and is a possible justification of fear of floating behaviour. The least open model scenario in the group, the delayed pass-through case, had relatively little difference in the variation in CPI inflation between policies. This, too, is expected. Because the exchange rate doesn't affect inflation with the same intensity, those policies with greater real exchange rate intervention are not as suited to this case as they might be to models with greater openness and higher pass-through. As the more open economies are the ones conjectured to have a greater fear of floating, this is suggestive that those policies may be justified under these scenarios.

The financial vulnerability case is distinct due to its effect on output. Output and inflation variability is higher in this case across all policies than the other scenarios. This is due to the perverse effect that contractionary devaluation has on output and inflation in that interest rates and the exchange rate are sending mixed signals. For example, consider a shock that reduces output. The policy response of lowering the nominal interest rate will place upward pressure on output. But it will also depreciate the exchange rate, which, in turn, further lowers output and possibly inflation. Hence, the interest rate response represents a loosening of policy but the exchange rate causes a tightening effect. This occurs for most policy types but the effect is mitigated to some extent for the fear of floating policies, FCRT and RER/IT, by the ability to use the interest rate to react to the exchange rate movement that is initially causing the contractionary devaluation.

5.4.3. Dynamic Properties

In order to assess the first order properties of each policy and model configurations, Figures 5.1-5.4 present some impulse responses of the key variables in the model to some of the exogenous shocks. The responses of inflation, output and the real exchange rate to a demand and risk premium shock respectively are examined. This exercise allows for a comparison based on the degree of exchange rate intervention for each model scenario. Furthermore, how the policy instruments react to specific shocks is more readily observable in the impulse response functions than in the second moment properties.

First, some general observations. The dynamic paths for CPI and domestic inflation are much more closely aligned for the fear of floating policies, FCRT and RER/IT than they are for FDIT and FCIT. This is due to the fact that, because the exchange rate movements are negated by the fear of floating policies, there is less of a difference between non-traded and CPI inflation. This is an interesting result in that it suggests that the implementation of an inflation targeting policy with intervention (as well as a RER/IT policy) reduces the need for central banks to be concerned with domestic inflation.

As one would expect, the difference between CPI and domestic inflation in the baseline and high openness case is more pronounced than for the model with delayed pass-through for the FDIT and FCIT. This occurs because CPI inflation becomes more important in a more open economy. Greater openness increases the ultimate effect of policy on CPI inflation by the interest rate (instrument) effect through the exchange rate and traded inflation. The reverse is the case for the delayed pass-through case.

The impulse responses allow the opportunity to observe the policy response to the various shocks. Consider a positive demand shock under the baseline, openness and delayed pass-though scenarios. For FDIT and FCIT, the policy response is to increase interest rates. This has the effect of reducing output, reducing domestic and CPI inflation to varying degrees depending on the extent of pass-through and openness. It also appreciates the exchange rate, which augments the interest rate as a policy-tightening device. For the FCRT and RER/IT policies, the appreciation incurs its own policy response, a decrease in interest rates. This moves output, inflation and the exchange rate in the opposite direction as the first policy response. The result is that the real exchange rate movement is offset but the original shock to demand and the nominal interest rate will converge more slowly and this is borne out in the FCRT and RER/IT panels of Figure 5.1 to 5.3.

Consider the risk premium shock for the baseline, high openness and delayed pass-through scenarios. Because this shock is transmitted through the exchange rate (a depreciation), there is no immediate policy response for FDIT. The response for the FCIT policy occurs only to the extent that CPI inflation is driven by the exchange rate and, as such, is likely to be stronger in the high openness case and weaker in the delayed pass-through case. For FCIT as well as the FCRT and RER/IT policies, the depreciation brings about an increase in the interest rate more quickly.

Now consider a demand shock for the financial vulnerability scenario. As with the other scenarios, for FDIT and FCIT, the response to the shock is to increase interest rates which results in an output reduction and an appreciation. Due to a net contractionary devaluation situation, the appreciation now causes output to rise, thereby offsetting the output effect of the interest rate increase. For FCRT and RER/IT, the appreciation encourages an interest rate decrease and this has the opposite effect on output as the initial response to the demand shock. This is a dilution of the effect of the policy response to the demand shock and it results in output, inflation and the interest rate to converge more slowly while alleviating significant movements in the exchange rate.

A risk premium shock influences output directly as well as through the exchange rate under this scenario. The decrease in output occurring directly from the risk premium shock is exacerbated by the contractionary effect of the depreciation that resulted from the risk premium shock. As a result the policy response will be mixed in the FDIT and FCIT case. In the fear of floating policies, the interest rate response of the depreciation is to raise interest rates. This has an ambiguous effect on output as output is affected directly by the interest rate move and by the (contractionary) exchange rate effect of the interest rate increase. Unlike the other scenarios discussed above, all policy types are ineffective under financial vulnerability because, in an open economy, the policy rate transmits to output directly and indirectly though the exchange rate and the indirect transmission is affected by contractionary devaluation.

5.5 Conclusion

This chapter has examined a range of policy types for a variety of model configurations with a view to finding out the most suitable policy for each model. The basic framework of an optimal monetary regime where the policy instrument is the interest rate is used to examine the effect of policies that contain, in various degrees, an exchange rate objective. The policies that are examined are flexible domestic inflation targeting (FDIT), flexible CPI inflation targeting (FCIT), a regime that contains FCIT but is accompanied by an exchange rate as a secondary objective (FCRT) and a real exchange rate targeting regime where CPI inflation is a secondary objective (RER/IT). This Chapter, therefore, assesses the suitability of such a system as an organising framework capable of handling the trade-offs inherent in having a multiplicity of objectives where the exchange rate is formally accepted as one of these objectives.

The focus has been to observe the different policies within four scenarios, namely a baseline open economy, one representing high openness, another representing delayed pass-through and the final one capturing contractionary devaluation arising from financial vulnerabilities. These factors are considered present in developing economies and evidence is presented in Section 5.2 of their existence in East Asia.

As expected, there is no clear consensus as to what might be considered the best all round policy but some patterns emerge. For most model scenarios, CPI inflation targeting policy is preferred to domestic inflation targeting. Most of the models presented, even the baseline, can be categorised as an open economy that is influenced by conditions in the rest of the world. As a result, the exchange rate variation that impacts the CPI takes on some importance. The cost of addressing domestic inflation at the expense of other objectives seems to be too high for all model types. This certainly contrasts with many contributions to the literature.

For those scenarios that relate to the fear of floating phenomenon there is quite significant support for fear of floating policy types (that is those whose loss function contains a non-zero weight for q, FCRT and RER/IT). It is this result that is most significant in the context of this Chapter. It implies that for those economies where openness, high pass-through and balance sheet effects are an issue, central bank concerns about currency movements are justified in that the volatility of the exchange rate is much smaller for those policies than for FDIT or FCIT. An additional feature of the fear of floating policies is that, under all model scenarios, the control of exchange rate movements occurs with relatively little cost to inflation. The nature of the trade offs are often dependent on the source of the shock to the model. This confirms much of the recent work in this topic. The inclusion of the exchange rate in the loss function will induce an overreaction (relative to what is needed for inflation) in the policy instrument for a risk premium shock and an under-reaction in the case of a domestic shock. Such different exchange rate reactions for a similar policy rule may well justify the case for a discretionary kind of policy that accounts for the nature of shocks. This may lead to possible credibility problems, an area of very real concern that is not dealt with in this Chapter but a topic for future research.

Table 5.1
Openness, exchange rate pass-through and financial vulnerability: East Asia vs industrial economies

	Openness		Pass-through		Financial vulnerability	
	Debelle (2001)[1]	Ho and McCauley (2003)[2]	Choudri and Hakura (2001)[3]	Hausmann et al (2000)[4]	Ho and McCauley (2003)[5]	Ho and McCauley (2003)[6]
Indonesia	70%	66%	0.41	0.92	0.26	2.67
Korea	87%	69%	0.10	0.59	0.00	5.53
Malaysia	232%	-	-	-	-	-
Singapore	341%	-	-	-	-	-
Thailand	124%	98%	0.12	0.19	12.51	7.68
Philippines		89%	0.33	1.16	0.35	4.82
Australia	45%	34%	0.10	0.48	12.26	49.27
Canada	87%	70%	0.11	0.19	13.13	26.68
UK	56%	42%	0.02	0.06	40.43	13.38
USA	26%	19%	0.02	0.34	84.22	86.57

[1] Source: Debelle (2001). Measured as (exports +imports)/nominal GDP for 2000
[2] Source Ho and McCauley (2003) measured as (exports+imports)/GDP and the average is taken for the period 1998-2001
[3] Source Choudri and Hakura (2001) but taken from Ho and McCauley (2003). Taken as the regression coefficient of ΔlogCPI on Δlog effective exchange rate.
[4] Source Hausmann et al (2000) but taken from Ho and McCauley (2003). Estimate from error correction model. Takes log CPI on log US exchange rate + log commodity price index for UK and non-European countries. For the rest, log CPI on log DM exchange rate + log German CPI.
[5] Taken from Ho and McCauley (2003) but based on the ABILITY 1 measure from Hausmann et al (2000). Measured as the ratio of the stock of debt issued by country X in currency X and the stock of debt issued by Country X in all currencies.
[6] Taken from Ho and McCauley (2003). Measured as the ratio of bank loans from country X in currency X and bank loans from Country X in all currencies.

Table 5.2
Loss Function Coefficients

	μ_π^N	μ_π^c	μ_y	μ_i	$\mu_{\Delta i}$	μ_q
FDIT	1	0	0.5	0	0.01	0
FCIT	0	1	0	0	0.01	0
FCRT	0	1	0.5	0	0.01	0.5
RER/IT	0	0	0	0	0.01	1.0

Table 5.3
Model Parameters, Baseline

Parameters	Values	Description
β_1	0.60	Degree of persistence in output gap
β_2	0.10	Effect of real interest rate on output gap
β_3	0.05	Real exchange rate effect on output gap
β_4	0.00	Financial vulnerability
β_5	0.10	Effect of foreign output on domestic output
α_1	0.50	Backward looking(ness) of domestic inflation
α_2	0.05	Output effect on domestic inflation
α_3	0.01	Effect of real exchange rate on domestic inflation
$\square_{v}$	0.80	Persistence of risk premium
$\square_{y}$	0.80	Persistence of foreign output
$\square_{\pi}$	0.80	Persistence of foreign inflation
g_{π}	1.50	Foreign Taylor rule coefficient
g_{y}	0.50	Foreign Taylor rule coefficient
$\sigma^2_{\varepsilon y}$	1.00	Variance of demand shock
$\sigma^2_{\varepsilon \pi}$	1.00	Variance of inflation shock
$\sigma^2_{\eta v}$	1.00	Variance of risk premium shock
$\sigma^2_{\eta y}$	1.00	Variance of foreign demand shock
$\sigma^2_{\eta \pi}$	1.00	Variance of foreign inflation shock
$\sigma^2_{\eta i}$	1.00	Variance of foreign interest rate shock
δ	0.99	Discount rate for loss function

Table 5.4
Extensions to Baseline Model

Variable	Decription	Baseline Value	Range
λ	Proportion of traded good in Consumpion	0.35	0.80
κ	Degree of exchange rate pass-through (Leitemo and Soderstrom 2001)	1.00	0.50
β_4, γ_q	Balance sheet effect – Risk Premium (Morón and Winkelried, 2003), (CCV's)	0.00, 0.00	-0.15, 0.15

Table 5.5
Coefficients to the Optimal Rule

Baseline

Policy	π^N_t	y_t	υ_t	i^*_t	π^*_t	y^*_t	i_{t-1}	π^T	q_{t-1}
FDIT	0.85	1.51	0.37	-	0.26	0.29	0.39	-	-
FCIT	-0.65	-0.23	1.3	1.02	-0.75	-0.05	-	-	-0.16
FCRT	0.84	0.09	0.96	0.96	-0.77	0.02	0.01	-	-0.14
RER/IT	0.85	0.10	0.96	0.96	-0.77	0.03	0.01		-0.05

Higher Openness

Policy	π^N_t	y_t	υ_t	I^*_t	π^*_t	y^*_t	i_{t-1}	π^T	q_{t-1}
FDIT	0.85	1.51	0.37	-	0.26	0.29	0.39	-	-
FCIT	-0.11	-0.05	1.03	1.01	-0.79	-0.01	-	-	-0.04
FCRT	0.76	0.07	0.97	0.98	-0.79	0.02	-	-	-0.23
RER/IT	0.84	0.09	0.96	0.97	-0.79	0.02	0.00		-0.16

Incomplete Pass-through

Policy	π^N_t	y_t	υ_t	i^*_t	π^*_t	y^*_t	i_{t-1}	π^T	q_{t-1}
FDIT	0.85	1.51	0.37	-	0.26	0.29	0.39	-	-
FCIT	0.35	0.08	0.97	0.71	-0.39	0.05	0.10	0.18	-0.18
FCRT	0.83	0.11	0.95	0.93	-0.74	0.03	0.02	0.02	-0.02
RER/IT	0.85	0.11	0.95	0.95	-0.76	0.03	0.01	0.01	-0.01

Financial Vulerability

Policy	π^N_t	y_t	υ_t	i^*_t	π^*_t	y^*_t	i_{t-1}	π^T	q_{t-1}
FDIT	1.22	0.33	1.14	0.23	0.27	0.14	0.30	-	-
FCIT	-0.56	-0.14	1.12	1.01	-0.78	-0.02	-	-	-0.18
FCRT	0.81	0.07	0.93	0.96	-0.76	0.02	0.01	-	-0.13
RER/IT	0.85	0.09	0.92	0.96	-0.77	0.02	0.01		-0.05

Table 5.6,
Unconditional Standard Deviations

5a.Baseline Model

Policy	π^N	π^c	y	q	i
FDIT	1.61	2.17	1.09	5.54	2.97
FCIT	1.29	1.15	1.54	7.63	3.29
FCRT	1.95	1.44	1.33	0.40	3.07
RER/IT	2.03	1.49	1.33	0.12	3.10

5b. Higher Openness

Policy	π^N	π^c	y	q	i
FDIT	1.61	4.36	1.09	5.54	2.97
FCIT	1.55	0.45	1.49	6.02	2.84
FCRT	1.88	1.48	1.34	0.66	3.04
RER/IT	2.01	1.65	1.34	0.17	3.10

5c. Incomplete pass-through

Policy	π^N	π^c	y	q	i
FDIT	1.61	1.44	1.09	5.54	2.97
FCIT	1.24	1.06	1.40	6.84	2.74
FCRT	1.96	1.42	1.33	0.39	3.04
RER/IT	2.03	1.40	1.33	0.13	3.09

5d. Financial Vulnerability

Policy	π^N	π^c	y	q	i
FDIT	1.16	1.51	1.63	3.83	3.14
FCIT	1.22	1.11	2.09	6.38	4.21
FCRT	2.01	1.48	1.52	0.55	2.87
RER/IT	2.18	1.60	1.66	0.15	3.00

Figure 5.1
Impulse Responses, Baseline Model

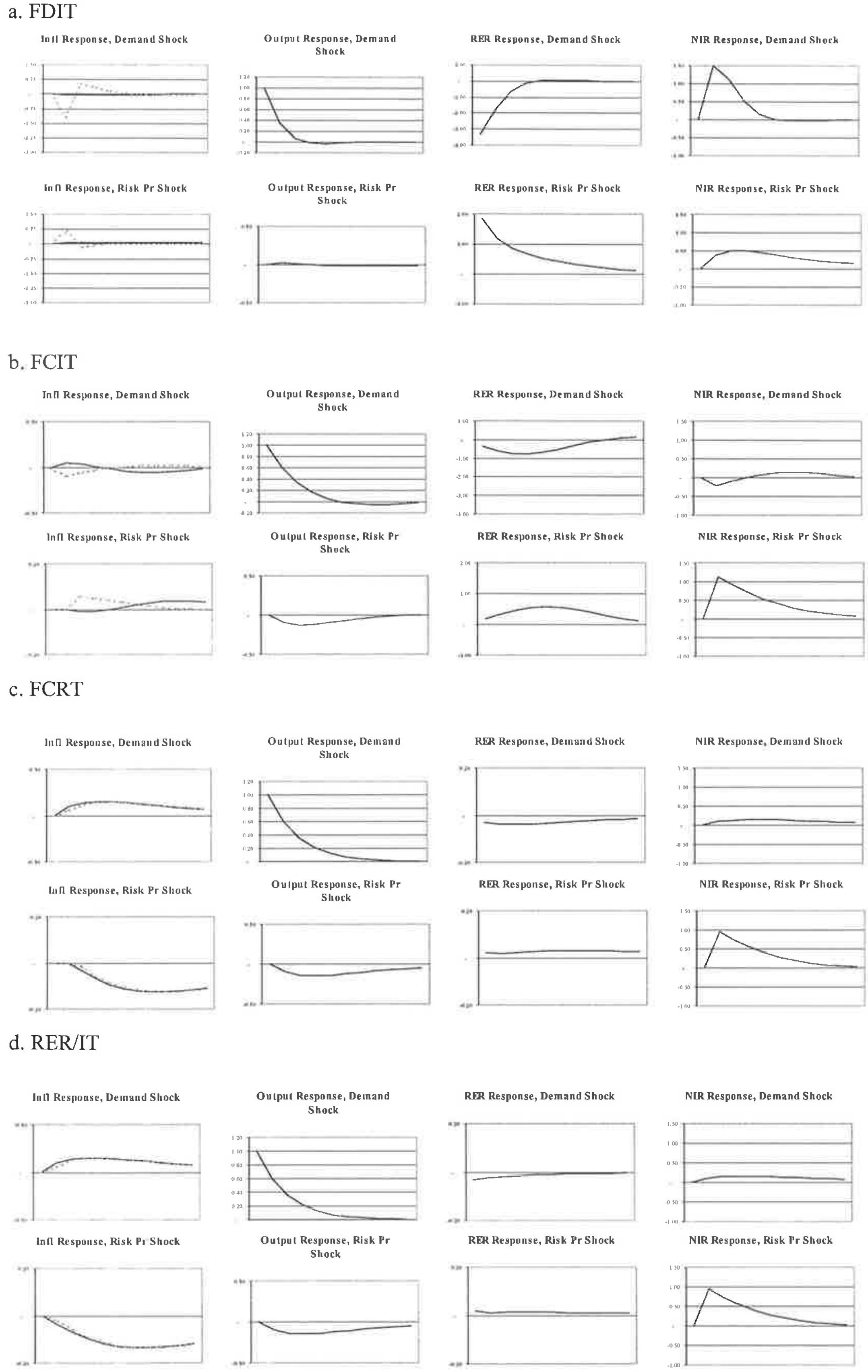
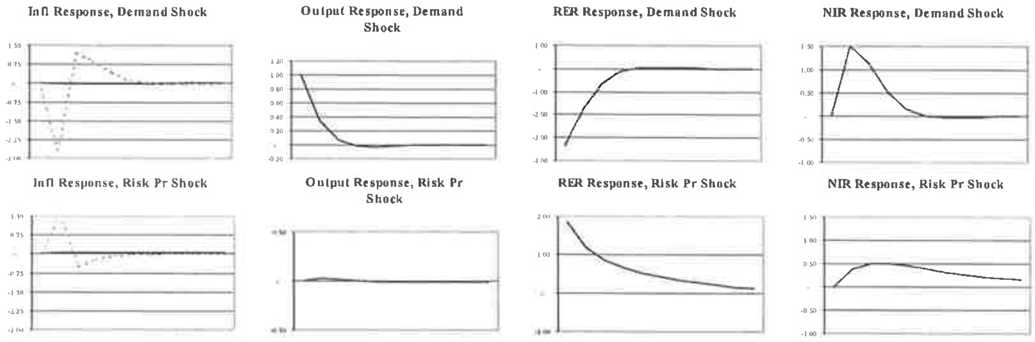
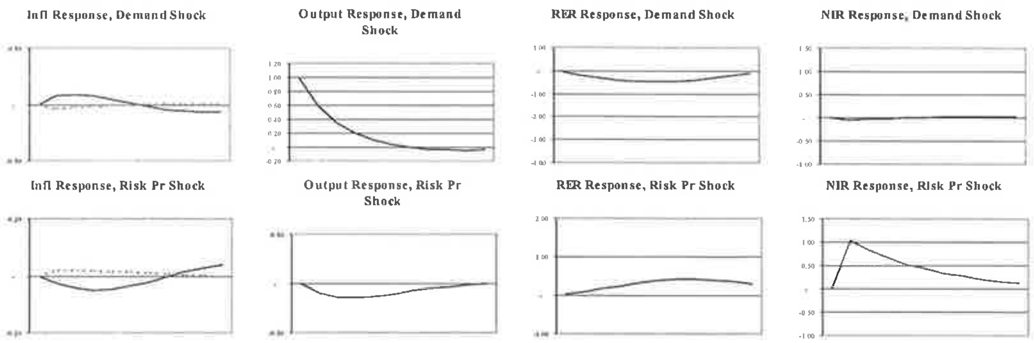


Figure 5.2
Impulse Responses, High Openness

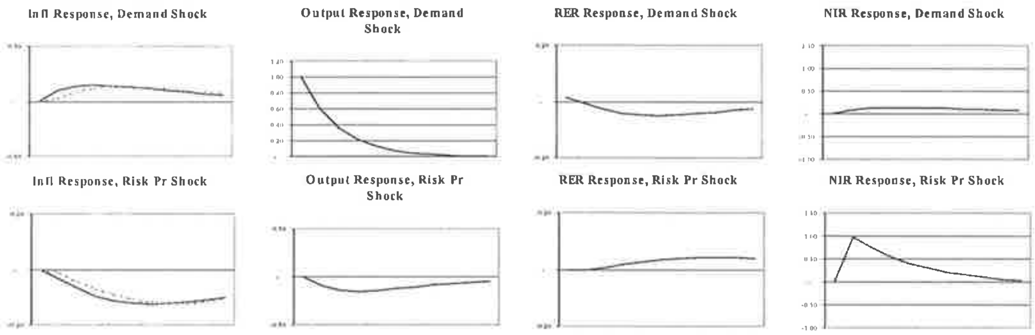
a. FDIT



b. FCIT



c. FCRT



d. RER/IT

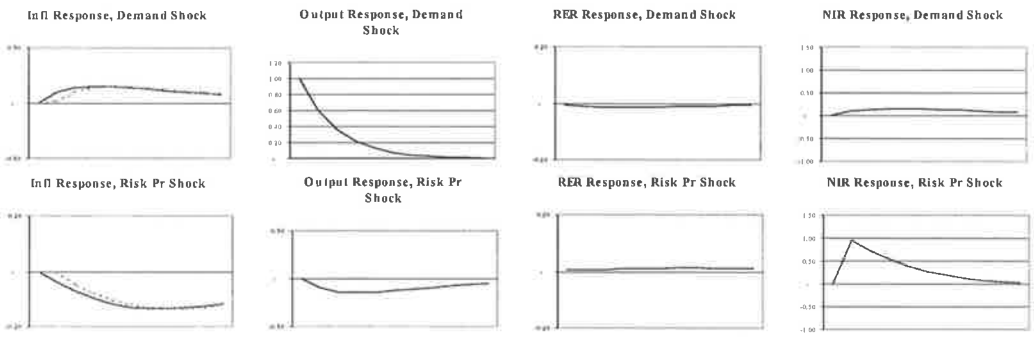
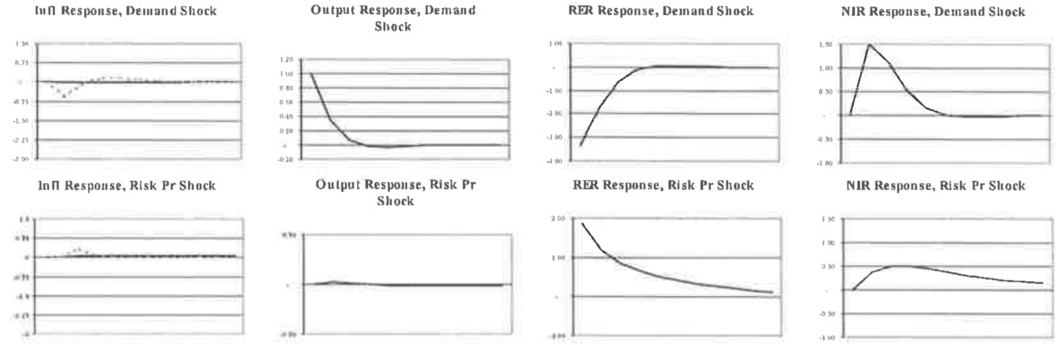
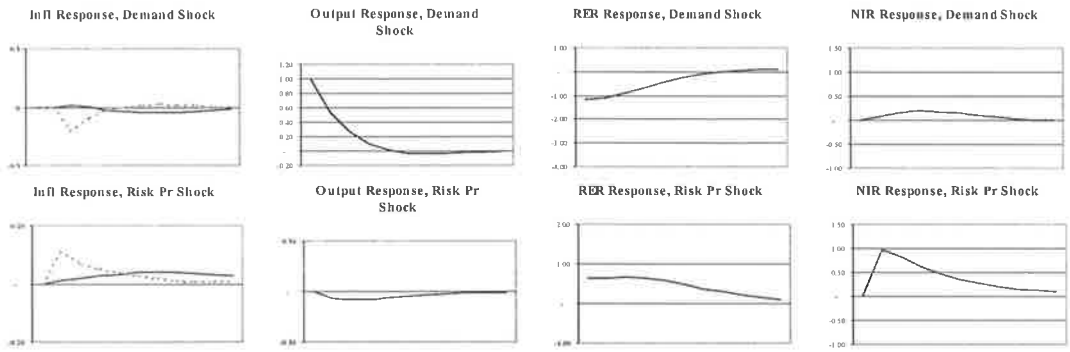


Figure 5.3
Impulse Responses, Delayed Pass-Through

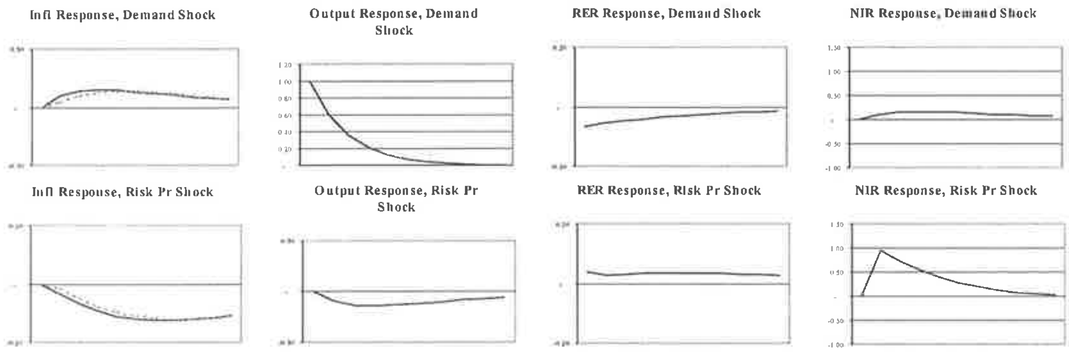
a. FDIT



b. FCIT



c. FCRT



d. RER/IT

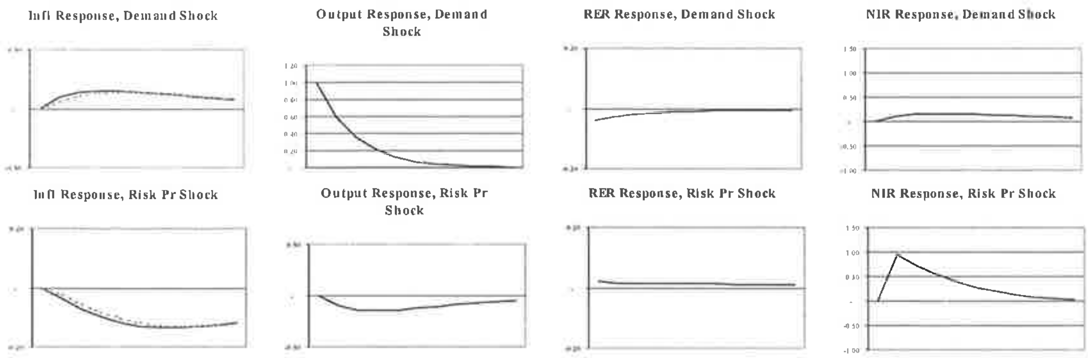
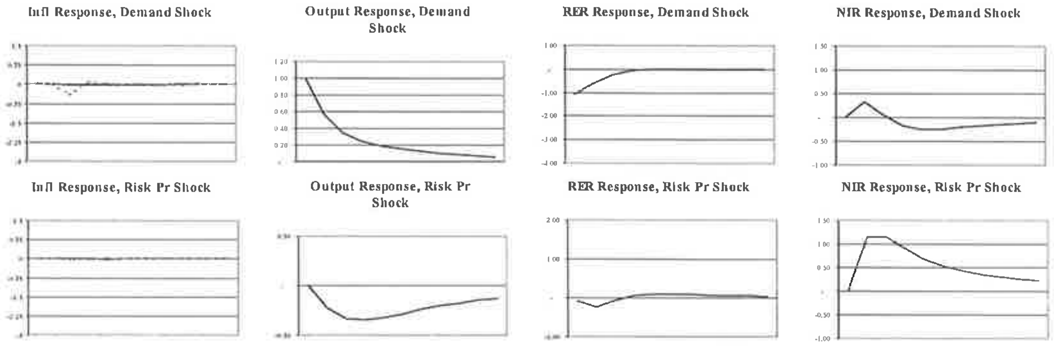
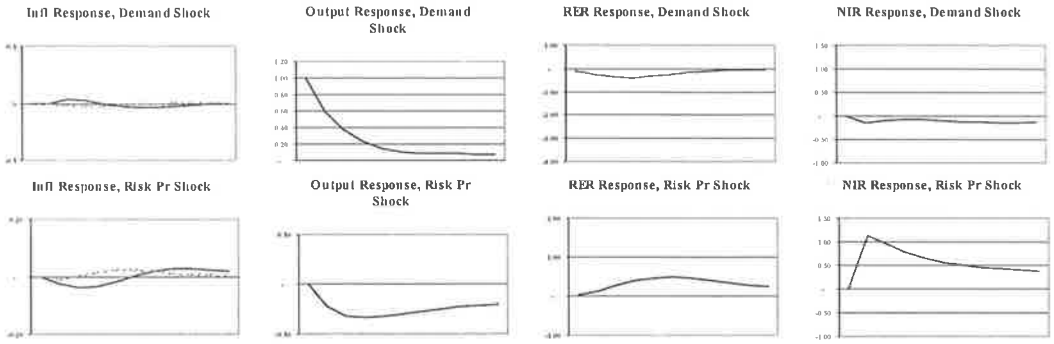


Figure 5.4
Impulse Responses, Delayed Pass-Through

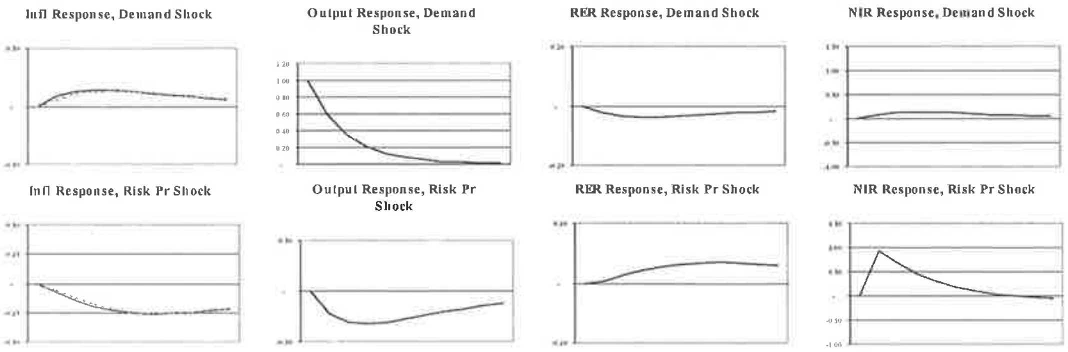
a. FDIT



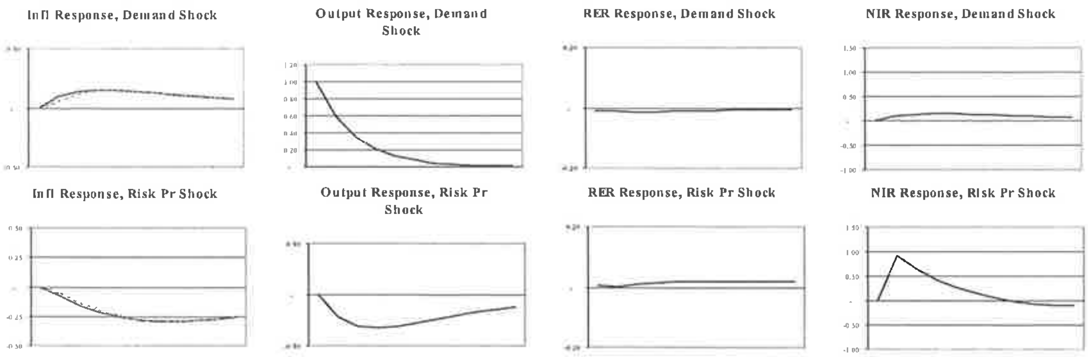
b. FCIT



c. FCRT



d. RER/IT



6
Conclusions, Policy Implications and Scope for Future Research

The crisis in East Asia represented something of a catalyst for the central banks of Korea, Thailand, Indonesia Malaysia and the Philippines to revise their monetary and exchange rate policy regimes. The prevalent policy prescription at the time was that posited by the bipolar view. This suggested central banks adopt rigidly fixed exchange rate regimes or fully flexible arrangements in replacement of the soft pegs that were used before the crisis. The economies mentioned above all complied to the bipolar view in the immediate aftermath of the crisis; Malaysia implemented a rigidly fixed regime protected by capital and exchange controls and Korea, Thailand Indonesia and the Philippines adopted inflation targeting type arrangements that, in principal at least, are accompanied by greater exchange rate flexibility.

This dissertation has examined the effectiveness of various manifestations of monetary policy before and after the crisis. Chapter 2 focuses on how the exchange rate regime changed after the crisis. The primary conclusions from this chapter are that exchange rates are indeed more flexible post-crisis (except Malaysia) but the level of flexibility is not as high as a sample of industrial economies known to be floaters. Furthermore, there is evidence of a reversion to a US dollar peg and, in some cases, a Japanese yen peg. Given the implementation of inflation targeting systems in the region, this would, at first glance, appear inconsistent with the normative idea of inflation targets and floating exchange rates. How does an inflation targeting country maintain an exchange rate objective? This issue is dealt with in Chapters 4 and 5.

Chapter 3 has examined a facet of monetary policy pre-crisis, namely the sterilisation of the reserve effects of capital inflows in the face of a heavily managed exchange rate. The interest rate model assessed how effective sterilisation is where there is moderate to high capital mobility. The implication of such a relationship is that, if sterilisation is successful at neutralising the monetary effect of a reserve inflow, then it is likely to negate the downward pressure on the interest rate that is brought about by the inflow of capital. As such, this pressure on interest rates may further induce capital inflow, therefore underpinning a further need for sterilisation. The results indicate that there is some evidence of a relationship between the extent of sterilisation and the domestic interest rate. These results are stronger when a lag structure is built into the model.

While the model is empirically tested using pre-crisis data, there is nothing to preclude the use of a sample that includes the crisis and post crisis periods. In fact, this is a possible area for future research. A crisis and post-crisis study might be useful in investigating the possible sterilisation of capital *outflows*. If effective, this may place downward pressure on interest rates, which potentially promotes further outflow of capital (Rajan 2004). The model presented in Chapter 3 can also be employed to assess the effectiveness of sterilisation on the interest differential in an attempt to find further explanations for the interest premium puzzle. A further possibility for future research relates to the risk premium. In the model, the capital mobility coefficient is assumed to capture factors pertaining to imperfect asset substitution. Future development of this model may involve separating the effects of capital (im)mobility and imperfect asset substitution.

The post-crisis time period is dominated by the implementation of inflation targeting systems in the region, particularly in Korea, Thailand, Indonesia and the Philippines. Chapter 4 addresses this issue. Using a simple macro model with parameters calibrated to Thailand, the chapter assesses a range of optimally derived and simple monetary policy rules in keeping with extensive recent literature on inflation targeting. The calibration to Thailand is a key feature of the model in that it allows the policy rules to be evaluated in a framework that corresponds to East Asian conditions. Much of the recent work in this area focuses on industrial economies. A constraint to this work is that too few models are *estimated* rather than *calibrated*. This is especially a problem at this time as there is insufficient post-crisis macro data in East Asia to estimate a suitable empirical model.[1] This explains the reliance on a calibrated model. Future research in this area will involve specifying an estimated model in the style of Beechey et al (2000), Debelle and Wilkinson (2002) and Collins and Siklos (forthcoming). This model can be applied to the inflation targeting economies in the region for the purposes of conducting cross country policy simulations and analysis.[2]

One of the main results of this Chapter is that those policy rules that react to the exchange rate do not appear to be any better than the simple inflation targeting and Taylor type rules. This has implications for the issue of fear of floating in that it

[1] That said, the simple OLS results seem quite robust despite including the crisis period in the sample. See Chapter 4.
[2] It is clear that model parameterisation is crucial to the performance of particular policy rules. This is evident in Chapters 4 and 5 where the inclusion of the exchange rate in the construction of policy improves the dynamic and stochastic properties in the models in chapter 5 but not in the model in chapter 4. Recall that the model in Chapter 4 is calibrated to Thailand.

possibly suggests that inflation targeting regimes work better, at least under this particular parameterisation of the model, if not distracted by an exchange rate objective. Furthermore, the model highlights the existence of contractionary devaluation. This inhibits the successful employment of inflation targeting by weakening the effect of the interest rate through the exchange rate channel.

The issue of contractionary devaluation is investigated in Chapter 5. Contractionary devaluation (or depreciation) is said to be caused by liability dollarisation and is one of a number of possible reasons why central banks exhibit a fear of floating. The other reasons presented in Chapter 5 are high openness and high exchange rate pass-through. Each of the fear of floating scenarios is present in East Asia relative to industrial economies. Chapter 5 presents a model the captures the salient characteristics of the scenarios and assesses the effectiveness of different styles of optimal monetary policy on each one. The policies differ by the degree of exchange rate intervention. Those with no intervention are floating exchange rate policies (mainly inflation targeting type policies); those with some reaction to the exchange rate are regarded as fear of floating policies.

There is quite significant support for fear of floating polices in respect to the fear of floating scenarios. This implies that there is some justification for central banks possessing a fear of floating. The results seem to indicate that, as with existing work in this area and also from Chapter 4, the appropriate policy action depends on the nature of the shock the model. That not withstanding, two significant (and related) results emerge. The first is that a purely inflation-oriented policy incurs very high costs in terms of output and exchange rate volatility. The second is that the fear of floating policies can reduce the variability in the exchange rate at a relatively low cost to inflation and output variability. This is a further justification for fear of floating.

A number of possibilities for future research emerge from Chapter 5. The first is that the fear of floating scenarios – especially financial vulnerability – are quite stylized in the model. A plausible next step is to specify financial vulnerabilities more tightly using the micro foundations found in Cespedes, Chang and Velasco (2000a,b) and Devereaux and Lane (2003). Another area for future research is the closer examination of optimal policy rules. The policies presented in this chapter are based on standard inflation targeting policies and the fear of floating policies are essentially extensions of that policy where the weights in the central bank loss function are altered to reflect an exchange rate objective. This appears plausible as a sensitivity exercise but requires greater theoretical underpinnings. A final suggestion for future research is to empirically examine the relationship between exchange rate regimes and the fear of floating scenarios.

In sum, several themes are present in the issues considered in this dissertation. Consider the following two: Firstly, the bipolar view of exchange rate regimes is not being adhered to when observing the *de facto* arrangements. As has been indicated in Frankel (1999), Fischer (2001), Chang and Velasco (2000) and Edwards (2002), the bipolar view should be revised to consider exchange rate arrangements that sit in a continuum between rigidly fixed and fully flexible systems. The post-crisis policies in East Asia seem to occupy positions in the continuum that can be considered intermediate regimes. This is due to the general reluctance of central banks to allow the currency to float.

A second theme relates to the possibility of finding an organising framework that systematically analyses the effectiveness of intermediate regimes. Some initial attempts have been made by Parrado (2004), Cespedes, Chang and Velasco (2000a,b) and Chapter 5 of this dissertation. The loss function would appear to be a very obvious way to capture central bank preferences and any analysis should probably begin with its specification. The current practice of allocating weights to the loss function and using the weights as an indication of the relative importance of one variable against another, while quite instructive, can also be regarded as a little simplistic in that it offers no guidelines into how a central bank manages the objective strategically. The first order conditions of a loss-minimisation problem, resulting in a policy rule, essentially have the same problem. It provides information about the current behaviour of a central bank, but not about how it plans to manage the inherent trade-offs among a multiplicity of objectives. The eventual result of this line of research might possibly be a contribution to a theory of managed floating.

Appendices

Appendix 1: Appendix to Chapter 2

1A. Augmented Dickey-Fuller (ADF) Tests for Money Market Rates

Country	ADF Test Statistic	1% CV	5% CV	10% CV	Notes
Korea	-3.22	-4.06	-3.46	-3.16	Intercept, trend, no lagged differences
Thailand	-3.60	-3.51	-2.89	-2.58	Intercept, no trend, no lagged differences
Indonesia	-2.96	-3.51	-2.89	-2.58	Intercept, no trend, no lagged differences
Malaysia	-1.72	-3.51	-2.89	-2.58	Intercept, no trend, 1 lagged difference
Philippines	-7.92	-4.06	-3.46	-3.16	Intercept, trend, no lagged differences

1B. ADF Test for Residuals of Interest Rate Regression (2.12) for Malaysia and Korea

Country	ADF Test Statistic	1% CV	5% CV	10% CV	Notes
Korea (OLS)	-8.43	-2.58	-1.94	-1.62	No intercept, no trend, no lagged differences
Korea (TSLS)	-8.33	-2.58	-1.94	-1.62	No intercept, no trend, no lagged differences
Malaysia (OLS)	-7.99	-2.58	-1.94	-1.62	Intercept, no trend, 2 lagged differences
Malaysia (TSLS)	-8.42	-2.58	-1.94	-1.62	Intercept, no trend, 1 lagged difference

Appendix 2: Appendix to Chapter 4

2A. Model Solution for unique Rational Expectations equilibrium in a linear, dynamic, stochastic macroeconomic model.

The following is a summary of the solution method. Söderlind (1999) and Söderström (2003) shows that the RE solution under commitment is given by the following central bank problem:

The central bank's problem is:

$$\min E_0 \sum_{t=0}^{\infty} \beta^t L_t \tag{A2.1a}$$

Subject to

$$x_{t+1} = Ax_t + Bi_t + \xi_{t+1}. \tag{A2.1b}$$

The Lagrangian is as follows:

$$\Omega_0 = E_0 \sum_{t=0}^{\infty} \beta^t [X_t'QX_t + 2X_t'Ui_t + i_t'Ri_t + 2\rho_{t+1}(AX_tBi_t + \xi_{t+1} - X_{t+1})] \tag{A2.2}$$

The FOCs with respect to X_t, i_t and ρ_{t+1} are:

$$\begin{aligned} &\beta QX_t + \beta Ui_t + A'\rho_{t+1|t} - \rho_t = 0 \\ &U'X_t + Ri_t + B'\rho_{t+1|t} = 0 \\ &AX_t + Bi_t + \xi_{t+1} - X_{t+1} = 0 \end{aligned} \tag{A2.3}$$

These FOCs in matrix form represent three sets of equations, one each for X_{t+1}, i_{t+1} and $\rho_{t+1|t}$. These are then partitioned as follows:

$$\begin{bmatrix} I & 0 & 0 \\ 0 & 0 & \beta A' \\ 0 & 0 & -B' \end{bmatrix}\begin{bmatrix} x_{t+1} \\ i_{t+1} \\ \rho_{t+1|t} \end{bmatrix} = \begin{bmatrix} A & B & 0 \\ -\beta Q & -\beta U & I \\ U' & R & 0 \end{bmatrix}\begin{bmatrix} x_t \\ i_t \\ \rho_t \end{bmatrix} + \begin{bmatrix} \xi_{t+1} \\ 0 \\ 0 \end{bmatrix} \qquad \text{(A2.4)}$$

where x_t, i_t and ρ_t are the state variables and forward looking variables, the control variable and their corresponding multipliers respectively. After taking expectations, the model can be expressed as follows:

$$GE_t\begin{bmatrix} k_{t+1} \\ \lambda_{t+1} \end{bmatrix} = D\begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} \qquad \text{(A2.5)}$$

where G is the 3x3 matrix on the left hand side of (A2.4) and D is the 3x3 matrix on the right hand side and:

$$k_t = \begin{bmatrix} x_{1t} \\ \rho_{2t} \end{bmatrix}, \lambda_t = \begin{bmatrix} x_{2t} \\ i_t \\ \rho_{1t} \end{bmatrix}$$

The model is solved for a unique rational expectations (RE) solution using the Schur matrix decomposition (see Klein, 2000, for more details).

The decomposition for (A2.5) is;

$$G = QSZ^H \tag{A2.6a}$$

$$D = QTZ^H \tag{A2.6b}$$

where Q and Z are unitary matrices, S and T are upper triangular matricies, Z^H is the transpose of the complex conjugate of Z, and, as this is a *generalized* Schur decomposition, the eigenvalues of G and D are given by t_{ii}/s_{ii}.

To find the stable RE solution, the rows in Q, S, T and Z are reordered so that the n_θ stable roots are first and the unstable n_δ roots are last.

The system is rearranged to categorise the stable and unstable roots as follows:

$$\begin{bmatrix} \theta_t \\ \delta_t \end{bmatrix} = Z^H \begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} \tag{A2.7}$$

$$\begin{aligned}
SE_t\begin{bmatrix} \theta_{t+1} \\ \delta_{t+1} \end{bmatrix} &= SZ^H E_t\begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} \\
&= Q^H GE_t\begin{bmatrix} k_{t+1} \\ \lambda_{t+1} \end{bmatrix} && \text{Using } S=Q^HGZ \text{ and } Z^HZ=1 \\
&= Q^H D\begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} && \text{Using (A2.5)} \\
&= TZ^H\begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} && \text{Using } D=QTZ^H \text{ and } Q^HQ=1 \\
&= T\begin{bmatrix} \theta_t \\ \delta_t \end{bmatrix} && \text{(A2.8)}
\end{aligned}$$

To obtain the stable and unstable eigenvalues, partition according to θ_t and δ_t.

$$\begin{bmatrix} S_{\theta\theta} & S\theta\delta \\ 0 & S\delta\delta \end{bmatrix} E_t \begin{bmatrix} \theta_{t+1} \\ \delta_{t+1} \end{bmatrix} = \begin{bmatrix} T_{\theta\theta} & T_{\theta\delta} \\ 0 & T_{\delta\delta} \end{bmatrix} \begin{bmatrix} \theta_t \\ \delta_t \end{bmatrix} \qquad \text{(A2.9)}$$

To get a stable solution, $\delta_t = 0$. Hence, $E_t\theta_{t+1} = S_{\theta\theta}^{-1}T_{\theta\theta}\theta_t$ (A2.10)

Using (A2.7) and partitioning Z according to k and λ, and θ and δ,

$$\begin{aligned} \begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} &= \begin{bmatrix} Z_{k\theta} & Z_{k\delta} \\ Z_{\lambda\theta} & Z_{\lambda\delta} \end{bmatrix} \begin{bmatrix} \theta_t \\ \delta_t \end{bmatrix} \\ &= \begin{bmatrix} Z_{k\theta} \\ Z_{\lambda\theta} \end{bmatrix} \theta_t \end{aligned} \qquad \text{(A2.11)}$$

$$\text{then } \theta_0 = Z_{k\theta}^{-1}k_0 = Z_{k\theta}^{-1}\begin{bmatrix} x_{10} \\ 0 \end{bmatrix} \qquad \text{(A2.12)}$$

From equation (A2.1b), we know that $x_{1t+1} - x_{1t+1|t} = \xi_{t+1}$ and we also know from Bachus and Drifill 91986) that $\rho_{2t+1} - E_t\rho_{2t+1} = 0$. Using, (A2.11):

$$\begin{bmatrix} \xi_{t+1} \\ 0 \end{bmatrix} = k_{t+1} - E_t k_{t+1} = Z_{k\theta}(\theta_{t+1} - E_t\theta_{t+1}) \qquad \text{(A2.13)}$$

Use (A2.10) to yield:

$$\theta_{t+1} = E_t\theta_t + Z_{k\theta}^{-1}\begin{bmatrix} \xi_{t+1} \\ 0 \end{bmatrix} = S_{\theta\theta}^{-1}T_{\theta\theta}\theta_t + Z_{k\theta}^{-1}\begin{bmatrix} \xi_{t+1} \\ 0 \end{bmatrix} \qquad \text{(A2.14)}$$

Using (A2.11) to get

$$
\begin{aligned}
k_{t+1} &= Z_{k\theta}\theta_{t+1} \\
&= Z_{k\theta}S_{\theta\theta}^{-1}T_{\theta\theta}\theta_t + \begin{bmatrix} \xi_{t+1} \\ 0 \end{bmatrix} \\
&= Z_{k\theta}S_{\theta\theta}^{-1}T_{\theta\theta}Z_{k\theta}^{-1}k_t + \begin{bmatrix} \xi_{t+1} \\ 0 \end{bmatrix} && \text{Using (A2.12)} \\
&= Mk_t + \begin{bmatrix} \xi_{t+1} \\ 0 \end{bmatrix} && \text{(A2.15)}
\end{aligned}
$$

$$
\begin{aligned}
\lambda_t &= Z_{\lambda\theta}\theta_t = Z_{\lambda\theta}Z_{k\theta}^{-1}k_t && \text{(A2.16)} \\
&= Ck_t
\end{aligned}
$$

The solution takes the following form;

$$
\begin{bmatrix} x_{1t+1} \\ \rho_{2t+1} \end{bmatrix} = M\begin{bmatrix} x_{1t} \\ \rho_{2t} \end{bmatrix} + \begin{bmatrix} \xi_{t+1} \\ 0 \end{bmatrix} \qquad \text{(A2.17)}
$$

and

$$
\begin{bmatrix} x_{2t} \\ i_t \\ \rho_{1t} \end{bmatrix} = C\begin{bmatrix} x_{1t} \\ \rho_{2t} \end{bmatrix} \qquad \text{(A2.18)}
$$

The optimal rule is given by $i_t = -F_{opt}\begin{bmatrix} x_{1t} \\ \rho_{2t} \end{bmatrix}$ and $-F_{opt}$ is the sub-matrix given by rows ($n_2+1:n_2+n_i$) of the matrix C.

The model under a simple fixed MPR is given by:

$$
i_t = - FX_t \qquad \text{(A2.19)}
$$

where the element in $F_{(1xn)}$ are exogenously determined. Hence, the model in equation (12) becomes:

$$X_{t+1} = (A\text{-}BF)X_t + \xi_{t+1} \tag{A2.20}$$

The unique rational expectations solution to this model is found using the Schur method as in the commitment case above.

Given the elements to this rule, the dynamics of the economy are:

$$x_{1t+1} = Mx_{1t} + \varepsilon_{t+1} \tag{A2.21}$$

$$x_{2t} \quad = Nx_{1t} \tag{A2.22}$$

where the value of the loss function, J_o, is given in Söderlind (1999).

Appendix 3: Appendix to Chapter 5

3A. State Space Representation of Model in Chapter 5

The state space system in given by equation (5.13)-(5.15) where:

$$A = \begin{bmatrix} e_{11} \\ \beta_1 e_2 + \beta_3 A_{10} - \beta_4 A_3 + \beta_5 A_5 + \beta_2 e_{11} \\ \theta_v e_3 + \gamma_q e_{10} \\ g_\pi \theta_\pi e_5 + g_y \theta_y e_6 \\ \theta_\pi e_5 \\ \theta_y e_6 \\ e_0 \\ \kappa_1 (e_1 - e_9 + e_{10}) + e_8 (1 - \kappa_1) \\ e_{10} \\ A_5 + e_{10} - e_{11} - e_4 - e_3 \\ A_{11} \end{bmatrix}$$

$A_{11} = (1/1-\alpha_1)[e_{11} - \alpha_1 e_1 - \alpha_2 A_2 - \alpha_3 A_{10}]$

$B=[0\ \beta_3\text{-}\beta_2\ 0\ 0\ 0\ 0\ 1\ \ 0\ 0\ 1\ -(1/1-\alpha_1)[\alpha_2(\beta_2\text{-}\beta_3)+\alpha_3]'$

$$Cx = \begin{bmatrix} e_1 \\ e_2 \\ \lambda A_8 \\ e_0 \\ -e_7 \\ e_{10} \end{bmatrix}, \quad Ci = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 0 \end{bmatrix}$$

and K is a (6x6) matrix with the diagonal, $[\mu_{\pi N}, \mu_y, \mu_{\pi C}, \mu_i, \mu_{\Delta i}, \mu_q]$

Appendix to Chapter 4 and 5

3B. Solution for Optimal Policy Under Discretion

Söderlind (1999) and Söderström (2002) shows that the RE solution is given by the following central bank problem:

The central bank's problem is:

$$\min E_0 \sum_{t=0}^{\infty} \beta^t L_t \tag{A3.1a}$$

Subject to:

$$x_{t+1} = Ax_t + Bi_t + \xi_{t+1}. \tag{A3.1b}$$

Optimal policy under discretion essentially involves period-by-period optimisation by the central bank subject to the evolution of the state. As such, we guess a value function that is quadratic in the state variables.

$$\begin{aligned} J_t &= x'_{1t} V_t x_{1t} + v_t \\ &= \min_{i_t} \{X'_t QX_t + 2X'_t Ui_t + i'_t Ri_t + \beta E_t [x'_{1t+1} V_{t+1} x_{1t+1} + v_{t+1}]\} \end{aligned} \tag{A3.2}$$

where the final expression is the Bellman equation. There is some rearranging in order to restate the model in terms of the state variables, x_1, only. This involves guessing that the forward-looking variables depend linearly on the state variables as follows:

$$x_{2t+1|t} = C_{t+1} x_{1t+1|t} \tag{A3.3}$$

After partitioning A and B according to x_1 and x_2, we know that

$$x_{2t+1|t} = A_{21}x_{1t} + A_{22}x_{2t} + B_2 i_t$$

$$= C_{t+1}[A_{11}x_{1t} + A_{12}x_{2t} + B_1 i_t] \qquad (A3.4)$$

Solving for x_{2t} yields:

$$x_{2t} = D_t x_{1t} + G_t i_t \qquad (A3.5)$$

where:

$$D_t = [A_{22} - C_{t+1}A_{12}]^{-1}[C_{t+1}A_{11} - A_{21}] \qquad (A3.6)$$

$$G_t = [A_{22} - C_{t+1}A_{12}]^{-1}[C_{t+1}B_1 - B_2] \qquad (A3.7)$$

Then, substitute (A3.5) with (A3.1b) to obtain the model as a function of the state variables, and is expressed as follows:

$$x_{1t+1} = A^*_t x_{1t} + B^*_t i_t + \xi_{t+1} \qquad (A3.8)$$

where:

$$A^*_t = A_{11} + A_{12}D_t \qquad (A3.9)$$

$$B^*_t = B_1 + A_{12}G_t \qquad (A3.10)$$

and using (A3.5) and (A3.8) the period loss function is written as follows:

$$x'_t Q_t + 2x'_t U_t i_t + i'_t R_t i_t = x'_{1t} Q^*_t + 2x'_{1t} U^*_t i_t + i'_t R^*_t i_t$$

where:

$$Q^*_t = Q_{11} + Q_{12}D_t + D_t'Q_{21} + D_t'Q_{22}D_t \qquad \text{(A3.11)}$$

$$U^*_t = Q_{12}G_t + D_t'Q_{22}G_t + U_1 + D_t'U_2 \qquad \text{(A3.12)}$$

$$R^*_t = R + G_t'Q_{22}G_t + G_t'U_2 + U_2'G_t \qquad \text{(A3.13)}$$

The Bellman equation in terms of the state variables, x_{1t} is now:

$$\begin{aligned} x'_{1t}V_t x_{1t} + v_t = \min_{i_t}\{&x'_{1t}Q^*_t x_{1t} + 2x'_{1t}U^*_t i_t + i'_t R^*_t i_t \\ &+ \beta E_t[(A^*_t x_{1t} + B^*_t i_t + \xi_{t+1})'V_{t+1}(A^*_t x_{1t} + B^*_t i_t + \xi_{t+1}) + v_{t+1}]\} \end{aligned} \qquad \text{(A3.14)}$$

The first-order conditions to this problem are:

$$2U^{*}_t{}'x_{1t} + 2R^*_t i_t + 2\beta B^{*}_t{}'V_{t+1}A^*_t x_{1t} + 2\beta B^{*}_t{}'V_{t+1}B^*_t i_t = 0 \qquad \text{(A3.15)}$$

The decision is of the form, $i_t = -F_t x_{1t}$ where:

$$F_t = [R^*_t + \beta B^{*}_t{}'V_{t+1}B^*_t]^{-1}[U^{*}_t{}' + \beta B^*_t V_{t+1}A^*_t] \qquad \text{(A3.16)}$$

This is then substituted into the Bellman equation. The optimum is found by finding the value of V (and, hence, the value of F and C) by iterating on the Ricatti equation using a numerical algorithm that updates V 'backwards in time' (see Ljungvist and Sargent, 2000 for details). The time invariant solution is given by:

$$X_{1t+1} \quad = (A_{11} + A_{12}C - B_1F)x_{1t} + \varepsilon_{t+1} = Mx_{1t} + \varepsilon_{t+1} \qquad \text{(A3.17)}$$

$$x_{2t} = (D - GF)x_{1t} = Cx_{1t} \qquad \text{(A3.18)}$$

$$i_t = -Fx_{1t} \qquad \text{(A3.19)}$$

The value of the loss function is given by:

$$J_0 = x'_{10} V x_{10} + (\beta/1-\beta) tr(V\Sigma_\varepsilon) \tag{A3.20}$$

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