Exchange Rate Regime and Exchange Rate Performance: Evidence from East Asia

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Thesis Abstract

This thesis is intended to be part of a vigorous debate currently going on in the international community of exchange rate regime, monetary policy and related core issues in East Asian economies. From different angles and aspects, this thesis contributes to the related literature, and provides fresh theoretical arguments and comprehensive study on the exchange rate regime and exchange rate performance in East Asia.

This thesis firstly investigates the performance and characteristics of exchange rate regimes in a group of East Asian economies during the 1990s. The determination of local currency, the flexibility of exchange rate regime, as well as the regional coordination of exchange rate management have been thoroughly examined. This thesis then considers the implications of exchange rate regimes on the monetary policy. It examines whether the adoption of new exchange rate regime has affected monetary autonomy, concerning the sensitivity of domestic interest rates to international interest rates under different currency regimes, from the cases of the selected East Asian economies during 1994-2004. One of the aspects of the choices of exchange rate regime is its implications for the magnitude of exchange rate volatility and the transmission of this volatility into other countries in the region. This thesis thus carries out an empirical investigation on the exchange rate volatility and cross-country contagion/spillover effect within foreign exchange markets for a group of East Asian countries in the context of the 1997/98 financial crisis. In addition, this thesis provides an investigation on the measurement of foreign exchange market pressure and currency crisis proneness, as well as examines interrelations between exchange market pressure and monetary policy. The post-crisis interactions among EMP, domestic credit growth, and the interest rate differential between domestic and foreign interest rates, in particular, have been investigated for a representative group of East Asian countries. Finally, this thesis provides further evidence on the relationship between stock prices and exchange rates, from the typical case of Hong Kong, to realise what kind of causality prevailed over the

period 1995-2001. Based on the high frequency weekly data, both long-run and short-run dynamics between stock prices and exchange rates in Hong Kong are addressed.

Various forms of evidence and empirical techniques are extensively applied and fully evaluated for the specific questions addressed in this research. These practical methodologies include Ordinary Least Square (OLS), Generalised Method of Movements (GMM), Generalised Autoregressive Conditional Heteroskedasticity (GARCH), Exponential GARCH (EGARCH), Vector Autoregressions (VAR) and their Impulse Response Functions (IRF), Unit Root Tests, Cointegration, and Granger Causality Tests. All kinds of data sets and sample periods employed in this research provide an interesting comparison to the existing related studies.

The main findings and key ideas drawn from this research have important implications for policy markers on the exchange rate management. The study on specific research topics and the comprehensive and thorough applications of various econometric methodologies provide valuable insight in characteristics and patterns of East Asian foreign exchange markets.

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Chapter 1

General Thesis Introduction

1. 1 Background and Motivation of Research

With the development of increasing integration in global financial markets and the growth in the international trade and financial liberalisation, the emerging East Asian economies have attracted enormous attention from both economists and policy markers. The 1997/98 financial crisis, in particular, has raised a number of theoretical issues and puzzles, among which are the questions such as what the characteristics of the East Asian exchange rates are, and what the appropriate exchange rate regime for the small and open emerging economies is. The long lasting debate with respect to the exchange rate management is typically framed in terms of the trade-off between credibility and flexibility, while the recent arguments switch attention to the preference of corner solutions (the "hard peg" or the "free float") and intermediate regimes such as limited flexibility, crawling bands, target zones, basket pegs and managed floating. Regarding the East Asian experiences, it is widely accepted that most East Asian currencies maintained *de facto* pegs to the U.S. dollar in the pre-crisis period. Such *de facto* pegs to the U.S. dollar sometimes destabilised the real effective exchange rates of these currencies and this pegged regime is universally recognised as one of the causes of the crisis in the East Asian countries. Several economists have, thus, proposed the desirability of intermediate exchange rate regimes in East Asia that might stabilise their effective exchange rates (Bénassy-Quéré, 1999a; Williamson, 1999, 2000; Rajan, 2002). The "bipolar" or "two-corner solution" view of exchange rates, in contrast, states that intermediate exchange rate regimes between hard and floating pegs are not sustainable (Fischer, 2001). Moreover, the "fear of floating" view proposed by several studies suggests that only a short time after the crisis, the exchange rate regimes of East Asian economies have in fact returned to their previous fixed regimes, despite the fact that their official exchange rates were officially declared to be flexible (McKinnon, 2000;

Hernández and Montiel, 2001; Calvo and Reinhart, 2002). The hypothesis of "fear of floating" further argues that "two-corner solution" is realistic for many emerging economies (Hausmann *et al*., 2001; Calvo and Reinhart, 2002).

Based on the intensified debates and prevailing thoughts on the choice of optimum exchange rate regimes for most Asian countries, a question regarding evaluation of the post-crisis exchange rate polices in East Asia arises: is the pre-crisis U.S. dollar standard still dominating the exchange rate policies, or has another path been followed by East Asian countries after learning a lesson from the crisis? Moreover, recent studies have acknowledged the fact that the declared exchange rate policies in some East Asian economies do not match the actually implemented policies in practice, implying an evident gap between the *de jure* and *de facto* exchange rates in many East Asian countries. Hence, identifying the actual operation of exchange rate arrangements based on observed outcomes for exchange rates and other variables, and empirically detecting the flexibility of exchange rate regime in the transition period, are a crucial topic that this research tackles.

In the context of the debate on the appropriate currency regime in East Asia, the impact of exchange rate regimes on the independence of monetary policy is highlighted after the 1997/98 currency crisis. In theory, with a pegged exchange rate under free capital movements, monetary policy is committed to the single goal of maintaining the exchange rate at its officially announced level. The domestic interest rates cannot be set independently. On the other hand, under a flexible exchange rate arrangement, the domestic interest rate should be less sensitive to changes in international interest rates, if other things equal. Changes in the exchange rates would absorb the shocks of international interest rate and thereby provide "insulation" for domestic interest rates. Countries with intermediate regime should also display less sensitivity to international interest rates than countries with firm pegs. Nevertheless, the recent prevailing thoughts such as "fear of floating" argue that countries with *de jure* flexible regimes do not allow their exchange rates to move freely (Calvo and Reinhart, 2002). Frankel *et al*. (2002) further point that factors such as lack of credibility, exchange rate pass-through, as well

as foreign-currency liabilities prevent countries from adopting an independent monetary policy no matter what their announced regimes are. Some researchers (for example, Shambaugh, 2004) also point out most countries that have liberalised their capital flows or are in the process of doing so and few countries have monetary freedom in today's world. Thus a tight connection to relevant base economy is witnessed by most countries and there would be no difference between pegged and non-pegged countries under this scenario.

In the case of East Asia, one of the distinctive characteristics is that the exchange rate regimes adopted by East Asian countries have varied significantly in the wake of the 1997/98 financial crisis. The diversified exchange rate regimes in the Asian region can be detected from the form of a hard peg currency board arrangement to the case of free floating system. Hence, the experience from East Asian emerging countries poses an interesting research question: Has the adoption of new exchange regime in the post-crisis period affected monetary autonomy? If so, how do the local interest rates react to international interest rates (U.S. interest rates) in the pre- and post-crisis periods? Do the traditional view and prediction theory regarding the currency regimes and monetary autonomy still hold for East Asian economies? All of these considerations drive us to carry out a statistical examination on the impact of exchange rate regimes on the independence of monetary policy. Specifically, this research attempts to address this issue through investigating the sensitivity of domestic interest rates to international interest rates under different currency regimes adopted before and after the 1997/98 financial crisis.

To evaluate a given exchange rate regime, we may consider its ability to face periodic and potentially contagious financial crises. East Asia provides a fruitful laboratory to study the event of financial crisis and the accompanied transition in exchange rate regimes. In fact, the experience from East Asia (1997), Latin America (1994) and Russia (1998) are typical examples of financial market collapses in the 1990s. One distinct characteristic of these incidents is that the crisis quickly spreads from one market to the entire or even other regions. Thus there is a growing concern among

researchers and policy markers to investigate the causes and effects of such crises. Most of the earlier research, in general, aims to identify the linkages and transmission mechanisms across countries. In particular, the strong trade linkages and macroeconomic similarities have been proved by several theoretical researches as major sources to spread the crisis (Eichengreen *et al*., 1996, Glick and Rose, 1999; Van Rijckeghem and Weder, 1999; Kaminsky and Reinhart, 2000; and Ahluwalia, 2000). More recent studies on the transmission mechanisms make a distinct difference between tranquil periods and crisis periods and attempt to investigate normal interdependence or spillover effect and contagion of financial crisis.

Motivated by the crisis study, another focus of this research is to expand the existing research by looking into the presence of volatility transmission effect in the foreign exchange market, which has, in contrast to stock and bond markets contagion/spillover, still received limited attention. For the case of East Asia, most existing literature mainly examines the transmission mechanism from the origin of the crisis, i.e. Thailand, to other regional countries. Differently from the previous work, this study conducts an empirically examination on whether volatility of one exchange rate market is transmitted to others in some way, and if so, to what extent this volatility contagion/spillover effect works during the crisis or tranquil period. From the perspective of volatility transmission analysis, the patterns of linkages among regional foreign exchange markets can be recognised accordingly. The findings would help policy markers to deign appropriate polices in case an adverse shock is observed in one foreign exchange market where the volatility contagion/spillover effect is empirically evident.

Motivated by recent debate, this research also tackles the issues of monetary policy regarding the experience of crisis-affected Asian countries in the 1997/98 financial collapse. Existing literature mainly focused on addressing the following questions: Was the monetary policy too tight or too loose before and after the crisis? Could a tight monetary policy (especially with higher interest rates) have successfully defended the exchange rates? The traditional view suggests that tighter monetary policy, as

implemented through lower domestic credit growth or higher interest rates, should in principle help strengthen a currency whether this is reflected in the exchange rate, in additional to foreign reserves, or both. Nevertheless, a "revisionist" view proposes that raising interest rates could actually exacerbate the currency deprecation and a "Laffer curve" could be found, following which contractionary monetary policy induces a panic among investors and a loss of a currency's value (see, Corsetti et al., 1998; Furman and Stiglitz, 1998; Radelet and Sachs, 1998a, 1998b; Pakko, 2000). Also a fiscal-based theory, in which higher interest rates mean a higher burden on the public sector, implies that the currency would not strengthen without a corresponding adjustment of the primary surplus (Flood and Jeanne, 2000; Lahiri and Vegh, 2000, 2001).

More and more attention from both academic and political worlds has also been drawn to the development of the exchange rate and the actions of the monetary authorities, leading to a growing concern over the pressure of exchange market as well as the degree of foreign exchange management. Measuring the speculative pressure of currency and countries susceptibility to crisis becomes one of centered issues. On the other hand, there is no consensus on the appropriate reaction of monetary policy to the pressures on the domestic currency in literature. The 1997/98 financial crisis has prompted a handful of countries (for instance, Korea, Indonesia, Philippines, and Thailand) in the East Asian region to explicitly or implicitly alter their monetary policies in addition to their exchange rate policies. In these countries, exchange rate regime has been switched from a "rigid" one to a more flexible one, and the monetary policy has been fashioned around an inflation objective, that is, inflation targeting regimes. In the existing literature, little has been done to emphasise the interactions between monetary policy and currency pressure on the post-crisis East Asia. It is, then, important to draw out policy lessons learned from episodes such as the Asian financial crisis and to examine whether and by how much, monetary policy responds to the exchange market pressure under more flexible exchange rate and inflation-targeting regimes adopted by East Asian countries after the crisis.

In addition, a distinct feature of the 1997/98 financial crisis was the almost simultaneous decline in asset prices and currencies, leading to the turmoil in both stock and currency markets in a group of Asian countries. This motivates us to dwell on the relationship between stock markets and exchange rate or currency market. When investigating the possible relationship between stock markets and exchange rate or currency market, the main concern is usually over the direction of causality between the said variables. However, the literature of this field are far from reaching any consensus on the interactions between stock markets and foreign exchange markets, specifically, on the direction or a particular sign of the relationship: for instance, the traditional approach ("flow oriented" models) suggests that exchange rates lead stock prices with arbitrary correlation. In contrast, the proponents of portfolio approach represented by the "stock oriented" models argues that stock prices lead exchange rates with negative correlation.

In fact, understanding the dynamic links between stock and foreign exchange markets has important policy implications. Theoretically, the relationship between asset prices is an important input to open macroeconomic models as well as international portfolio diversification and hedging models. Practically, establishing the relationship between these two variables provides informative implication for investors in their search of diversification opportunities and for the hedging of their investment strategy. It also would be necessary for economic and financial policymakers and regulators to know the interaction between exchange rates and stock markets if they are to formulate the appropriate polices (for example, to predict and prevent the crisis). It is thus advisable to carry out further tests and analysis of these issues on the particular market interested. Hence, this research provides further evidence on the relationship between stock prices and exchange rates, from the particular case of Hong Kong market, to realise what kind of causality prevailed over the period 1995-2001. We select Hong Kong as a case study for three reasons: First, being the second largest stock market in Asia, exceeded only by Japan, Hong Kong plays a significant role as a major international financial center and is characterised by its high degree of internationalisation, free trade and flow, and information financial network. Second, the exchange rate regime adopted in Hong Kong

is quite unique: with currency board arrangement (CBA), Hong Kong fixes its nominal exchange rate against U.S. dollar at a specific level. Third, the Hong Kong dollar has remained remarkably stable under the anchor of the linked exchange rate, while many other currencies in the region have all suffered sharp depreciation over the financial crisis. Hence, we can infer that the Hong Kong experience differs from that of most Asian economies, offering a particularly interesting opportunity to investigate the long-run and short-run causal relationship between stock prices and exchange rates.

1.2 Objectives of Research

Overall, the East Asian experience offered a fruitful laboratory to examine the above mentioned research issues. This thesis intends to be an important and significant part of a vigorous debate currently going on in the international community about exchange rate regime, monetary policy and related issues in East Asian emerging countries. In particular, this thesis contributes to the literature in East Asian economies by providing a solid empirical analysis, fresh theoretical arguments, and a better understanding in the exchange rate regime and exchange rate behaviour in East Asian countries/regions. The main research questions are identified to guide the overall research. They are: How to evaluate exchange rate regime and exchange rate performance in East Asia over the last few years? What are the recent trends of Asian currencies, especially after the crisis? What are the implications for the East Asian exchange rate management and policy?

The main research questions can be developed into the following five sets of sub-topics with their corresponding research questions addressed by the five empirical chapters, respectively:

1. Exchange rate regimes of East Asia: performance and characteristics before and after the 1997/98 financial crisis

- How much influence did international anchor currencies such as U.S. dollar, Japanese yen and Euro/Deutsche mark have on the local East Asian currencies before and after the crisis?

- Has the flexibility of exchange rate regime increased after the crisis compared to the pre-crisis period?

- Has the regional exchange rate coordination strengthened in the post-crisis period?

2. Exchange rate regimes and monetary independence: the transmission of interest rates in East Asia

- Has the adoption of new exchange regime in the post-crisis period affected monetary autonomy? If so, how did the local interest rates react to international interest rates (U.S. interest rates) in the pre- and post-crisis periods?

- Do the traditional view and the prediction theory regarding the currency regimes and monetary autonomy still hold for East Asian economies?

3. Exchange rate volatility and its contagion/spillover effect from the evidence of East Asia

- Did volatility of one exchange rate market transmit to others in some way? If so, to what extent this volatility contagion/spillover effect worked during the crisis or tranquil period?

4. Exchange market pressure (EMP) and monetary policy in the post-crisis East Asia

- How to measure the tensions (pressure) on the foreign exchange market and countries susceptibility to crisis?

- What is the relationship between EMP and monetary policy, especially for the post-crisis East Asia? How did monetary policy affect EMP? What was the reaction of monetary policy to EMP?

5. The interaction between stock prices and exchange rates: Evidence from Hong Kong

- Are there any dynamic long-run and short-run relationships between stock prices and exchange rates?

- What is the direction of causality between the two variables? Does stock price affect exchange rate or the other way around?

1.3 Outline of Thesis

This thesis consists of five empirical papers (or chapters) on different aspects of exchange rate regimes and exchange rate behaviour of East Asian economies. The following structure is adopted:

Chapter 1 is a general introduction to the whole thesis.

Chapter 2 begins by briefly reviewing the theoretical choice of exchange rate regime from optimum currency area theory, impossible trinity theory, and currency crisis theory. It also provides a critical assessment on the prevailing thoughts and arguments put forward for East Asian countries regarding the desirable exchange rate regimes. Then this chapter conducts an empirical investigation on the exchange rate arrangements of East Asian countries over 1990s. The related analysis is conducted on the data gathered during a longer period that spans from 1990 to 2005 which fully captures the possible change of exchange rate regimes in the pre-crisis, mid-crisis and post-crisis periods. The study considers determinants of exchange rates under a currency basket of U.S. dollar, Japanese yen and Euro/Deutsche mark as international anchor currencies for East Asian countries' exchange rate stabilisation. We then compare the degree of influence of U.S. dollar and Japanese yen and Euro/Deutsche mark on the local currency during the pre-crisis period with that during the post-crisis period. Additional robustness tests of related hypotheses are performed. By constructing a flexibility index, this study also

explores whether the flexibility of exchange rate regime has increased since the pre-crisis period towards the post-crisis period.

Regarding the debate on the feasibility of regional monetary arrangement, Chapter 2 also tests whether a regional coordination of exchange rate has been strengthened in the post-crisis period. Previous studies mainly examined the possibility of an optimum currency area by reviewing the evidence of trade patterns, economic shock, factor mobility and monetary transmission mechanism. Despite the arguments being made for optimum currency area or monetary union within Asia, there seems to be relative little discussion of the need for exchange rate coordination. This thesis attempts to materialise regional coordination in exchange rate management, carrying out Granger causality tests on the bilateral relations among regional currency values to compare the causal effect between possible pairs of any two currencies under the studies on the pre-and post-crisis periods, respectively.

The impact of the exchange rate regimes on the monetary policy independence is an important question in the context of the debate on the choice of currency regimes. Due to the fact that exchange rate regimes adopted by the East Asian countries in the wake of the regional crisis have varied significantly, Chapter 3 mainly examines the influence of exchange rate regime on the monetary independence in East Asian economies before and after the 1997/98 currency crisis. Specifically, this chapter examines whether the adoption of new exchange rate regime has affected monetary autonomy, concerning the sensitivity of domestic interest rates to international interest rates under different currency regimes, for the selected East Asian economies during 1994-2004. In principle, under floating regimes, changes in the exchange rates would absorb the shocks of international interest rate and thereby provide “insulation” for domestic interest rates. Hence, for a given degree of capital mobility, we would expect the sensitivity of local interest rates to international base rates increases with the rigidity of the exchange rate regime. This study takes the short term interest rate as a measure of monetary policy

and assumes that autonomy can be measured by movements in these rates[1]. The link between local interest rates of eight East Asian economies (Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore and Thailand) to foreign interest rates (U.S. interest rates) under different currency regimes will be examined accordingly.

Chapter 3 extends the literature in three ways: First, most of previous studies mainly relay on the official or *de jure* classification of exchange rate regime. Considering the classification of exchange rate regime might be sensitive to empirical results, our study in Chapter 3 employs the Reinhart and Rogoff (2004) coding as an alternative (*de facto*) classification to test the robustness of results. Second, large data set and long time period are used in this chapter, for which results are compared with the existing related studies. The choice of the sample period depends on the possibility of contrasting alternative exchange rate regimes. Third, the Generalised Method of Movements (GMM) technique is adopted to capture the methodological issues such as endogeneity of international interest rate shocks as well as heteroskedasticity of unknown form in the disturbance terms.

One aspect of the choices of exchange rate regime is its implications for the magnitude of exchange rate volatility and the transmission of this volatility into the other countries in region. Chapter 4 provides an empirical investigation on the exchange rate volatility and cross-country contagion/spillover effect within foreign exchange markets for a group of East Asian countries in the context of the 1997/98 Asian financial crisis and the period afterwards. This chapter begins with a brief review of the theoretical perspective on financial market contagion as well as the empirical measurement on the contagion. Then it employs domestic currencies as an indicator to identify the presence of contagion in the foreign exchange markets from the viewpoint of volatility transmission.

The GARCH-typed models which explicitly consider conditional volatility in the time series data are adopted in this study to overcome the assumption of constant variance

[1] Short term interest rates are taken into account since these are the most relevant for monetary policy.

that made by most of the previous studies in literature. To be specific, using the gathered high frequency data, the volatility of seven foreign exchange markets in East Asia has been modelled in the frameworks of GARCH (p, q) for both crisis and tranquil periods. As an alternate estimation, the EGARCH (p, q) model is applied to capture the possible size effect, sign effect and persistence effects on the volatility of exchange rates dynamic. In order to identify the presence of volatility contagion, a particular interest of Chapter 4 is to look into the possible volatility transmission from Korea, a crisis-affected market, to other regional exchange markets during the crisis period. This chapter also pays specific attention to the possible volatility spillover from Hong Kong to other regional markets over the tranquil period. In doing this, an extension of GARCH (p, q) model that includes an exogenous regressor in the conditional variance is employed to address the problem. Creating more insights into the volatility of foreign exchange market would be informative for recognising the nature and linkage of financial markets. Any possible evidence of volatility transmission within regional exchange rate markets would support the argument of contagion/spillover effect.

Contributing to the considerable debate regarding the issues of exchange rate and monetary policy, Chapter 5 not only attempts to measure foreign exchange market pressure and currency crisis proneness, but also investigates the interactions between exchange market pressure (EMP) and monetary policy for five East Asian countries (Indonesia, Korea, Philippines, Singapore and Thailand). Rather than focusing on exchange rate movements alone as most previous empirical studies did, our study uses EMP to gauge the strength of the domestic currency in order to capture tensions on the currency and degree of exchange rate management from monetary authorities. Firstly, we especially compare and evaluate two model-independent EMP indices as measures of currency crisis proneness. Secondly, extending the existing literature, most of which merely focus on East Asian countries prior to or during the crisis, we attempt to explore the relationship between exchange market situation and monetary policy stance, especially for the post-crisis period that has not been mainly taken into account in previous studies. The vector autoregresson (VAR) approach and impulse response function as well as Granger causality test are employed in this chapter to capture the

interaction among three variables: EMP, domestic credit growth and interest rate differential between domestic and foreign interest rates. This framework not only shows the response of EMP to the monetary policy shocks, but also yields a policy reaction function that captures the effects of lagged innovations in both EMP and the interest differential on domestic credit growth. The analysis of this study provides further evidence of monetary policy responses to pressures on currency in the post-crisis or recent East Asia where more flexible exchange rate and inflation-targeting regimes have been prevailed.

Chapter 6 discusses the issue of the relationship between stock prices and exchange rates. The literature in general provides evidence in the joint determination between the both markets. Nevertheless, there is no theoretical consensus on the direction of causality relationship: does stock price affect exchange rate or the other way around? Against this background, Chapter 6 provides further evidence on the relationship between stock prices and exchange rates, from the particular case of Hong Kong asset markets, to realise what kind of causality prevailed over the period from 1995 to 2001. Based on the high frequency weekly data, both long-run and short-run dynamics between stock prices and exchange rates in Hong Kong are addressed.

Compared to previous work, Chapter 6 applies a full set of empirical methodologies to investigate the relationship between both markets. The stationarity property of data has been firstly addressed by conducting a set of robust unit root tests. The conventional unit root tests that most previous studies extensively applied ignore the possibility of structure break, particularly during a period when major event happens, such as a financial crisis. In this case, the conventional unit root tests could be unreliable. Therefore, our analysis takes unit root tests with structural break into account to avoid possible erroneous results. The long-run relationship between stock prices and exchange rates are explored by employing both Engle-Granger two-step method and Johansen cointegration procedure. The Granger causality tests in the setting of the vector autoregressive (VAR) together with the impulse response (IR) function are adopted in this study to examine the short-run causal relationship between two variables. This

study further explores the relative importance of each variable in forecasting the other. In addition, most previous studies have been conducted under periods where the stock markets are operating under normal conditions. It would be important and interesting to consider situations where asset markets such as the foreign exchange and equity markets are under stress given that the frequent occurrence of such scenarios in financial markets history. Therefore, our study provides a fully examination of the relationship between exchange rates and stock prices during normal and stressful conditions. The results of this investigation have implications in terms of policy and in terms of hedging of portfolios for Hong Kong financial market.

Chapter 7 summarises the main findings and contributions of this research. Some policy implications and areas for future research are also identified in this part.

The following chapters contain a more detailed description of the material covered in this general introduction.

Chapter 2

Exchange Rate Regimes of East Asia: Performance and Characteristics Before and After the 1997/98 Financial Crisis

2.1 Introduction

Exchange rate management is one of the core issues of macroeconomic policies. There has been a long history of debate over the advantages of fixed versus floating exchange rate regimes. Such debate is typically framed in terms of the trade-off between credibility and flexibility (Taguchi, 2004). The conventional view suggests that a fixed exchange rate regime can reduce exchange rate volatility and provide a credible anchor for monetary policy. Alternatively, a flexible exchange rate allows for more independent monetary policy. The recent debates pay attention to the preference of intermediate regimes such as crawling, target zones and basket pegs or the corner solutions with the "hard peg" or the "free float". However, no consensus has been reached so far. As the debates go further, some prevailing thoughts over the exchange rate regimes have been proposed. One hypothesis is the "two-corner solution" which involves opting either full flexibility or rigid commitments to fixed exchanges (Eichengreen, 1994). According to this hypothesis, the intermediate exchange rate regimes are no longer feasible and are going to disappear. Moreover, as another prevailing concept, the hypothesis of "fear of floating" has pointed out that the countries in lack of credibility do not do exactly what they say (Calvo and Reinhart, 2002). Such view leads to the speculation that the emerging economies are likely to move towards hard pegs rather than floats.

In particular, the attention in exchange rate management in East Asian countries has been refocused after the 1997/98 financial crisis. How to characterise the exchange rate regimes in East Asian economies remains a research topic of considerable discussion. Regarding this, debates on the choice of optimum exchange rate regimes have been

intensified accordingly. The pre-crisis U.S. dollar pegged regime is widely deemed as one of the causes of the crisis. Then following doubts concerning the post-crisis exchange rate polices in East Asian countries arise: are the East Asian countries retuning to the pre-crisis U.S. dollar standard, or have they learned a lesson from the crisis and found another path to follow?

Recent literature has confirmed the gap between *de jure* and *de facto* exchange rate policies conducted in several countries. Empirical studies thereby began to examine the actual operation of exchange rate arrangements in emerging markets, through observing the actual performance of exchange rates and other variables such as foreign exchange reserves and interest rates (Hernández and Montiel, 2001). In particular, the actual behaviour of exchange rate policies in East Asia after the 1997/98 currency crisis has been highlighted by several recent empirical studies (Baig, 2001; Frankel *et al*., 2002; Calvo and Reinhart, 2002; Kim, 2003; Reinhart and Rogoff, 2004; Shambaugh, 2004; Levy-Yeyati and Sturzenegger, 2005). Instead of reckoning on the *de jure* (official) regime classifications reported by IMF, recent researchers suggest the importance of analysis of the *de facto* exchange rate arrangements. Motivated by this doctrine, it is thus necessary to investigate the *de facto* exchange rate policies by investigating the flexibility of exchange rate regime in the post-crisis transition period.

The objectives of this chapter are to provide an empirical investigation in the exchange rate regime and exchange rate behaviour of selected typical East Asian economies (China-mainland, Hong Kong, Indonesia, Korea, Philippines, Singapore and Thailand), and to identify and evaluate their post-crisis exchange rate practice. Our methodology for empirical investigation follows closely those in the previous literature, but improves them in some important aspects: First, this study examines a longer period that spans from the year of 1990 to 2005 which fully captures the transition of exchange rate regimes in the pre-crisis and mid-crisis periods, and in particular, the post-crisis period from January 1999 to December 2005, compared to the existing related studies. Second, a comprehensive examination on the roles of U.S. dollar, Japanese yen and Euro on the East Asian currencies has been conducted from a set of formal statistics tests, and our

analysis implies recent transition to the currency basket regime for most East Asian countries. Third, few studies address the coordination of exchange rate arrangements, this paper explores the progress of regional exchange rate policy coordination in the post-crisis period.

The reminder of this chapter is organised as follows: Section 2.2 begins by briefly outlining the theory of exchange rate regime choice. Section 2.3 briefly reviews the development of exchange rate arrangements in East Asian economies over 1990s and assesses the recent debates and some prevailing thoughts on the appropriate regime choice. Section 2.4, Section 2.5 and Section 2.6 provide a thoroughly investigation on the actual exchange rate behaviour and exchange rate regime of East Asia in the advent of the 1997/98 currency crisis. The conclusion remarks together with a summary of implications are presented in Section 2.7.

2.2 Theoretical Perspectives on the Choice of Exchange Rate Regimes

The choice of an appropriate exchange rate regime is one of the most fundamental policy issues in open economies. Each regime has its advantages and disadvantages. The history of debates on exchange rate regime choice can be framed in terms of the trade-off between credibility and flexibility (Taguchi, 2004). A conventional view suggests that a fixed exchange rate regime can work as a credible nominal anchor for monetary policy and help reduce transaction costs and exchange rate risks. Also, lower inflation expectations and reduced exchange rate volatility are arguments in favor of fixed exchange rate system. A floating exchange rate regime, on the other hand, allows the domestic monetary authority to pursue an independent monetary policy. In the following section, we selectively review three classical theories on the determination of exchange rate regimes.

2.2.1 Optimum Currency Area Theory

The early literature on the subject of the exchange rate regime was based on the theory of optimum currency area (OCA) and focused on the characteristics that determined whether a country would be better off, in terms of maintaining internal and external balance, with different choices of exchange rate regimes. An optimum currency area is defined as "a region for which it is optimal to have a single currency and a single monetary policy" (Frankel 1999, p.11). The theory of OCA proposes a set of criteria for establishing a monetary union with perfectly fixed exchange rates and a common monetary policy among the members of country. The OCA theory can also be used as the argument for contrasting the relative merits of fixed regimes against floating ones. The traditional way of choosing exchange rate regime is derived from the OCA theory developed by Mundell (1961). Mundell's work was further supplemented by important offerings from McKinnon (1963) and Kenen (1969). Several criteria have been proposed to assess and evaluate whether a country should belong to an optimal currency area by many authors (see, for example, Mundell, 1961; McKinnon, 1963; and Kenen, 1969): the symmetry of external shocks, the degree of labor mobility, the degree of openness, and the extent of economic diversification. For instance, small open economies are better served by a fixed exchange rate regime. Also the less diversified a country's production and export structures, the stronger the case for fixed exchange rates becomes. Besides the criteria that depend on the state of the economy, the policy oriented criteria has been emphasised in the discussion later moved toward (see, for example, Haberler, 1970; Fleming, 1971; Ishiyama, 1975). The desired policy trade-offs which include similarity of rates of inflation, degree of policy integration, degree of price and wage flexibility, and real exchange rate variability still play a role in the discussion about monetary integration.

As the main part of theory of monetary integration, these traditional criteria have been used to assess whether a country should peg or float its currency against currencies of countries in a specific optimum currency area. This theory predicts that the fixed exchange rate is most appropriate for countries that are closely integrated through

international trade and factor movements (Mundell, 1961). When a country has geographically concentrated trade, a high degree of internal factor mobility and a low inflation differential relative to its main trading partners, the fixed regime is also a preferable arrangement for this country. Alternatively, flexible exchange rate is more appropriate for countries which are exposed to real shocks (Bleaney and Francisco, 2002). In particular, McKibbin and Le (2002) suggest a flexible exchange rate is a better option for a country which is not well diversified and faces different external shocks, is relatively open in terms of trade to another country or a group of countries in a currency block but has negligible labor mobility across its border. Thus, the theory establishes certain criteria according to which a country is more or less suitable for a fixed or a flexible exchange rate regime choice.

Nevertheless, the traditional criteria have been criticised to be incomplete and partial. Recent developments in international macroeconomics have led to the new elements of new OCA theory and highlight that participation in OCA also involves some cost. Therefore, country has to evaluate carefully the cost and benefits of joining to currency areas before participation. For instance, Tavlas (1993) points out OCA theory has largely been modified since the discussion has turned to expectation formation, credibility and time inconsistency. There have been several formal modelling efforts of currency areas as the development of new OCA theory (see, for example, Helpman and Razin, 1982; Bayoumi, 1994; Buiter, 1995; Ricci, 1997; Neumeyer, 1998).

Overall, OCA theory has been an important theoretical foundation in the choice of the exchange rate regime for a given country. Despite of the fact that the criteria developed under OCA theory are not easily put into practice, the prominence of OCA theory in selection of an exchange rate regime has been highlighted by several studies. In particular, the criteria of OCA theory provide considerable insight in studying the monetary integration and it has been a classical theorem in the design of the European Economic and Monetary Union (EMU).

2.2.2 Impossible Trinity Theory

A large strand of literature has discussed another benefit of flexible exchange rate relying on the doctrine of the impossible trinity or trilemma, which simply states that a country cannot simultaneously maintain exchange rate stability, capital mobility and monetary autonomy. According to this trilemma, each country can choose no more than two of the following three features of its policy regime: (1) open capital market (free capital mobility across borders), (2) an independent monetary policy, and (3) a fixed (pegged) exchange rate.

Historically, the monetary arrangements in the world have been dominated by various combinations of these three features for different eras. For instance, the benefits of free capital flows and the stability of a fixed relation of the currency to gold had been highlighted by major trading countries under the classical gold standard of the nineteenth century. Under the Bretton Woods system, the capital mobility had been given up by many countries as an attempt to maintain both fixed exchange rates and monetary independence. Nowadays, a regime that gives up fixed exchange rates in favor of capital mobility and floating exchange rates has been collectively dominated among major industrial regions. In terms of the impossible trinity theory, under the condition of high international capital mobility, a flexible exchange rate allows policy makers to implement the independent monetary policy. However, if domestic authorities cannot make good use of it, such independence of monetary policy needs to be surrendered in order to import stability from other countries. In addition, Christl (2006) suggests the trade-off between monetary independence and exchange rate stability might be affected by other factors such as central bank independence, administrative capacity, as well as depth and liquidity of foreign exchange market.

More attention has been paid to the emerging countries which have opened up their financial markets that involved in the recent emerging market crises. Most countries hit by crises had pegged exchange rates. In terms of the trilemma view, the crises reflect a signal that open capital markets, monetary independence and pegs were incompatible

and “bipolar view” or “two corner solutions” have been put forward as the only viable options for these countries. Eichengreen (1994) is one of the first proponents of the so-called “Hollowing of the Middle” theory or “bipolar view” according to which only the two-corner solution “hard pegs” and “full floats” are feasible in a world of high capital mobility. This view is further supported by Fisher (2001) who argues that high capital mobility makes intermediate regime less viable in financially open economies. Since monetary policy under this circumstance cannot simultaneously achieve a stable exchange rate and smooth cyclical output fluctuations, these countries should pursue the corner solution strategy and adopt either a hard peg or a pure float. In addition, the effectiveness of controls for capital inflows and outflows is deemed to be very limited, at least on a sustained basis (Ariyoshi *et al*., 2000). Considering the rapid process of financial deepening and innovation also may reduce the effectiveness of capital control, the traditional trinity dilemma is usually reduced to the two options or a monetary policy-exchange rate stability trade-off.

2.2.3 Currency Crises Theory

The theoretical and political arguments regarding the exchange rate regimes have been intensified following the currency crises as well as the collapse of several traditional fixed or crawling peg arrangements in the 1990s. The merits and drawbacks of both fixed and floating exchange rate regimes have been compared and debated. More and more attention has been given to the ability of a given exchange rate regime to face periodic and potentially contagious financial crises. Thus, the vulnerability of countries to currency crises under different exchange rate regimes has been highlighted by extensive literature in evaluating the exchange rate regime.

In the literature on exchange rate instability, one approach that often referred to as first-generation models[2] views a currency crisis as the unavoidable outcome of unsustainable policy stances or structural imbalances (Krugman, 1979). This view

[2] The approach was pioneered by Krugman (1979) who adapted a model by Salant and Henderson (1978) to the analysis of currency crises. It was further refined by Flood and Garber (1984).

stresses that the exchange rate regime is a component of border policy package, and the regime can be sustained only if it does not conflict with other monetary and fiscal objectives. It is further implies that the expansionary monetary policy combined with a fixed exchange rate leads to external imbalances (Krugman, 1979). This is because under a fixed exchange rate regime, domestic credit expansion in excess of money demand growth would lead to a gradual but persistent loss of international reserves. This would eventually lead to a speculative attack on the currency. Extending this logic, many others thereafter investigated the implications of market speculation against an exchange rate regime, including the precise time of collapse of a regime (see Flood and Garber, 1984; Connolly and Taylor, 1984, and others). Fischer (1999) and Krueger (1999), among others, point out that fixed exchange rate regimes often lack credibility and invite speculation against the pegged rate, in particular when unfavorable conditions arise. Rana (1998) also argues that the return to an announced peg is an open invitation for future speculative attacks in the context of the ongoing crisis that severe banking sector and low levels of reserves are evident. These scholars also claim that the costs associated with increases in exchange rate variability are lower when compared with the costs incurred when speculators attack a pegged exchange rate system. Thus, adherents of this view suggest the merit of floating exchange as a mechanism to prevent the crisis.

On the other hand, some studies point out that a floating system would bring about considerable volatility in the exchange rates. This is particularly for the affected countries where financial markets are not well developed and foreign exchange rate markets are weak (see, for example, Rana, 1998). Several researchers argue that floating exchange rates indeed exhibit great volatility and such excess volatility has in some cases restrained the international trade (Flood and Rose, 1995; Rose, 2000; Klein and Shambaugh, 2004). The flexible exchange rate regime is also argued to increase risk premiums through increased volatility in the exchange rate, giving rise to moral hazard problems for poorly regulated banking system, and thereby increase nation's vulnerability to currency crises (McKinnon, 2000). Fixed exchange rates, according to this alternative view, will result in lower risk premiums and bankers will face less

temptation to increase their dollar liabilities. The intermediate regime of managed floating become worth considering in light of these problems regarding both peg and floating regimes. For example, Ohno (1999) point out moving to a crawling peg system may be advisable in this context as it combines the advantages of both fixed and flexible exchange rates. Not only impose disciplines on exchange rate polices, it also provides flexibility if the country is affected by capital flights. Nevertheless, the intermediate regime is not a panacea and soft pegs (or crawling pegs) are viewed to be more crisis-prone than the regimes at either end of the continuum of exchange rate system (Fischer, 2001). Soft pegs are argued to be unsustainable and hard pegs and free floating extremes have been gaining ground among practitioners in favor of this argument. Haile and Pozo (2006), in particular, argue that pegs that are not truly pegs appear to invite speculation against the currency, increasing the odds of currency crisis.

Nevertheless, some researchers recently argue that nations can choose, in principle, to pursue a fixed, floating, or intermediate exchange rate regime without being concerned that one or another is apt to increase the odds of currency crises. For example, Stiglitz (2002) suggests that neither fixed nor flexible rate can properly be blamed as the crisis trigger. Instead, liberalisation of capital market together with macroeconomic and "bail-out" policies makes countries more vulnerable to shocks and thereby is responsible for currency crises. In recent years, as Kaminsky and Reinhart (1999) argue, currencies crises have been increasingly associated with financial fragilities and several researchers have tested for external common shocks or market contagion[3]. Haile and Pozo (2006) find no role played by the actual or *de facto* exchange rate regime in determining currency crisis periods. It is not distinguishable for different exchange rate regimes in terms of raising susceptibility to currency crises. They further point out currency crises can be propagated by economic polices and certain unsustainable exchange rate policies rather than alternative exchange rate regimes. Overall, the question that which kind of exchange rate regime contributes to the incidence of currency crisis still remains debatable and controversial.

[3] Other papers that discuss financial contagion include, for example, Eichengreen *et al*. (1996), Glick and Rose (1999), Sachs *et al*. (1996) and Tornell (1999).

2.3 A Review of Exchange Rate Arrangements in East Asia

2.3.1 Classification of Exchange Rate Regimes: *de jure* vs *de facto*

The exchange rate regimes have changed significantly in many East Asian economies since the financial crisis in 1997. The International Monetary Fund (henceforth, IMF) regularly publishes exchange rate arrangements reported by its member countries according to its own classification scheme. Table 2.1 reports the IMF classifications (*de jure*) of currency regimes for East Asian countries over the last 20 years. It indicates several facts as follows: First, East Asia has exhibited a variety of exchange rate arrangements, ranging from a currency board system (Hong Kong) to independently floating (Japan, Philippines)[4]. Between these two polar cases, there are conventional fixed pegs to a single currency (China and post-crisis Malaysia) or a currency basket (Singapore and pre-crisis Thailand) as well as intermediate regime/managed floating (pre-crisis Korea, Indonesia, and Singapore). Second, official exchange rate arrangements change in the direction of greater exchange rate flexibility for Korea, Indonesia, and Thailand after the crisis. Malaysia, in contrast, moved in the opposite direction and pegged to the U.S. dollar after the crisis. Hong Kong, Japan, Singapore, and Philippines have maintained identical exchange rate regimes before and after the 1997/98 financial crisis.

It is well acknowledged that the U.S. dollar had played a dominant role as an international anchor currency in the East Asian economies before 1997: Hong Kong adopted the fixed exchange rate regime with a currency board arrangement. The Chinese RMB was also pegged to the U.S. dollar but with occasional adjustments. The Thai baht and Malaysian ringgit were similarly stable against the U.S. dollar, although these monetary authorities officially adopted a multiple currency basket system. Singapore, Korea and the Philippines also targeted their currencies to the U.S. dollar rather loosely by combining discretion and market pressure with varying weights.

[4] Note that exchange rate arrangements of Indonesia, Korea and Thailand also experienced the independently floating during the sample period according to the IMF classification.

Indonesia was on a *de facto* crawling peg to the U.S. dollar by sliding the rupiah by several percent per year to offset the inflation gap between home and abroad. After 1997, most of the crisis-affected Asian economies have shifted their exchange rate regimes from *de facto* U.S. dollar pegs to floating ones[5]. Thailand, Indonesia, Korea, and Philippines began to adopt floating exchange rate system since the crisis. In contrast, Malaysia stated pegging to the U.S. dollar in September 1998. China and Hong Kong have also kept their currencies pegged to the U.S. dollar after the crisis. Recently, the Chinese government announced that the official exchange rate system have shifted to the managed floating in July 2005. Malaysia also gave up pegging U.S. dollar and began to adopt the managed floating subsequently.

The recent literature on the classification of exchange rate regimes identifies a growing disconnect between *de jure* and *de facto* exchange rate regimes. The IMF classification (*de jure*) relies exclusively on official declaration by each government and shows some contradictions with the prevailing *de facto* classifications. Calvo and Reinhart (2002) argue that the *de jure* exchange rate arrangements do not always describe the actual practice of exchange rate polices, nor do they offer sufficient information on accurate state and evolution of exchange rate polices in emerging East Asia, particularly for crisis-affected countries. Thus, a number of recent studies focus on the *de facto* regime classification and mainly examine the observable outcomes and actual behaviour of exchange rates (Frankel *et al*., 2002; Calvo and Reinhart, 2002; Kim, 2003; Reinhart and Rogoff, 2004; Shambaugh, 2004; Levy-Yeyati and Sturzenegger, 2005).

2.3.2 Prevailing Thoughts on Exchange Rate Regimes in East Asia

Suggested Regime Types for East Asian Economies

The pre-crisis U.S. dollar pegged regime was universally recognized as one of the causes of crisis in East Asian countries. It is suggested that the *de facto* pegs to the U.S. dollar sometimes destabilized the real effective exchange rates of these currencies in the

[5] See Baig (2001) for a detailed description of exchange rate behaviour in East Asia after the crisis.

pre-crisis period. In particular, as the Japanese yen depreciated against the U.S. dollar from 1995 to 1997, appreciation of the real effective exchange rates reduced the export competitiveness and increased current account deficits in the East Asian economies (Corsetti *et al*., 1998 and Ito *et al*., 1998). Regarding the desirable exchange rate regimes, several proposals have been brought forward for East Asian economies. The IMF advocates more flexible exchange rate regimes among East Asian economies, or at least those countries should prepare for an existed strategy if they currently adopt fixed exchange rates (Mussa *et al*., 2000). Recent experience of financial crises suggests that openness, higher capital mobility and low inflation, which are typical characteristics for emerging markets in East Asia, make flexible exchange rates more viable.

In contrast, a number of authors pointed out many weaknesses of flexible exchange rates and various forms of fixed exchange rate regimes have been proposed for East Asian economies: either to the USD (dollar standard bloc) (McKinnon, 2000), or a common basket of USD/Euro/Yen (Goto and Kawai, 2001), the basket/band/crawl – or BBC (Williamson, 2000), or a common Asian currency unit (ACU) (Ogawa and Ito, 2000). Moreover, a common arrangement such as an optimal currency area (OCA) among East Asian countries has been proposed. However, some other authors have suspicions on feasibility of East Asian OCA, considering the given immature economic fundamentals. De Brouwer (2001) argues that East Asian economies are so diversified in terms of trading partners and export components, which require very different monetary and exchange rate responses when dealing with external shocks.

The desirability of intermediate exchange rate regime has also been proposed by several researchers as the intermediate exchange rate regime might stabilise their effective exchange rates (Bénassy-Quéré, 1999b; Williamson, 1999, 2000; Rajan, 2002). In contrast, the "Hollowing of the Middle" view or "bipolar" (two-corner) solution suggests that only hard peg and independent floating are viable regimes while the regimes in the middle such as a soft peg or a managed float are argued to be unsustainable and crisis-prone since they lack credibility and are vulnerable to speculation attacks (see, for example, Fischer, 2001). However, some studies recognize

that managed floating and other middle regimes are viable for many countries with certain conditions of capital mobility and economic development (for example, Mussa *et al*., 2000). According to this view, interior solutions turn out to be the best (or at least the second best) for many countries with low capital mobility, underdeveloped capital and foreign exchange markets.

"Fear of Floating" Hypothesis

Another concept, which has become popular in the recent literature on exchange rate regime choice, is the "fear of floating". This argument suggests the actual behaviour of exchange rate management is close to a managed or pegged arrangement, in spite of their officially declared floating policy. Several studies (see, for example, Hernández and Montiel, 2001; Calvo and Reinhart, 2002) point out that only a short time after the crisis, the exchange rate regimes of East Asian economies have in fact returned to their previous (*de facto*) fixed regimes despite their official announcements that exchange rates are flexible. Some researchers further state that the so-called floating exchange rate regimes of the East Asian countries are not really floating, by showing statistical evidence that East Asian currencies are reverting back to *de facto* dollar pegs (McKinnon, 2000; McKinnon and Schnabl, 2004). Many countries, in which *de jure* free floating exchange rate regimes are claimed to be adopted, have attempted to reduce exchange rate fluctuations through foreign exchange interventions (i.e., in the case of Korea, see Park *et al*., 2001).

There are many reasons can be attributed to the "fear of floating":

First, it is widely believed that exchange rate stability would significantly promote trade and investment while no direct implication from standard theory strongly supports this argument. Studies suggest that institutionally fixed exchange rates (i.e., common currency, currency boards or dollarization) can stimulate trade, which in turn boosts income. Proponents of the European Monetary Union have used such an argument extensively in support of a single regional currency. Some other empirical evidence

shows that fixed exchange rates have positive effect on investment, directly or indirectly through real interest rate (Ghosh *et al*., 1995; Levy-Yeyati and Sturzenegger, 2001). Hence, the adoption of fixed exchange rates is argued to promote growth through high saving and investment for emerging market. This in turn may explain why these countries have a tendency of "fear of floating".

Second, the dollarization liability is the other factor to induce "fear of floating". As pointed by Cavoli and Rajan (2003), many emerging economies are unable to borrow overseas in their domestic currencies and these countries thereby accumulate foreign currency debt liabilities which are primarily denominated by dollar or foreign currencies. This is commonly referred to as the "original sin" or "dollarization liability" problem (*Hausmann* et al., 2001). In addition, exchange rate stability is important to emerging economies because a sharp depreciation in these countries' currencies would alter the domestic currency value of their external debt and thereby the net worth of the economies. This may further put domestic banking and corporate sectors under severe bankruptcy pressure, resulting in a financial crisis (Williamson, 2000). In terms of this, the fixed exchange rate, more or less, seems preferable to East Asian economies that cannot preclude themselves from the original sin. This in turn may explain why these countries have a tendency of "fear of floating".

Third, in order to gain credibility and keep commitment to the monetary discipline, policymakers in emerging countries might restrain the high volatile of exchange rates. Reinhart and Rajan (2008) argue that the policymakers in emerging markets have a poor track record in monetary and fiscal policy. As a result, emerging markets may encounter large and frequent shocks to exchange rate expectations or to interest rate risk premiums. A true floating regime allows the exchange rate to absorb these external shocks while a true peg regime keeps the exchange rates stable by allowing the interest rates to adjust. Countries with "fear of floating" will allow for some flexibility in both exchange rates and interest rates but the latter variable absorbs most of the shock. This might explain why emerging economies with officially floating exchange rates have domestic interest rates whose volatility is considerably higher than that in the developed countries.

Fourth, Reinhart and Rajan (2008) point out another reason for "fear of floating" is that the domestic prices of small and open economies are relatively more venerable to exchange rate pass-through effects. The higher exchange rate pass-through implies that small and open economies may be more concerned about the potential inflationary consequences of exchange rate fluctuations. This would indicate there is more reason for these countries to fear floating. In addition, currency stability is viewed as a necessary condition for developing countries which access to global financial markets. As suggested by Reinhart and Rajan (2008), a sharp depreciation in the nominal exchange rate will often lead to a reversal of capital flows which is associated with a sharp adjustment in the current account combined with a contraction in output as well as a collapse in credit ratings.

In short, the debate over the desirable exchange rate regimes for East Asian countries seems to continue and it is necessary to clarify the position of this study among the aforementioned debates on exchange rate regimes. Our work follows the "fear of floating" hypothesis, considering the approach of "two-corner" solution does not seem to be realistic in many emerging East Asian economies under investigation. For the empirical analysis undertaken in the following sections, it is presumed that most emerging East Asian economies involved in the study have adopted "soft peg" regime in the exchange rate management, namely, intermediate regime placed between free floating and rigid fixed systems. Note that Hong Kong adopts the currency board arrangement in the exchange rate policy and it thus is not presumed as the "soft peg" group in the analysis.

Then under this framework, the next sections of this chapter will adopt several approaches to statistically examine the actual exchange rate behaviour and exchange rate regimes of East Asian economies in the advent of the 1997/98 currency crisis. By looking at data in a more detailed way, this chapter attempts to detect the possible change of exchange rate regimes for a group of East Asian countries in the pre-crisis, mid-crisis and post-crisis periods. Our study begins with examining the relative importance of the anchor currency, that is, roles of the U.S. dollar, the Japanese yen, and

the European euro in the exchange rate polices of eight East Asian economies. The changing role of these anchor currencies in the East Asian exchange rate management before and after the crisis will be fully investigated and testified upon a set of hypothesis. This study also explores whether the flexibility of exchange rate regime has increased from the pre-crisis period towards the post-crisis period. Furthermore, through analysing actual exchange rate movements, the regional coordination of exchange rate arrangements will be discussed in this study.

2.4 Empirical Investigation on the Exchange Rate Performance for East Asian Countries

2.4.1. Data Description and Preliminary Analysis

The exchange rate data used in this study are monthly series obtained from the International Financial Statistics of IMF, for the following sample countries/economies: China-mainland, Hong Kong, Japan, Thailand, Malaysia, Indonesia, Philippines, Korea, Singapore, EU, Germany and USA. The sample period covers from January 1990 to December 2005, and is splitted into three parts: the pre-crisis period of January 1990 to June 1997, the mid-crisis period of July 1997 to December 1998, and the post-crisis period of January 1999 to December 2005. Considering the unstable economic environment and the troubled foreign exchange markets in East Asia during the financial crisis, we mainly focus on two sub-data sets, namely the pre-crisis and post-crisis periods. Deutsche Mark serves here as a proxy for the Euro in the regressions for data gathered before 1999 while Euro is used instead for data gathered since January 1999. Thus, the partitioning of time periods allows for an examination of the particular significance of the Euro as a major currency since it actually came into existence.

Some statistics of the data in sample are presented in Table 2.2. Also, Figure 2.1 plots the movements of the exchange rates against Swiss Franc for each country during the

whole sampled period[6]. Figure 2.2 illustrates the annual exchange rate volatility of each country in sample over 1990-2005. The annual exchange rate volatility is defined as the standard deviation of the percentage changes of local currencies against U.S. dollar. Greater volatility of exchange rate can be obviously identified in 1997 for most East Asian countries with the exceptions of China (mainland) and Hong Kong. Much more volatile exchange rates movements can be observed for Indonesia, Korea, Philippines, Singapore and Thailand in the post-crisis period, consistently with either free floating or managed floating arrangements adopted by these countries after the crisis.

Table 2.3 depicts correlation coefficients between the exchange rate movements (the log first differences in the rate) for most crisis-affected countries in sample (China-mainland and Hong Kong are not considered here). The pre-crisis correlation coefficients were all close to unity due to their *de facto* U.S. dollar-pegged exchange rate arrangements. During the crisis period, however, the correlations of cross-currency suddenly declined. It is interesting to note that, towards the beginning of the post-crisis period, most of the correlations began to somehow rise, which was a sign of the restoration of more stable exchange rate arrangements in East Asia. However, these correlations have remained lower than what they were in the pre-crisis periods due to a flexible exchange rate arrangement adopted by most countries after the crisis.

2.4.2 Regression Based Approach to Exchange Rate Movements

One of the distinctive approaches to examine the *de facto* exchange rate arrangements in East Asia is to find, through regression analyses, which major currency or currency basket is chosen as a target for a particular country's exchange rate stabilisation and how closely such a relationship can be observed. If one country attempts to stabilize its exchange rate to a basket of multiple currencies, then the actual exchange rate arrangements can be reflected through the weights assigned by the authorities to the corresponding currencies in their exchange rate policies. In this way, the tasks are to identify specific currencies that comprise a basket used as a target for a particular

[6] The reason of using Swiss Franc as based currency is illustrated in the following section (Section 4.2).

country's exchange rate stabilisation, and to examine the influence of targeted or anchor currencies on local currency. We closely follow the Frankel and Wei (1994) model but highlight the role of Euro and take the stability analysis into account. Thus the exchange rate changes of each East Asian currency in this study are regressed on those of the U.S. dollar, the Japanese yen and the Euro. Note that Frankel and Wei (1994) and Ohno (1999) highlight that the impacts of other currencies such as the Euro/Deutsche Mark are negligible, and most previous studies mainly choose the U.S. dollar, Japanese yen but exclude Euro/Deustshe Mark as target currency in determining the value of East Asian currencies[7]. However, as suggested by Taguchi (2004), given East Asian diversified trade and foreign direct investment (FDI) relationships not only with the United States, Japan but also with the European Union, and given the continued large exchange rate volatility among the tripolar currencies, a reasonable exchange rate policy for many East Asian economies would be to stabilise rates to a basket of currencies consisting of the U.S. dollar, the Japanese yen, and the Euro. Therefore, the Euro/Deutsche Mark is taken into account in this study to re-examine its role in the determination of the values of East Asian currencies. The regression model is described as follows:

$$\Delta e(\frac{LC}{SF})_t = \beta_1 + \beta_2 \Delta e(\frac{USD}{SF})_t + \beta_3 \Delta e(\frac{JPY}{SF})_t + \beta_4 \Delta e(\frac{EU}{SF})_t + \varepsilon_t \qquad (2.1)$$

where,

LC : Local currency SF: Swiss Franc

Δe_t : First difference of log exchange rate on date *t*,

β_1 : Constant term,

β_K (k = 2, 3, 4): the weights of the U.S. dollar (USD), Japanese yen (JPY) and Euro (EU) on the local currency, respectively; ε_t : error term.

[7] Similar studies using Frankel and Wei (1994) model can be referred to, for example, Kwan (1995); Kawai and Akiyama (1998); McKinnon (2000).

In order to measure the exchange rate variation, the Swiss Franc is chosen as an arbitrary numeraire. As an independently floating currency of an advanced country, the Swiss Franc has a desirable property as a numeraire because it is widely transacted in international markets but little linkage with the East Asian currency and carries little weight in Asian trade. The estimated coefficients β_K are interpreted as the degree of influence of the U.S. dollar, Japanese yen and Euro, respectively, on the local currency. The value of β_K implies the weights assigned by the authorities to the corresponding currencies in their exchange rate policies. The estimated standard error of the residual is interpreted as a measure of the exchange rate volatility.

Exchange rate stabilisation to a single currency can be interpreted as a special case in which only one currency is identified with a significant and large positive weight, while the weights of other currencies are negligible, that is, the coefficient on the target currency for exchange rate pegging is close to unity, and the coefficients on the other currencies are all close to zero. In the case of that one country's currency is not pegged rigidly but is only loosely stabilised to another currency, the estimated coefficient for this target currency will be close to unity and be statistically significant, the standard error of residuals should take sufficiently small value. If one country's currency is tightly pegged, or stabilised to a basket of multiple currencies, then the estimated coefficient for this target currency should be statistically significant and its sum should approximately close to unity. In the case of a purely floating regime, no estimated coefficient for this target currency should be statistically significant, and the standard error of the residuals should be large.

Unit Root Tests

The estimation of Equation (2.1) requires tests for the presence of unit roots in the variables included in the equation. Before conducting the regression, the stationarity of all the data series is tested by employing Augmented Dickey-Fuller (ADF) test and Philips-Perron (PP) test. The length of lags included when implementing the unit root

tests are selected by the Schwarz Information Criterion (SIC). Table 2.4 reports that all the first-differenced data series are confirmed as stationary in both tests, thereby suggesting a regression analysis using all the first-differenced data series is valid.

Stability Analysis: CUSUM Test

It is not controversial that Asian crisis started with the Thai baht deprecation of July 1997. Nevertheless, it is still inconclusive as to when the financial crisis finished or whether it is really over. Hence, dating the post-crisis period becomes somewhat arbitrary for most previous studies. In addition, the financial crisis may have made a structural break in the relationship between East Asian currencies and anchor currencies (U.S. dollar, Japanese yen and Euro). Therefore, analysis of stability of regression equation would be necessary. This study performs the CUSUM test on the estimated equation for the pre-crisis period (January 1990 – June 1997) and the post-crisis period (January 1999 – December 2005).

The CUSUM test is based on the cumulative sum of the recursive residuals. It plots the cumulative sum together with the 5% critical lines and there is parameter instability if the cumulative sum goes outside the area between the two critical lines. To be specific, the CUSUM test is based on the statistic (Brown *et al*., 1975):

$$W_t = \sum_{r=k+1}^{t} w_r / s \qquad (2.2)$$

for $t = k+1,...,T$, where w is the recursive residual and s is the standard error of the regression fitted to all T sample points. If the coefficient vector remains constant from period to period, then $E(W_t) = 0$; but if coefficients changes, W_t will tend to diverge from the zero mean value line. The significance of any departure from the zero line is assessed by reference to a pair of 5 percent significance lines, the distance between which increases with t. Thus, movement of W_t outside the critical lines is

suggestive of coefficient instability. This technique is appropriate for time series data and might be used if we are not sure about when a structural break might have taken place. It can also check if the sub-sample periods under study are properly dated. As illustrated in Appendices 2.1 and 2.2, the CUSUM statistics of Equation (2.1) for the pre-crisis and post-crisis periods are within 5 percent critical lines, indicating relative stability in the estimated parameter values for the defined sub-sample periods. Therefore, it is justified to define the crisis period as July 1997 – December 1998, and we can hence safely define starting date of the post-crisis period as January 1999.

Regression Results Analysis

Pre-crisis Period

Table 2.5 provides a summary of regression results for the pre-crisis, mid-crisis and post-crisis periods. The estimation method is Ordinary Least Square (OLS). For the pre-crisis period, the estimated coefficients of the U.S. dollar were statistically significant and large (ranging from 0.711 to 1.043) in the Asia-8 currencies. Given that virtually all of the East Asian countries feature large magnitude of U.S. dollar coefficient estimates, accompanied by very small standard errors, and high goodness-of-fit results, it is clearly evident that currencies of East Asia maintained *de facto* pegs to the dollar in the pre-crisis period. In the cases of Singapore and Thailand, the magnitude of U.S. dollar coefficients were somewhat lower than those of the other sample countries, though generally highly significant, due to their formal or informal currency basket arrangements. The weights of Japanese yen and Deutsche mark were negligible for most currencies compared to the role of U.S. dollar, although the estimated coefficients of Japanese yen were also significant in some of the regressions (Korea, Singapore and Thailand). We also found the significant coefficients of Deutsche mark in Malaysia and Thailand. These results confirm the dominate role of U.S. dollar in the East Asian currencies and are in support of *de jure* or *de facto* dollar-stabilisation arrangements in many emerging East Asian economies during the pre-crisis period. Nevertheless, Japanese yen and Deutsche mark in general played limited role as part of

a currency basket in the pre-crisis period.

Crisis Period

The results obtained for the crisis period (July 1997 – December 1998) in most East Asian countries, reflecting the large swings in the regional currencies, feature poor goodness-of-fit, relatively smaller estimates of the dollar coefficient, as well as the large standard error of the regression for many crisis-affected countries in East Asia (Korea, Malaysia, Thailand). China and Hong Kong were relatively immune to currency speculation as far as the observed movements of exchange rates are concerned, and therefore we found no significant change in the dollar weight during the crisis. In the case of Philippines, the estimated coefficients on the dollar did not decline noticeably, but the adjusted R square declined sharply and estimated standard error of regression rose sharply. Even Singapore, which was not directly affected by the crisis, also witnessed declines in the dollar coefficients and in the adjusted R square. As the dollar weights declined in the mid-crisis period, the weights of the yen and Deutsche mark have significantly increased in some countries, particularly in Indonesia and Korea. However, considering the relative fewer observations in the mid-crisis period, the regression results might suffer from low power. During this period, Indonesia, Korea and Thailand switched their official classification of the exchange rate regimes from managed floating into independently floating. These events together with the initial exchange rate volatility following the regime switching can be reflected by the dramatic fall in the goodness-of-fit measures from the regressions.

Post-crisis Period

Results for the post-crisis period indicate a greater diversity in exchange rate arrangements than that in the pre-crisis period as shown in Table 2.5. On one hand, China and Hong Kong are under a stable dollar peg throughout this period, with dollar coefficients maintained at levels close to unity, and the adjusted R square close to one. The weights of U.S. dollar and adjusted R square are also close to unity in Malaysia,

which have returned to a formal dollar pegged arrangement in the post-crisis period. Considering the high Durbin-Watson statistic for Malaysia, the standard errors were also computed by the Heteroskedasticity consistent covariance of Newey and West (1987). Nevertheless, the estimation results were only marginally changed. On the other hand, for the countries such as Indonesia, Korea, Philippines, Singapore, and Thailand, the standard error of the dollar estimates are uniformly much larger and adjusted R squares are substantially lower than those in the pre-crisis period, indicating that the degree to which currencies are linked to the dollar is relatively less than those in the pre-crisis period. The results from the post-crisis regression do not support the view that these East Asian currencies have fully reverted to behaviour that is statistically indistinguishable from the pre-crisis characteristics.

In addition, the Japanese yen coefficients for Korea, Singapore and Thailand are statistically significant and much higher than values in the pre-crisis period. The magnitude of Euro coefficients have been detected much higher in Indonesia, Korea, Singapore and Thailand than they did in the pre-crisis period. Nevertheless, the only statistically significant Euro coefficient can be found in Singapore. These findings suggest that the currency regimes of Indonesia, Korea, Singapore and Thailand have moved in the direction of the greater flexibility, but not to the extreme pole of clean floating. This implies that the weights of anchor currencies in these countries approximately turned out to the currency basket levels recently. With regard to policy implications, we may conclude that these countries are not prepared to accept the constraints of a hard peg, or the polar extreme of free floating. However, the roles of Japanese yen and Euro after the crisis have become more important than those before the crisis in terms of determining the values of East Asian currencies.

2.4.3 The Roles of U.S. Dollar on the Local Currencies

According to the regression framework outlined in Equation (2.1), the extent to which the coefficient of U.S. dollar deviates from unity provides an indication of the flexibility of the currency against U.S dollar. Hence, the Wald coefficient test is applied for each

regression in the pre-crisis and post-crisis periods, to test the null hypothesis that the dollar coefficient is equal to one.

As displayed in Table 2.6, for the cases of China, Hong Kong, Indonesia, and Philippines, the null hypothesis is accepted for both pre-crisis and post-crisis periods at the 5 percent significance level, implying little flexibility of exchange rate against U.S. dollar in these four economies. In contrast, the null hypothesis is rejected by Korea, Singapore and Thailand for two sub-sample periods, and indicates relatively more flexibility of exchange rate against U.S. dollar, confirming the flexible exchange rate regime adopted by these countries. As for Malaysia, empirical tests show the opposite results for the pre-crisis and post-crisis periods, that is, less flexibility of exchange rate against U.S. dollar has been identified after the crisis than it did in the pre-crisis period. This result is consistent with the U.S. dollar pegged exchange rate regime officially adopted by Malaysia in the post-crisis period.

In addition, coefficient equivalence test is conducted to compare the weights of dollar in the currency basket before and after the crisis. Specifically, we hypothesise that the degree of pegging to the U.S. dollar in the post-crisis period was the same as the pre-crisis period. Following the hypothesis test by McKinnon (2000), one could reject this null if:

$$\left|\frac{(\beta_2)post-(\beta_2)pre}{\hat{s}_2(post)}\right| > 2 \quad [8] \qquad \text{where } \hat{s}_2 \text{ is the standard errors of } \beta_2 \tag{2.3}$$

This test is unnecessary in the cases of China, Hong Kong, which have fixed their exchange rates against the U.S. dollar across the whole sample period. Table 2.7 summarises the results for the rest of sample countries. We find that four out of six sample countries (except Indonesia and Singapore) reject the null hypothesis of equal

[8] In fact, if the statistics is higher than 1.96, then the null hypothesis is rejected at the 5 percent level of significance.

U.S. dollar coefficients before and after the crisis, implying significant changes of the U.S. dollar weights on these local currencies after the financial crisis. This finding is broadly consistent with the previous regression analysis, confirming the evidence of changing role of U.S. dollar in the currency basket of these countries (Korea, Malaysia, Philippines, and Thailand) in the post-crisis period.

2.4.4 The Weights of the Japanese Yen on Local Currencies before and after the Financial Crisis

For the whole sample period, we find that the weights of the Japanese yen in the determination of East Asian currencies are estimated to be much smaller than the weights of the U.S. dollar. Most previous studies, investigating the role of the Japanese yen in the determination of the values of East Asian currencies, reported that it was quite negligible despite the status of Japan as a major trading partner of most East Asian countries. This somewhat surprising finding can be explained by the implicit dollar peg policy of the East Asian local monetary authorities who had feared exchange rate volatility. Since most East Asian countries have been constructing more-market oriented foreign exchange markets and floating exchange rate systems after the financial crisis, it is possible to expect that the role of Japanese yen has increased after the financial crisis. Therefore, this section examines the possibility of an increased role of the Japanese yen since the crisis.

If the negligible role of the yen in the determination of the value of the East Asian currencies is the result of their explicit or implicit dollar-peg policy, the impact of the yen on their currencies after the crisis is expected to be greater than that before the crisis, reflecting the increasing importance of Japan as their major trading partner. Hence, we employ the similar hypothesis test as outlined in Section 2.4.3, and the null hypothesis that the weight of Japanese yen remains the same across the two sample periods is tested against the alternative, which assumes that it has increased after the financial crisis. Specifically,

$$H_0 : \beta_3^1 = \beta_3^2$$
$$H_1 : \beta_3^1 < \beta_3^2 \qquad (2.4)$$

where β_3^1 and β_3^2 are the weights of the Japanese yen in the pre-crisis period and the post-crisis period, respectively. The null hypothesis can be tested by computing the following statistics:

$$\frac{\hat{\beta}_3^2 - \hat{\beta}_3^1}{\hat{s}_3^2}$$

where $\hat{\beta}_3^2$ and $\hat{\beta}_3^1$ are the estimated values for β_3^2 and β_3^1, and $\hat{s}_3^2$ is the standard errors of β_3^2. If the absolute value of statistics is higher than 1.96, then the null hypothesis is rejected at the 5 percent level of significance.

The statistics of hypothesis test are reported in Table 2.8. At the 5 percent significance level, this null hypothesis is rejected in China, Korea and Malaysia but is accepted in Hong Kong, Indonesia, Philippines, Singapore, and Thailand. This finding suggests that the weight of Japanese yen has increased in the post-crisis period for China, Korea, Malaysia, and implies the status of Japan as major trading partner in these three countries. As for other economies, the significantly increased role of the Japanese yen in determining the local currencies has not been found since the crisis.

2.5 The Flexibility of Exchange Rate Regime

As mentioned earlier, recent literature in exchange rate regimes in East Asia has documented a significant divergence between *de facto* and *de jure* exchange rate arrangements. Empirical studies like McKinnon (2001), Calvo and Reinhart (2002), and Fukuda (2002) suggest that exchange rates in East Asia can still be characterised as soft U.S. dollar pegs, while other studies (see, for example, Baig, 2001; Hernández and Montiel, 2001, Kawai, 2002) point out that exchange rates in East Asia have become

more flexible after the crisis. The diversity in these results, however, might be attributed to the different methodologies and measurements adopted by these empirical studies. In addition, different time periods and frequency of data used (daily, monthly or quarterly) could lead to the diverse conclusions. In this section, we revisit the evidence regarding the extent of flexibility of exchange rate regime for countries which either previously adopted the intermediate regime or have officially changed their exchange rate arrangements after the crisis. Hence, six East Asian countries including Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand are examined in this section. China-mainland and Hong Kong are dropped from the analysis here due to the fact that there are no officially changes of exchange rate arrangements for both economies after the financial crisis. Extending the literature, data of recent years (up to 2005) are concerned in this study to examine the recent trend of regime flexibility. For the purpose of consistency of dataset and sample period covered in this whole study, still, monthly frequency data series for the period from 1990 to 2005 are used in this section.

To detect the degree of flexibility, or inversely, the extent of intervention, an exchange rate flexibility index, similar to the work done by Glick and Wihlborg (1997), Bayoumi and Eichegreen (1998), and Baig (2001), is defined as follows:

$$\text{Flexibility Index} = \sigma_{ER} / (\sigma_{ER} + \sigma_{NFA}) \tag{2.5}$$

where σ_{ER} is the annual standard deviation of monthly (log) percentage changes in the exchange rate, σ_{NFA} is the annual standard deviation of monthly percentage changes in reserves (the ratio of net foreign assets divided by lagged base money)[9]. The movements of exchange rate or reserves, in isolation, might not provide an accurate picture of exchange rate regime. However, the combination of exchange rate and reserves can be viewed as a more informative indicator of exchange rate flexibility, which, could be used for further analysis of exchange rate regime behaviour. This index

[9] Line 11 of the IFS database (foreign assets of the monetary authorities) is used as the measure of foreign exchange reserves. The monetary base is obtained as Line 14 of the IFS.

combines the volatilities of exchange rates, and provides insights into the possible effects of reserve intervention from a policy perspective. By construction, the index ranges from 0 to 1. A low value in this instance implies less flexibility or a high degree of intervention. Other things being equal, high reserve volatility will reduce the index value, possibly indicating that reserves are being employed as a monetary policy tool in order to limit exchange rate flexibility, that is, the relatively highly pegged regime is operated accordingly. Thus, the closer index is to 1 ($\sigma_{NFA} \to 0$), the more flexible the exchange rate regime; and the closer to 0 ($\sigma_{ER} \to 0$), the more pegged the regime.

For comparative purpose, the whole sample is divided into the pre-crisis and post-crisis sub-samples to examine the discernible change before and after the 1997/98 financial crisis for each country. The results summarised in Table 2.9 tracks the flexibility of exchange rate regime based on the flexibility index defined in Equation (2.5) for each East Asian economies in the pre-crisis, mid-crisis and post-crisis period, respectively. It is apparent that there is relatively low flexibility index in the pre-crisis period (Table 2.9 (A)), suggesting an inflexibility of exchange rate regime for most sample countries. The index reflected in Table 2.9 (B) illustrates the crisis-related movements and reveals an increase in exchange rate flexibility during the crisis period, accompanied by the greater volatility of exchange rates. However, the post-crisis figures (Table 2.9 (C)) are broadly consistent the findings in the previous section: for Indonesia, Korea, Philippines, Singapore and Thailand, the exchange rates have become somewhat less flexible than the crisis period, but they remain consistently more flexible than pre-crisis years. In short, it is evident that most East Asian economies have been adopting exchange rate arrangements with greater flexibility after the crisis. The only exception can be found in Malaysia, whose exchange rate regime has become completely inflexible vis-à-vis the U.S. dollar. This finding is consistent with its pegged U.S. dollar exchange rate arrangements officially announced after the crisis.

2.6 Regional Coordination of Exchange Rate

As aforementioned, a group of countries in East Asia have subsequently changed their exchange rate arrangements after the crisis in 1997-98. A question arises is how this new environment influences on the East Asian economy. Researchers and policy markers are especially keen to investigate in the change in the economic linkages among these countries, as many of the East Asian countries are seeking for economic cooperation in various forms. It is generally believed that regional cooperation and integration have increased fast in trade, investment, and finance. The Asian financial crisis, to a certain extent, acted similarly as an exogenous shock to promote Asian monetary cooperation. For example, aside from the already established ASEAN free trade agreement, both China and Japan have shown much interest in forming a Free Trade Agreement with Korea. East Asian countries are also considering deepening monetary cooperation, indicated by the discussions followed by the Chiang Mai Initiative. The Chiang Mai Initiative agreed upon by the ASEAN plus 3 which mainly acted as a form of self-insurance in case of another financial crisis. It was the first significant regional financing arrangement to enable countries to cope with disruptive capital flows and maintain exchange rate stability. Subsequently, a more significant step was the decision by the Executive's Meeting of East Asia-Pacific Central Banks to set up the Asian Bond Fund (ABF) in dollar-dominated instruments in 2003. Aiming at developing a regional bond market, the ABF creates an operational framework which should advance and focus monetary cooperation. These endeavours have achieved considerable results, although somewhat slowly (Jung, 2008).

As the recent debates over the exchange rate regimes in East Asia are going further, some researchers argued that there must be coordination in selecting an exchange rate regime among countries in the region with similar trading structures and with high intra-regional trading shares. In particular, Bayoumi *et al*. (2000) analyse the possibility of an optimal currency area in East Asia but find ASEAN today is less suitable for a regional monetary arrangement than the euro area, after reviewing evidence on patterns

of trade, economic shocks, the extent of factor mobility and the monetary transmission mechanism. They further highlight the role of political commitment in forming a regional monetary arrangement. Ogawa and Ito (2000) point out an optimal exchange rate regime of country A depends on the exchange rate regime of country B, with which country A has a high proportion of trade. Kawai (2002) also highlights the greater coordination on the currency basket policy would be desirable for intra-regional exchange rate stability, and this needs to be supported by regional surveillance and financing mechanisms.

Our research does not intend to be involved in the above arguments on the feasibility of regional currency unit and exchange rate coordination in East Asia. Instead, we are interested in testing whether the regional exchange rate coordination has been strengthened after the Asian crisis. To materialize regional coordination in exchange rate, Granger causality test is conducted on bilateral relation among regional currency values. This is because the strong regional currency interdependence is the most important rationale for the regional exchange rate cooperation. The procedure employed is utilised in testing whether changes in one variable are a "cause" of changes in another. It also helps us to determine the predictability relation between the two variables. If coordination of exchange rate for two countries in the East Asian region has been increased, we may expect the evidence of significant predictability relation between their currencies. Hence, the following bivariate system can be constructed and estimated for all possible pairs of (x_t , y_t) series in the group:

$$\Delta y_t = \alpha + \sum_{j=1}^{N} \beta_j \Delta y_{t-j} + \sum_{j=1}^{N} \gamma_j \Delta x_{t-j} + \mu_t \tag{2.6}$$

$$\Delta x_t = \alpha + \sum_{j=1}^{N} \beta_j \Delta x_{t-j} + \sum_{j=1}^{N} \gamma_j \Delta y_{t-j} + \varepsilon_t \tag{2.7}$$

where y_t denotes currency of country y and x_t denotes currency of country x. All currencies are expressed against the U.S. dollar. The first differences of all log-level

series are used and marked as the operator of Δ. Therefore, not to reject $H_0 : \gamma_1 = \gamma_2 = ... = \gamma_k = 0$ in Equation (2.6) implies that changes of x_t do not Granger cause changes of y_t. Likewise, not to reject $H_0 : \gamma_1 = \gamma_2 = ... = \gamma_k = 0$ in Equation (2.7) implies that changes of y_t do not Granger cause changes of x_t.

Table 2.10 presents the results of Granger causality test on East Asian currencies pairs. The reported F-statistics with probabilities are the Wald statistics for the joint hypothesis $\gamma_1 = \gamma_2 = ... = \gamma_k = 0$. First, in the pre-crisis period, the null hypothesis is rejected on the causality from Chinese yuan to Malaysia ringgit, Japanese yen to Hong Kong dollar, Malaysia ringgit to Chinese yuan, Singapore dollar to Hong Kong dollar, and Thail baht to Hong Kong dollar at the five percent significance level, but accepted in other bilateral relations. This finding suggests a certain degree of predictability relation between currencies of some countries. Second, in the post-crisis period, the only evidence of causality can be found from Japanese yen to Philippine peso, Indonesia rupiah to Singapore dollar. The null hypothesis of non-causality cannot be rejected for other bilateral relations. Therefore, the results of Granger causality suggest little evidence of regional exchange rate coordination. This kind of coordination in the East Asian region has not been strengthened as a whole in the post-crisis period either. Our finding is in line with other empirical studies like Bayoumi *et al*. (2000) who suggest that little progress has been achieved in the monetary and exchange rate arrangements. It seems that the recent liberalisation and deregulation of financial markets in East Asian countries has driven them to closer integration into global financial markets rather than strengthening regional financial integration. This is possibly owing to the differences in the stages of development and in the legal and regulatory environments between these countries. Regarding this, East Asian countries still have to make strong efforts to promote regional monetary and financial cooperation. The firm political commitment to exchange rate decisions, at the same time, would be crucial to ensuring the form of a regional monetary and exchange rate arrangement.

2.7 Conclusion

This chapter has provided an empirical study on the exchange rate arrangements of East Asian countries. It examined the development of exchange rate arrangements in East Asian economies over the last 15 years. It considered both "official" and "observed" exchange rate arrangements and exchange rate behaviours of eight economies including both non-crisis affected countries and crisis-hit countries in order to provide a comparative study from an international perspective.

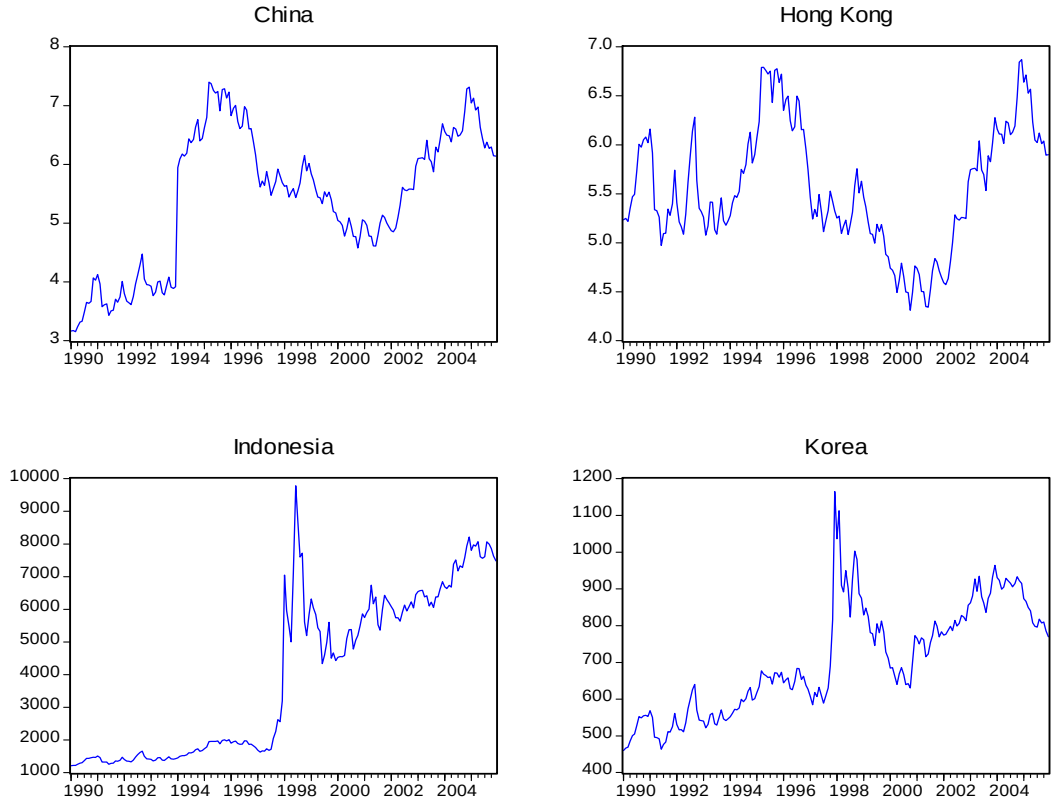
By examining the changing weights of the U.S. dollar, the Japanese yen, and the Euro as anchor currencies on the exchange rate stabilisation of East Asian countries, this study confirmed that the U.S. dollar played a dominant role as a *de jure* or *de facto* anchor for emerging East Asia until the 1997/98 currency crisis. We found that the distribution of exchange rate arrangements of the East Asian economies after the financial crisis is classified into two broad categories. One group is the case in some economies such as China, Hong Kong and Malaysia, where the weight of the dollar has regained or kept prominence. The other group is the case of Indonesia, Korea, Singapore, Philippines, and Thailand in which the dollar dominance reduced and maintained a *de facto* currency basket regime after the crisis. Moreover, the flexibility of exchange rate regime has indeed been increased for most East Asian countries which officially adopted the floating regime in the post-crisis period. The results suggest that the currency regimes of Indonesia, Korea, Singapore and Thailand have moved in the direction of the greater flexibility, but not to the extreme pole of clean floating. This again implies that the weights in these countries approximately turned out to the currency basket levels recently. The exchange rate regime of Malaysia has become completely inflexible vis-à-vis the U.S. dollar, consistent with its pegged U.S. dollar exchange rate arrangements officially announced after the crisis. In addition, the importance of regional financial cooperation in East Asia has been highlighted after the financial crisis of 1997/98. There is a storing perception about more effective regional frameworks which could help to prevent and manage the crisis. Given the changes of exchange rate

arrangements for a group of East Asian countries, we may expect the possible change in the regional coordination of exchange rate after the 1997/98 financial crises. However, the results of Granger causality tests provide little evidence on the increased regional coordination of exchange rate in the post-crisis East Asia.

A noteworthy implication from our empirical study is that a regime switch in an East Asian country indeed had an impact on the behaviour of exchange rates. Exchange rate policy plays an important role in influencing the movements of exchange rates. Despite more flexibility can be observed after experiencing transitional regime, the managed floating regimes rather than the free floating ones have been dominated for many emerging East Asian economies. Recently, the currencies of East Asian countries mainly move within a given band with their center targeted to a basket of anchor currencies including dollar, yen and Euro, given their diversified trade and foreign direct investment relationships with the United States, Japan and the European Union. This study further supports the argument of less possibility of forming an optimal currency area for East Asia region. Given the little evidence on the increased regional coordination in exchange rate after the crisis, strong efforts and firm political commitments are needed for East Asian countries to promote regional monetary and financial cooperation.

Figures:

Figure 2.1 Movements of Exchange Rates against Swiss Franc



(Continued) Figure 2.1 Movements of Exchange Rates against Swiss Franc

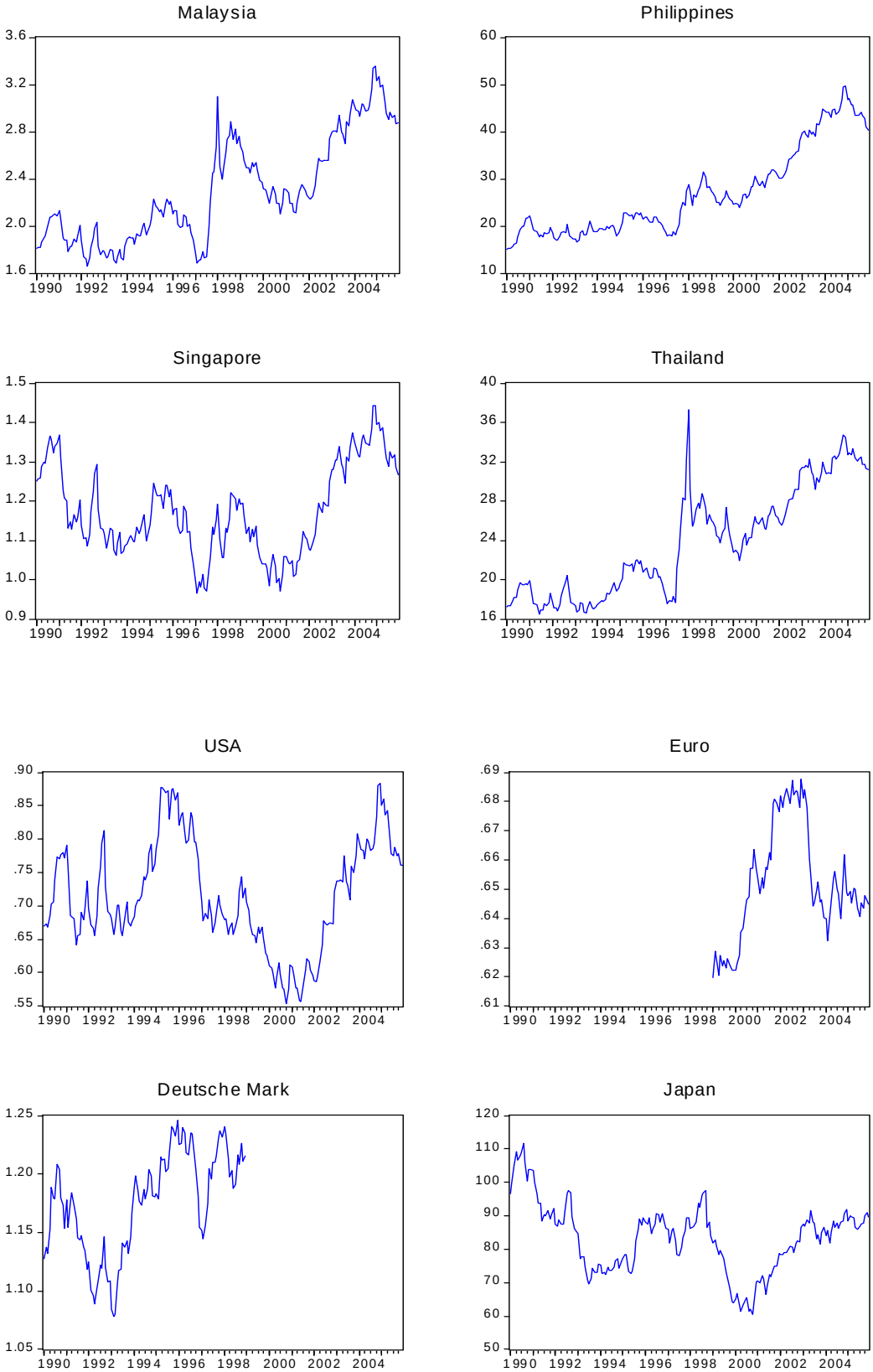
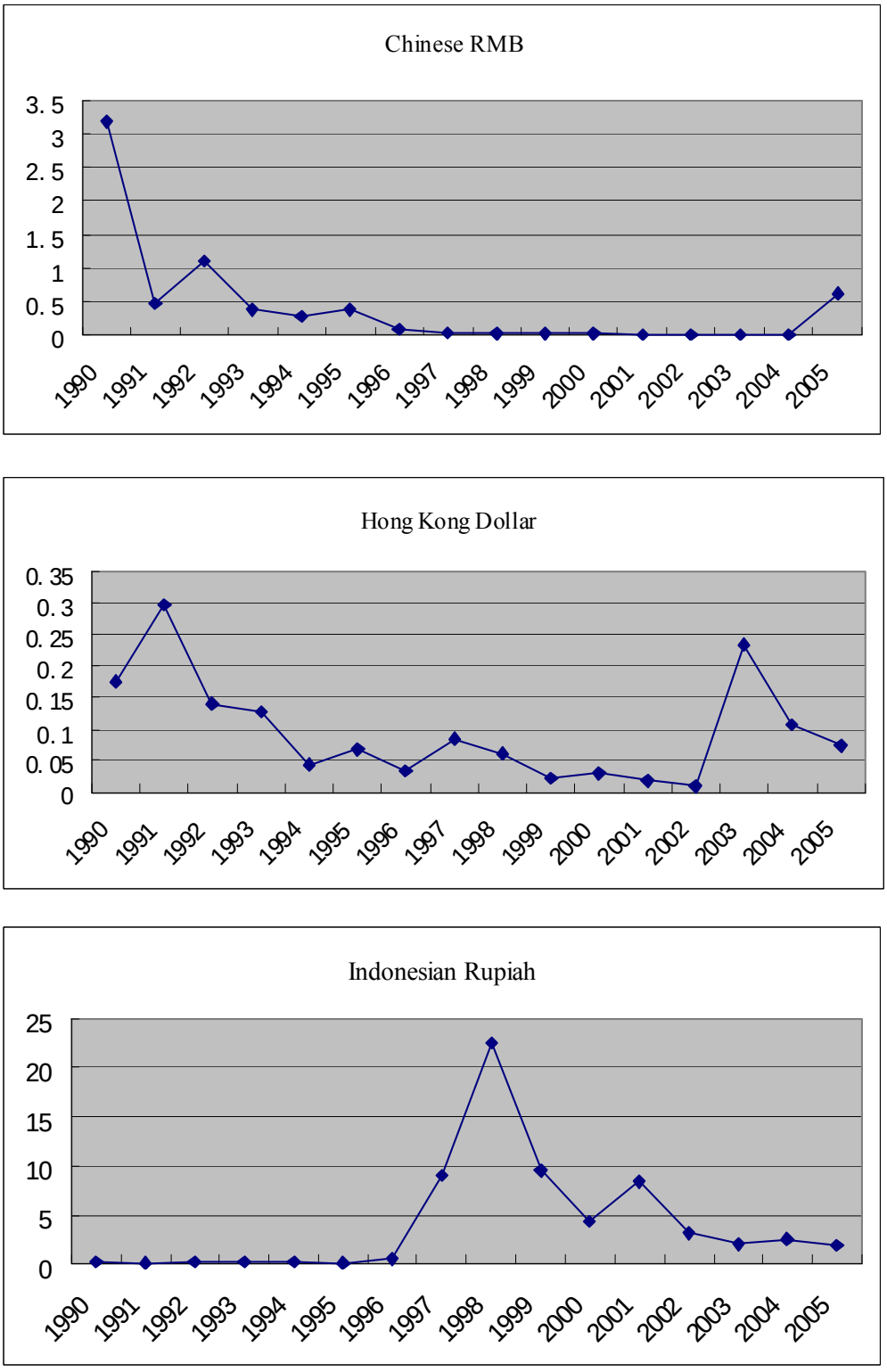
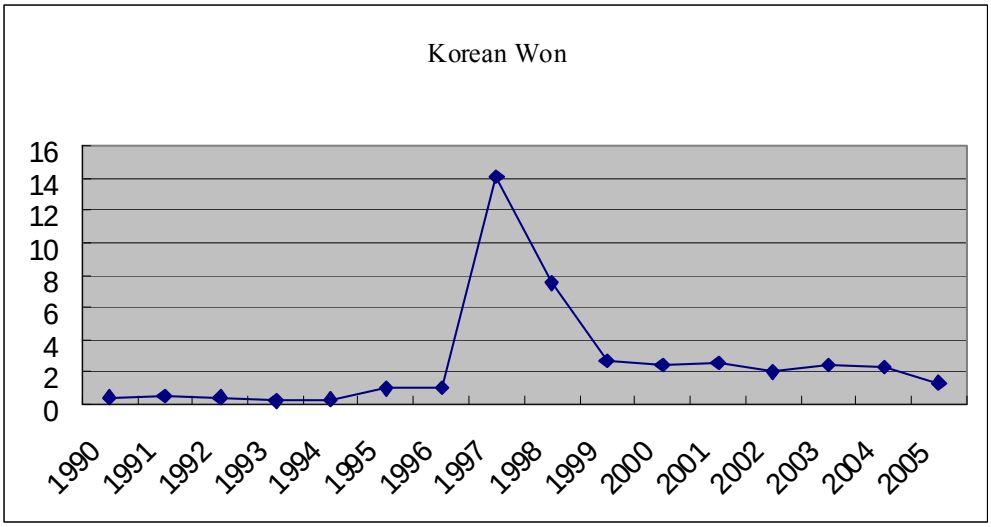
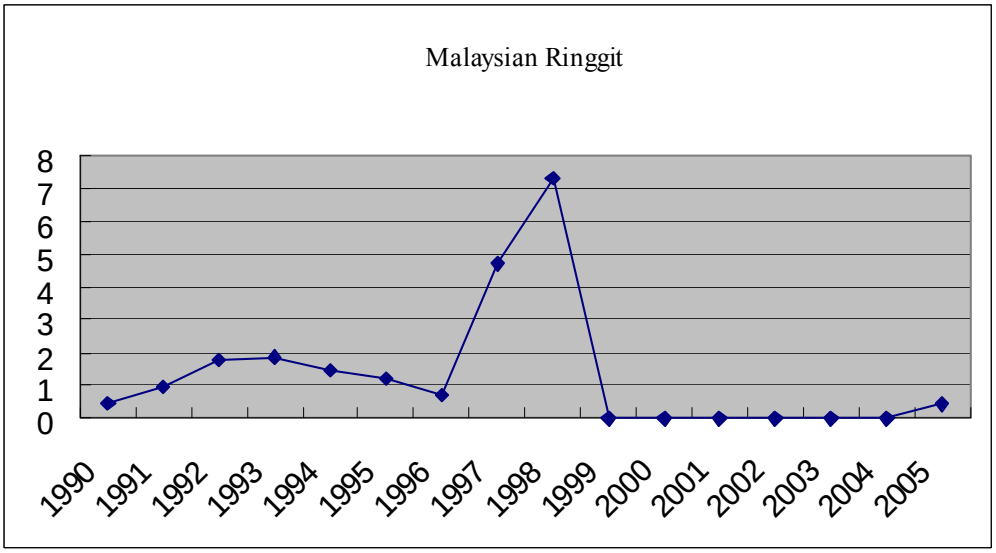


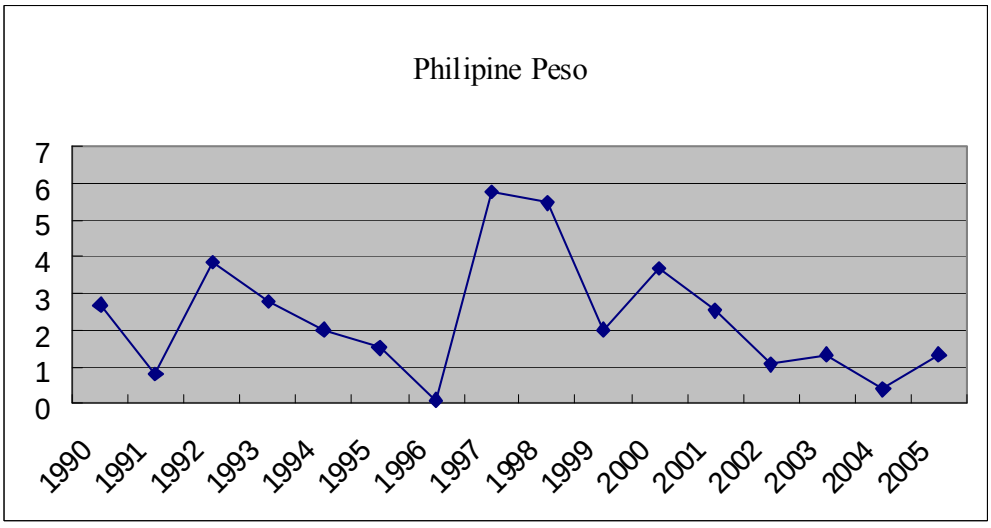
Figure 2.2 Standard Deviation of Exchange Rate against U.S. dollar (Percentage Changes)



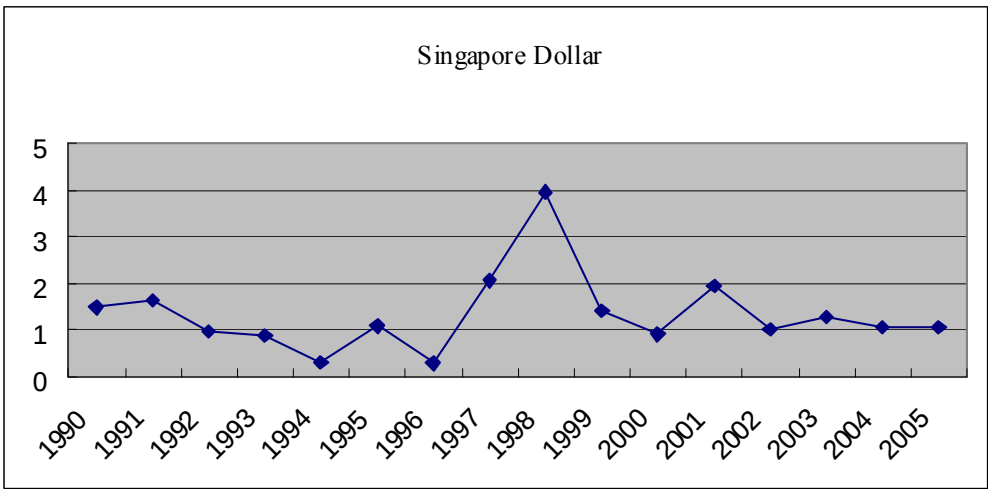
(Continued) Figure 2.2 Standard Deviation of Exchange Rate against U.S. dollar (Percentage Changes)

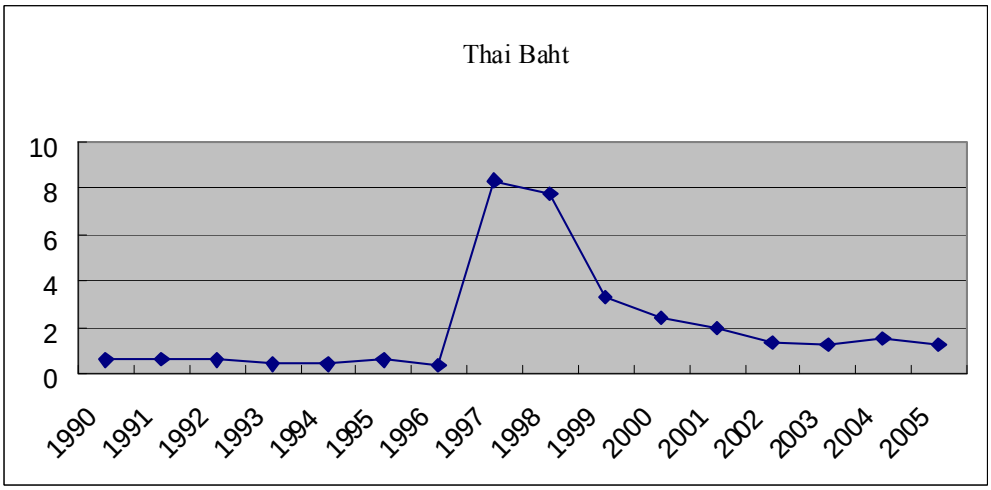






(Continued) Figure 2.2 Standard Deviation of Exchange Rate against U.S. dollar (Percentage Changes)





Tables:

Table 2.1 Official Exchange Rate Arrangements in the East Asian Economies

Country	Periods	Official Exchange Rate Regimes
China	Oct 1986-Sep 1998 Jan 1999-June 2005 July 2005-Present	Managed floating; Conventional fixed peg to the dollar; Managed floating
Hong Kong	Oct 1983-present	Currency board arrangement with a peg to the dollar
Indonesia	Dec 1983-July 1997 Aug1997-Sep 2001 Sep 2001-Present	Managed floating; Independently floating; Managed floating with no preannounced path for exchange rate
Japan	July 1982-Present	Independently floating
Korea	June 1982-Nov 1997 Nov 1997-present	Managed floating Independently floating
Malaysia	Sep 1975- June 1993 June 1993-Sep 1998 Sep 1998-June 2005 July 2005	Peg to other currency composite; Managed floating; Peg to the dollar; Managed floating
Philippines	Nov. 1984-Present	Independently floating
Singapore	Dec 1987-Present	Managed floating with no preannounced path for exchange rate
Thailand	Nov 1984-June 1997 July 1997-Sep 2001 Sep 2001-Present	Peg to other currency composite; Independently floating; Managed floating with no preannounced path for exchange rate

Source: International Monetary Fund, International Financial Statistics, various issues.

Table 2.2 Sample Mean and Standard Deviation

Variables	Mean	Std. Dev
EX_t^C	5.420	1.168
EX_t^H	5.551	0.619
EX_t^I	3970.059	2483.759
EX_t^M	2.292	0.440
EX_t^K	706.634	149.080
EX_t^P	26.948	9.295
EX_t^S	1.174	0.113
EX_t^T	23.809	5.478
EX_t^J	83.431	10.319
EX_t^U	0.715	0.080
EX_t^D	1.176	0.044
EX_t^E	0.652	0.019

Note: EX_t^i denotes the monthly exchange rate of the country i's currency against the Swiss Franc, where:
C= China,
H= Hong Kong,
I= Indonesia,
M= Malaysia,
K= Korea,
P= Philippines,
S= Singapore,
T= Thailand,
J= Japan,
U= US,
D= Germany,
E= Europe.

Table 2.3 Correlation Matrix of Exchange Rate Movements

Pre-crisis Period

	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand
Indonesia	1.000	0.973	0.937	0.875	0.965	0.993
Korea	0.973	1.000	0.919	0.850	0.956	0.977
Malaysia	0.937	0.919	1.000	0.825	0.934	0.943
Philippines	0.875	0.850	0.825	1.000	0.851	0.870
Singapore	0.965	0.956	0.934	0.851	1.000	0.976
Thailand	0.993	0.977	0.943	0.870	0.976	1.000

Mid-crisis Period

	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand
Indonesia	1.000	-0.003	0.587	0.351	0.445	0.631
Korea	-0.003	1.000	0.096	0.498	0.263	0.341
Malaysia	0.587	0.096	1.000	0.607	0.814	0.933
Philippines	0.351	0.498	0.607	1.000	0.571	0.743
Singapore	0.445	0.263	0.814	0.571	1.000	0.852
Thailand	0.631	0.341	0.933	0.743	0.852	1.000

Post-crisis Period

	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand
Indonesia	1.000	0.465	0.421	0.582	0.598	0.655
Korea	0.465	1.000	0.756	0.668	0.819	0.769
Malaysia	0.421	0.756	1.000	0.782	0.901	0.769
Philippines	0.582	0.668	0.782	1.000	0.793	0.835
Singapore	0.598	0.819	0.901	0.793	1.000	0.834
Thailand	0.655	0.769	0.769	0.835	0.834	1.000

Table 2.4 Unit Root Tests

Countries		ADF Statistics (Trend and Intercept)	PP Statistics (Trend and Intercept)
	Pre-crisis	-8.704***	-8.684***
China	Mid-crisis	-3.512*	-3.504*
	Post-crisis	-7.897***	-7.844***
	Pre-crisis	-7.810***	-7.810***
HongKong	Mid-crisis	-3.563*	-3.568*
	Post-crisis	-7.850***	-7.784***
	Pre-crisis	-7.933***	-7.933***
Thailand	Mid-crisis	-3.526*	-3.516*
	Post-crisis	-8.899***	-8.953***
	Pre-crisis	-8.727***	-8.723***
Philippines	Mid-crisis	-3.854**	-3.871**
	Post-crisis	-8.050***	-8.057***
	Pre-crisis	-8.186***	-8.149***
Korea	Mid-crisis	-3.915**	-3.914**
	Post-crisis	-8.404***	-8.403***
	Pre-crisis	-7.964***	-7.964***
Indonesia	Mid-crisis	-3.837**	-6.060***
	Post-crisis	-10.028***	-11.169***
	Pre-crisis	-8.031***	-7.966***
Malaysia	Mid-crisis	-4.032**	-4.343**
	Post-crisis	-7.959***	-7.892***
	Pre-crisis	-8.328***	-8.297***
Singapore	Mid-crisis	-3.601*	-3.585*
	Post-crisis	-8.772***	-8.801***
	Pre-crisis	-7.853***	-7.853***
USA	Mid-crisis	-3.502*	-3.491*
	Post-crisis	-7.950***	-7.882***
	Pre-crisis	-7.759***	-7.679***
Japan	Mid-crisis	-4.474**	-4.468**
	Post-crisis	-9.106***	-9.106***
Deutsch	Pre-crisis	-8.725***	-8.726***
mark	Mid-crisis	-4.110**	-4.109**
/ Euro	Post-crisis	-10.056***	-10.056***

Notes: ***, **, and * denote rejection of the null of unit root for the ADF and PP tests at the 1%, 5%, 10% significance levels, respectively. The currencies for each country in these tests are expressed as the log first difference exchange rates against Swiss Franc.

Table 2.5 Regression Results of Exchange Rate Movements

Numeraire: Swiss Franc

Chinese RMB

Period	Constant	US Dollar	Japanese Yen	Deutsch Mark/Euro	Adjusted R square	Durbin-Watson Statistic
	β_1	β_2	β_3	β_4		
Pre-crisis	0.006	0.927	-0.029	0.539	0.910	2.060
	(0.005)	(0.176)	(0.175)	(0.416)		
Mid-crisis	0.000	0.999	-0.001	-0.002	0.999	1.604
	(0.000)	(0.002)	(0.001)	(0.005)		
Post-crisis	0.000	1.005	-0.006	0.014	0.994	1.965
	(0.000)	(0.012)	(0.011)	(0.029)		

Note: Standard errors are in parentheses.

Hong Kong Dollar

Period	Constant	US Dollar	Japanese Yen	Deutsch Mark/Euro	Adjusted R square	Durbin-Watson Statistic
	β_1	β_2	β_3	β_4		
Pre-crisis	-0.000	0.996	-0.007	-0.011	0.999	2.470
	(0.000)	(0.005)	(0.005)	(0.013)		
Mid-crisis	1.80E-06	1.003	-0.001	-0.034	0.999	2.002
	(0.000)	(0.010)	(0.006)	(0.026)		
Post-crisis	2.67E-05	0.989	-0.002	0.005	0.999	1.862
	(0.000)	(0.005)	(0.004)	(0.013)		

Note: Standard errors are in parentheses.

(Continued) Table 2.5 Regression Results of Exchange Rate Movements

Numeraire: Swiss Franc

Indonesian Rupiah

Period	Constant β_1	US Dollar β_2	Japanese Yen β_3	Deutsch Mark/Euro β_4	Adjusted R square	Durbin-Watson Statistic
Pre-crisis	0.003	0.986	0.007	0.020	0.996	1.766
	(0.000)	(0.010)	(0.010)	(0.023)		
Mid-crisis	0.083	-2.879	0.771	0.869	0.276	2.030
	(0.069)	(0.076)	(1.667)	(1.785)		
Post-crisis	0.001	0.603	0.298	1.049	0.616	2.164
	(0.006)	(0.261)	(0.241)	(0.654)		

Note: Standard errors are in parentheses.

Korean Won

Period	Constant β_1	US Dollar β_2	Japanese Yen β_3	Deutsch Mark/Euro β_4	Adjusted R square	Durbin-Watson Statistic
Pre-crisis	0.003	0.926	0.112	-0.064	0.959	1.667
	(0.001)	(0.029)	(0.029)	(0.068)		
Mid-crisis	0.017	0.260	0.790	0.907	0.145	2.234
	(0.033)	(1.461)	(0.792)	(0.740)		
Post-crisis	-0.002	0.583	0.488	0.262	0.694	1.594
	(0.002)	(0.096)	(0.089)	(0.240)		

Note: Standard errors are in parentheses.

(Continued) Table 2.5 Regression Results of Exchange Rate Movements

Numeraire: Swiss Franc

Malaysian Ringgit

Period	Constant β_1	US Dollar β_2	Japanese Yen β_3	Deutsch Mark/Euro β_4	Adjusted R square	Durbin-Watson Statistic
Pre-crisis	-0.001	0.852	0.085	0.253	0.893	1.818
	(0.001)	(0.467)	(0.047)	(0.111)		
Mid-crisis	0.027	-0.324	0.185	0.849	0.178	1.976
	(0.022)	(0.967)	(0.524)	(0.475)		
Post-crisis	-6.98E-05	1.003	-0.003	0.014	0.997	2.668
	(0.000)	(0.008)	(0.007)	(0.020)		

Note: Standard errors are in parentheses.

Philippine Peso

Period	Constant β_1	US Dollar β_2	Japanese Yen β_3	Deutsch Mark/Euro β_4	Adjusted R square	Durbin-Watson Statistic
Pre-crisis	0.001	1.043	-0.021	0.321	0.767	1.848
	(0.002)	(0.086)	(0.086)	(0.205)		
Mid-crisis	0.016	1.023	0.330	0.406	0.211	2.243
	(0.017)	(0.769)	(0.417)	(1.970)		
Post-crisis	0.004	0.823	0.051	0.274	0.627	1.998
	(0.002)	(0.097)	(0.090)	(0.249)		

Note: Standard errors are in parentheses.

(Continued) Table 2.5 Regression Results of Exchange Rate Movements

Numeraire: Swiss Franc

Singapore Dollar

Period	Constant β_1	US Dollar β_2	Japanese Yen β_3	Deutsch Mark/Euro β_4	Adjusted R square	Durbin-Watson Statistic
Pre-crisis	-0.003	0.711	0.146	0.190	0.957	2.292
	(0.001)	(0.025)	(0.025)	(0.060)		
Mid-crisis	0.009	0.235	0.346	0.294	0.490	2.271
	(0.008)	(0.364)	(0.197)	(0.933)		
Post-crisis	-0.000	0.626	0.228	0.285	0.862	2.427
	(0.001)	(0.047)	(0.043)	(0.118)		

Note: Standard errors are in parentheses.

Thai Baht

Period	Constant β_1	US Dollar β_2	Japanese Yen β_3	Deutsch Mark/Euro β_4	Adjusted R square	Durbin-Watson Statistic
Pre-crisis	0.000	0.827	0.107	0.055	0.998	2.167
	(0.000)	(0.005)	(0.005)	(0.012)		
Mid-crisis	0.011	-0.109	0.377	0.300	0.201	1.987
	(0.025)	(1.095)	(0.593)	(0.803)		
Post-crisis	0.001	0.624	0.208	0.443	0.642	1.915
	(0.002)	(0.088)	(0.081)	(0.219)		

Note: Standard errors are in parentheses.

Table 2.6 Wald Coefficient Test

Null: the dollar coefficient is equal to one

Countries	Period	F-statistic/ Chi-square	Reject Null Hypothesis
China	1st	0.17	No
	2nd	0.17	No
Hong Kong	1st	0.51	No
	2nd	2.83	No
Indonesia	1st	2.25	No
	2nd	2.30	No
Korea	1st	6.70	Yes
	2nd	18.89	Yes
Malaysia	1st	9.95	Yes
	2nd	0.14	No
Philippines	1st	0.24	No
	2nd	2.99	No
Singapore	1st	131.10	Yes
	2nd	63.16	Yes
Thailand	1st	108.02	Yes
	2nd	18.49	Yes

Note: 1st denotes the pre-crisis period, 2nd denotes the post-crisis period.

Table 2.7 Hypothesis Test of Coefficient Equivalence (U.S. Dollar)

Null: coefficients of U.S. dollar are equal before and after the crisis

Countries	Statistics	Reject Null Hypothesis
Indonesia	-1.47	No
Korea	-3.57	Yes
Malaysia	18.88	Yes
Philippines	-2.1	Yes
Singapore	-1.81	No
Thailand	-2.31	Yes

Table 2.8 Hypothesis Test of Coefficient Equivalence (Japanese Yen)

Null: coefficients of Japanese yen are equal before and after the crisis

Countries	Statistics	Reject Null Hypothesis
China	2.09	Yes
Hong Kong	1.25	No
Indonesia	1.21	No
Korea	4.22	Yes
Malaysia	-12.57	Yes
Philippines	0.8	No
Singapore	1.91	No
Thailand	1.25	No

Table2.9 Degree of Exchange Rate Flexibility in the Period of 1990-2005

(A) Pre-crisis period

	1990	1991	1992	1993	1994	1995	1996
Indonesia	0.01	0.01	0.01	0.01	0.01	0.01	0.06
Korea	0.05	0.07	0.07	0.04	0.06	0.12	0.08
Malaysia	0.06	0.14	0.14	0.05	0.14	0.11	0.13
Philippines	0.43	0.11	0.27	0.24	0.21	0.19	0.02
Singapore	0.10	0.12	0.05	0.04	0.03	0.05	0.01
Thailand	0.06	0.06	0.05	0.04	0.06	0.05	0.03

(B) Crisis period

	1997	1998
Indonesia	0.24	0.33
Korea	0.39	0.15
Malaysia	0.50	0.22
Philippines	0.36	0.37
Singapore	0.11	0.09
Thailand	0.20	0.27

(C) Post-crisis period

	1999	2000	2001	2002	2003	2004	2005
Indonesia	0.27	0.18	0.22	0.14	0.11	0.12	0.10
Korea	0.08	0.11	0.08	0.05	0.05	0.05	0.04
Malaysia	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Philippines	0.18	0.22	0.23	0.09	0.09	0.06	0.10
Singapore	0.04	0.04	0.06	0.06	0.06	0.03	0.05
Thailand	0.14	0.24	0.31	0.16	0.10	0.32	0.26

Notes: the index is calculated by $\sigma_{ER}/(\sigma_{ER}+\sigma_{NFA})$ where σ_{ER} is the annual standard deviation of monthly (log) percentage changes in the exchange rate, σ_{NFA} is the annual standard deviation of monthly percentage changes in reserves (the ratio of Net Foreign Assets divided by lagged base money).

Table 2.10 Results of Granger Causality Tests on Bilateral Currency Values

A. Pre-crisis period (1990:1-1996:12)

F-Statistics (Probability)

Caused \ Cause	CNY	HKD	JPY	KRW	IDR	MYR	PHP	SGD	THB
CNY		0.177	0.820	1.160	3.218**	1.534	0.094	0.108	0.557
		(0.838)	(0.444)	(0.319)	(0.046)	(0.222)	(0.910)	(0.898)	(0.575)
HKD	0.120		0.010	0.798	1.025	1.566	0.621	0.007	0.244
	(0.887)		(0.990)	(0.454)	(0.364)	(0.216)	(0.540)	(0.993)	(0.784)
JPY	0.213	5.573***		0.371	1.324	0.782	1.056	1.689	0.101
	(0.809)	(0.006)		(0.691)	(0.272)	(0.461)	(0.353)	(0.192)	(0.904)
KRW	0.098	1.111	0.059		0.895	1.141	0.060	0.804	0.340
	(0.907)	(0.335)	(0.943)		(0.413)	(0.325)	(0.942)	(0.451)	(0.713)
IDR	13.669***	1.081	1.556	0.931		1.065	0.671	0.223	0.527
	(0.000)	(0.345)	(0.218)	(0.399)		(0.350)	(0.514)	(0.801)	(0.593)
MYR	0.944	0.886	0.485	2.258	1.467		0.186	0.080	0.229
	(0.394)	(0.416)	(0.617)	(0.111)	(0.237)		(0.831)	(0.924)	(0.796)
PHP	0.780	0.285	0.577	0.104	1.114	0.791		0.175	0.656
	(0.462)	(0.753)	(0.564)	(0.902)	(0.334)	(0.457)		(0.840)	(0.522)
SGD	1.653	8.572***	0.080	0.143	1.759	0.075	2.188		0.025
	(0.198)	(0.000)	(0.923)	(0.867)	(0.179)	(0.928)	(0.119)		(0.975)
THB	0.475	5.404***	0.545	0.580	2.705	0.690	1.477	2.631	
	(0.624)	(0.006)	(0.582)	(0.563)	(0.073)	(0.505)	(0.235)	(0.079)	

Notes: The null hypothesis is each currency in the first row does not Granger cause each currency in the first column. All currencies are in terms of units of U.S. dollar. The lag length is two months. ***, ** denote rejection of the null hypothesis at the 1% and 5 % significance level, respectively. P-values are in parentheses. CNY denotes Chinese Yuan; HKD denotes Hong Kong Dollar; JPY denotes Japanese Yen; KRW denotes Korean Won; IDR denotes Indonesia Rupiah; MYR denotes Malaysia Ringgit; PHP denotes Philippine peso; SGD denotes Singapore Dollar; THB denotes Thai Baht.

(Continued) Table 2.10 Results of Granger Causality Tests on Bilateral Currency Values

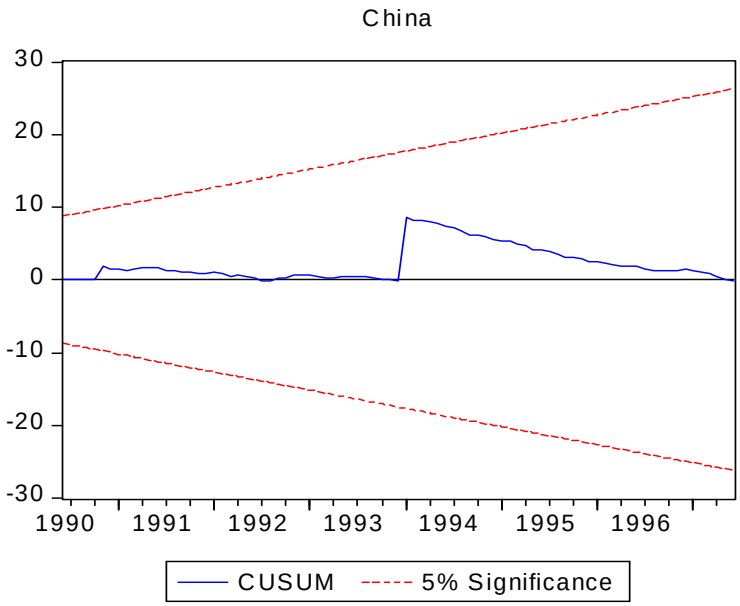
B. Post-crisis period (1999:01-2005:12)

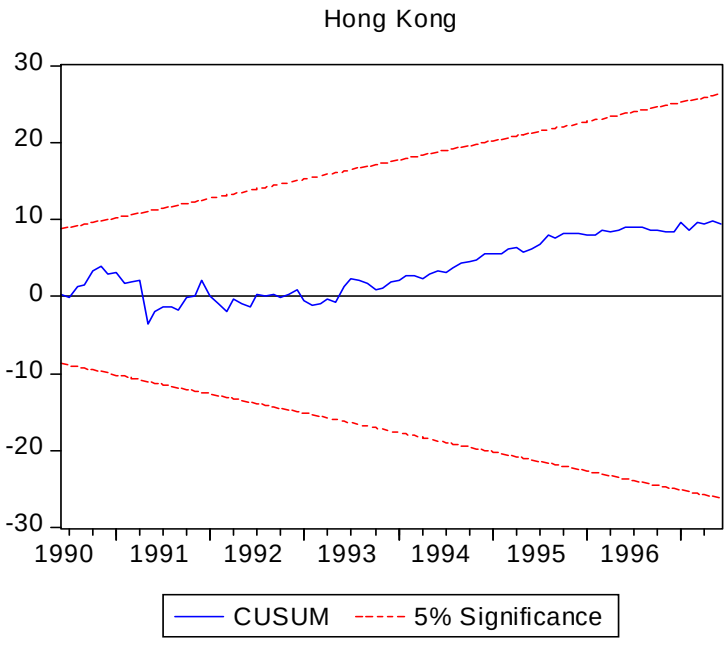
F-Statistics (Probability)

Caused \ Cause	CNY	HKD	JPY	KRW	IDR	MYR	PHP	SGD	THB
CNY		1.505	0.259	0.172	1.820	0.352	0.094	0.522	0.296
		(0.229)	(0.772)	(0.843)	(0.169)	(0.704)	(0.910)	(0.596)	(0.745)
HKD	1.938		0.608	0.112	0.974	0.163	0.128	0.644	0.520
	(0.151)		(0.547)	(0.894)	(0.382)	(0.850)	(0.880)	(0.528)	(0.596)
JPY	0.643	0.297		0.186	0.246	0.429	4.009**	0.347	0.862
	(0.529)	(0.744)		(0.831)	(0.782)	(0.653)	(0.022)	(0.708)	(0.427)
KRW	0.354	0.297	0.515		0.257	0.085	1.370	0.600	0.381
	(0.703)	(0.744)	(0.600)		(0.774)	(0.919)	(0.260)	(0.551)	(0.685)
IDR	0.073	0.748	0.209	0.207		0.513	0.102	0.607	0.239
	(0.930)	(0.477)	(0.812)	(0.814)		0.601	(0.903)	(0.548)	(0.788)
MYR	0.108	0.212	2.246	0.492	0.124		1.909	4.228**	1.038
	(0.898)	(0.810)	(0.113)	(0.613)	(0.884)		(0.155)	(0.018)	(0.359)
PHP	0.809	0.274	1.123	2.002	1.328	1.548		2.122	1.366
	(0.449)	(0.761)	(0.331)	(0.142)	(0.271)	(0.219)		(0.127)	(0.261)
SGD	0.825	0.353	0.600	1.257	0.538	0.794	0.881		0.152
	(0.442)	(0.703)	(0.551)	(0.291)	(0.586)	(0.456)	(0.419)		(0.859)
THB	0.904	0.941	0.749	0.368	1.076	0.818	0.587	0.332	
	(0.409)	(0.395)	(0.476)	(0.694)	(0.346)	(0.445)	(0.559)	(0.718)	

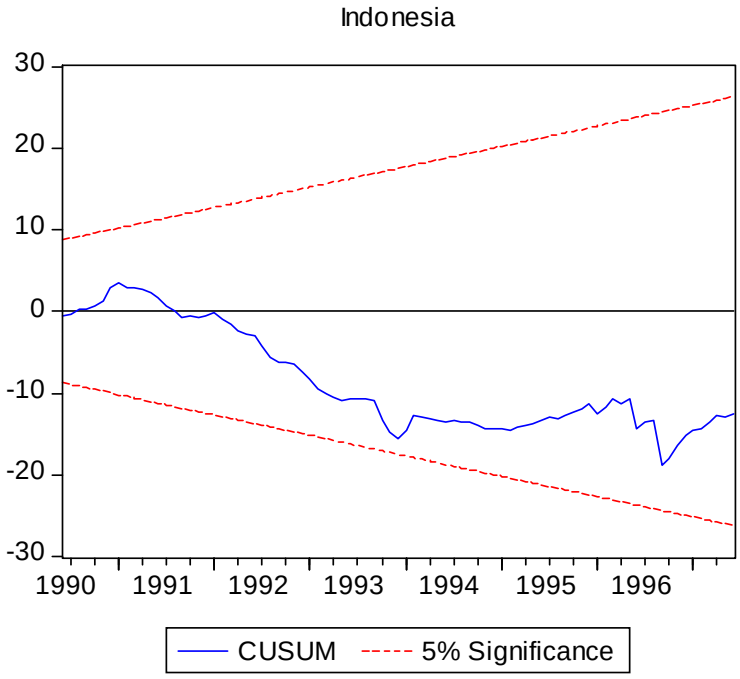
Notes: The null hypothesis is each currency in the first row does not Granger cause each currency in the first column. All currencies are in terms of units of U.S. dollar. The lag length is two months. ***, ** denote rejection of the null hypothesis at the 1% and 5 % significance level, respectively. P-values are in parentheses. CNY denotes Chinese Yuan; HKD denotes Hong Kong Dollar; JPY denotes Japanese Yen; KRW denotes Korean Won; IDR denotes Indonesia Rupiah; MYR denotes Malaysia Ringgit; PHP denotes Philippine peso; SGD denotes Singapore Dollar; THB denotes Thai Baht.

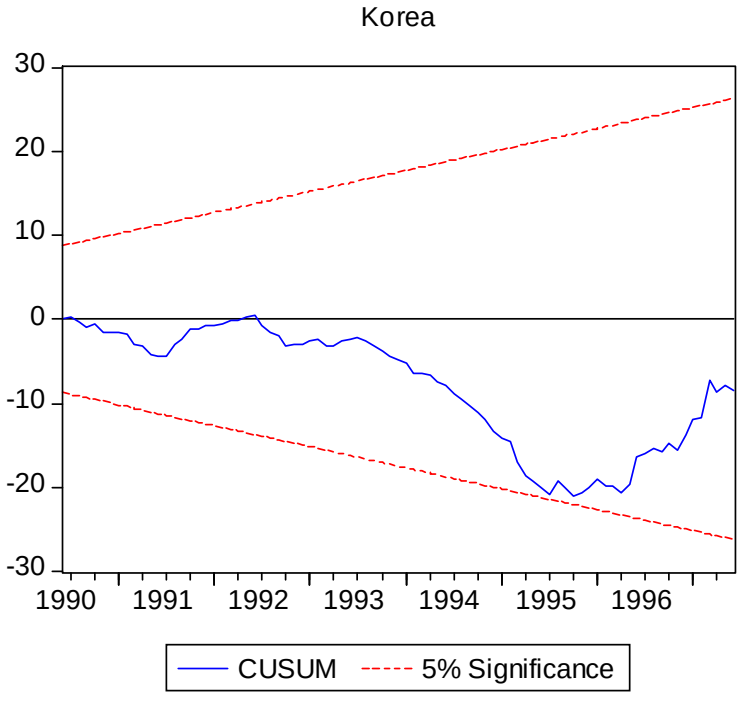
Appendix 2.1 CUSUM Tests for the Pre-crisis Period



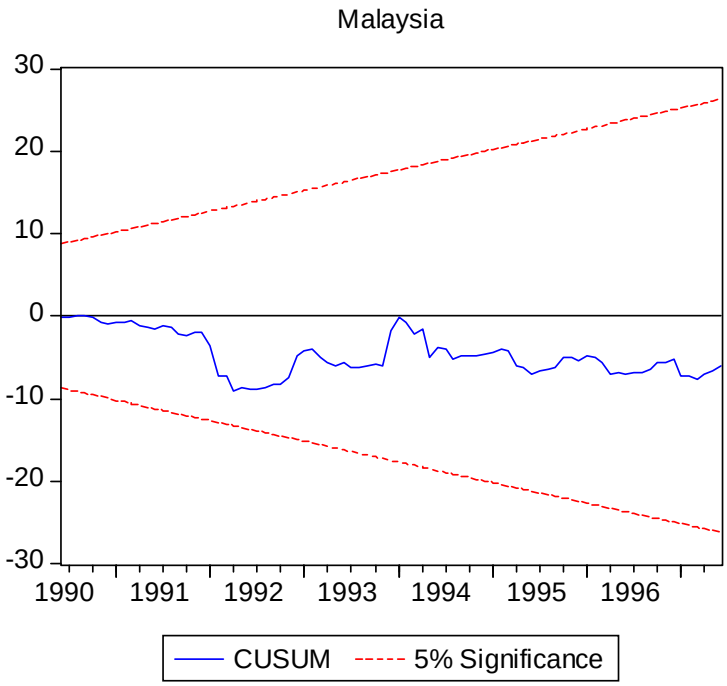


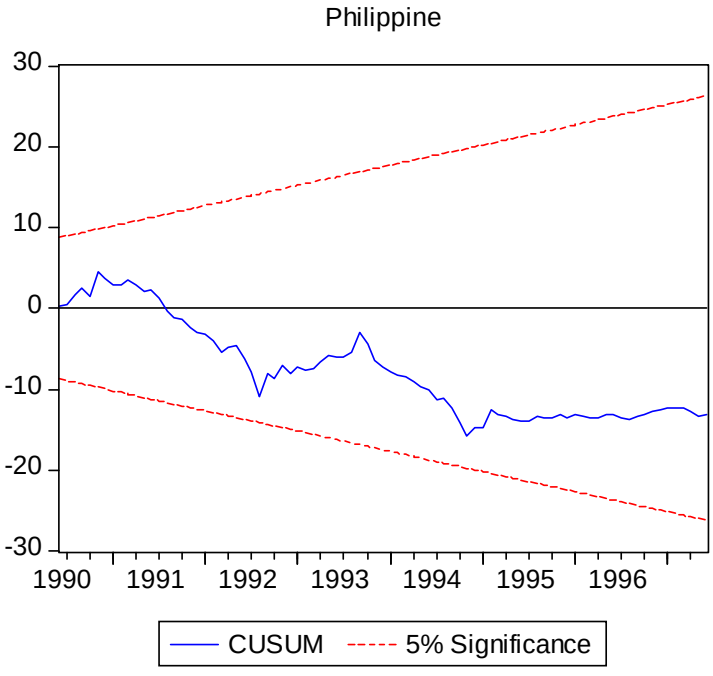
(Continued) Appendix 2.1 CUSUM Tests for the Pre-crisis Period





(Continued) Appendix 2.1 CUSUM Tests for the Pre-crisis Period





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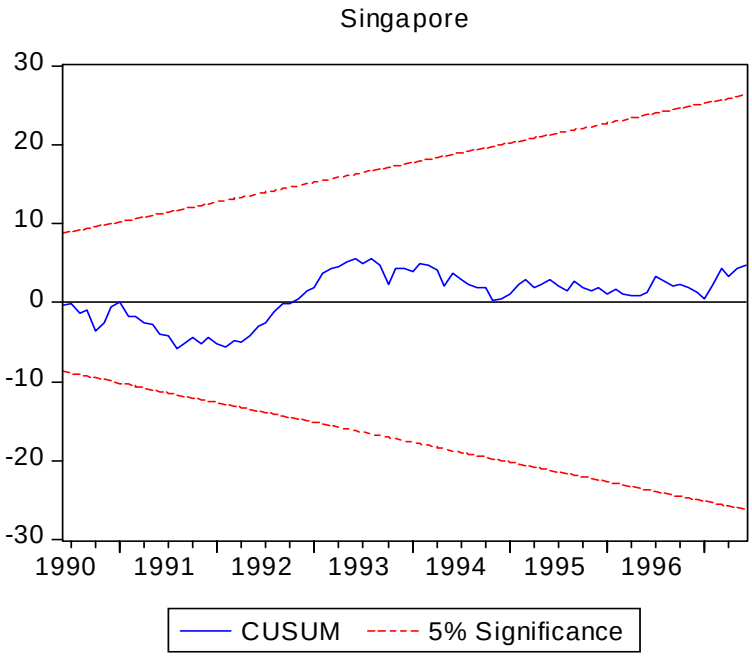
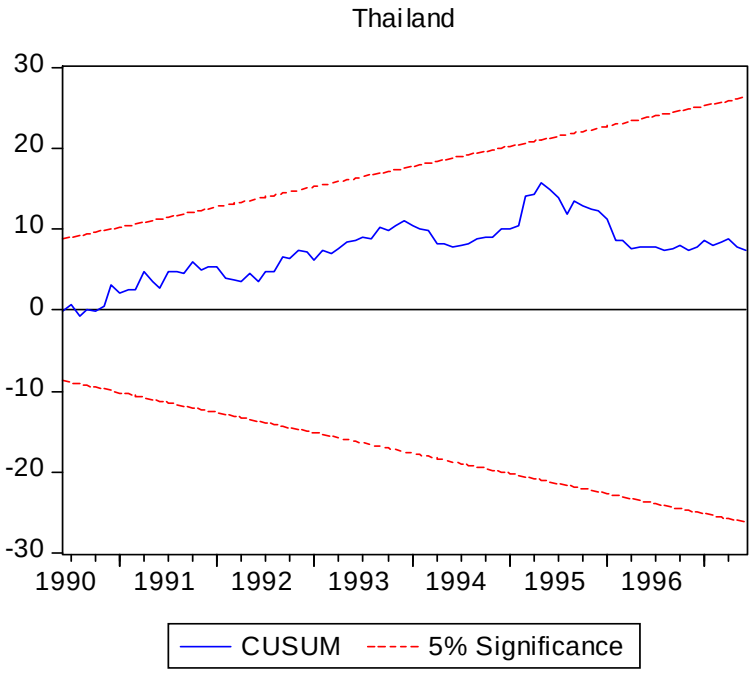
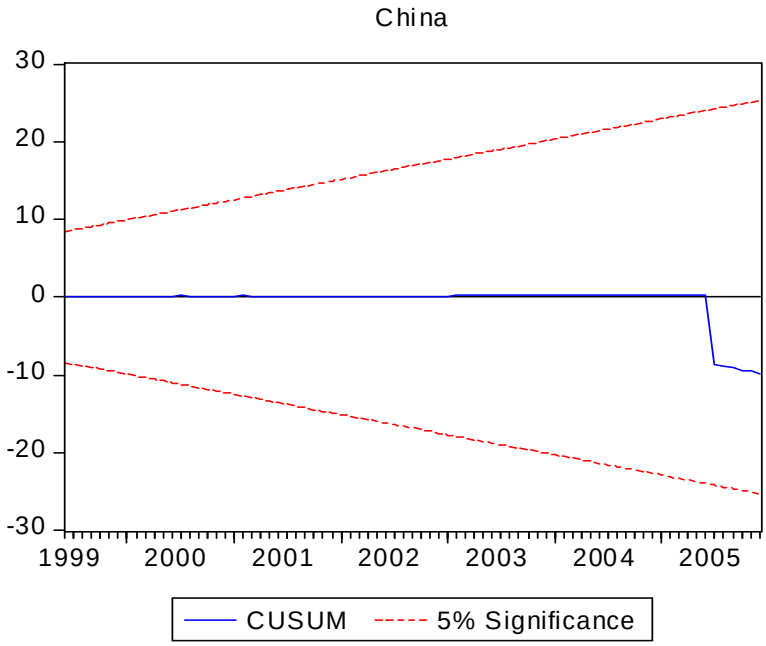
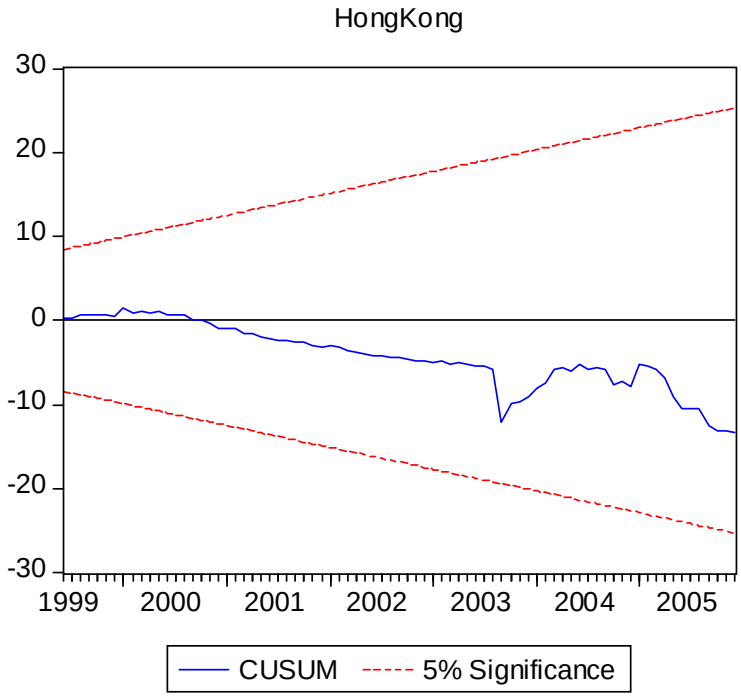


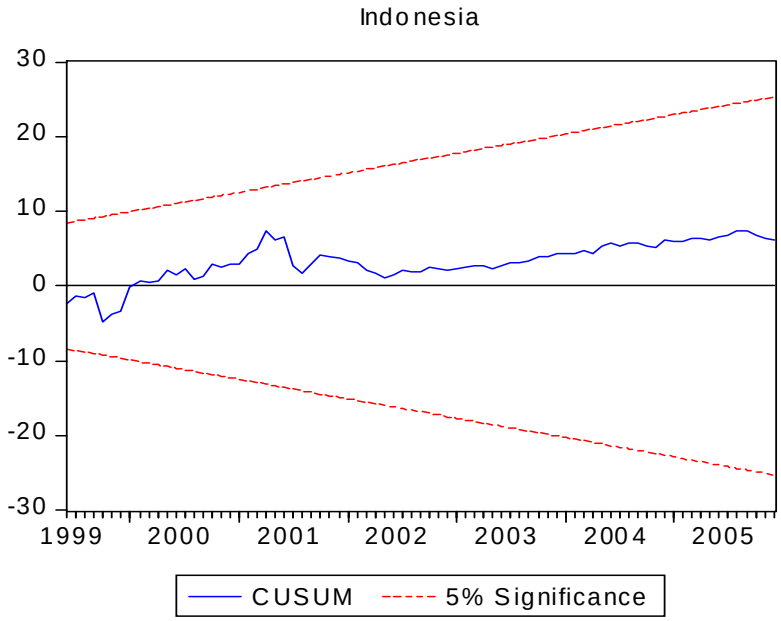


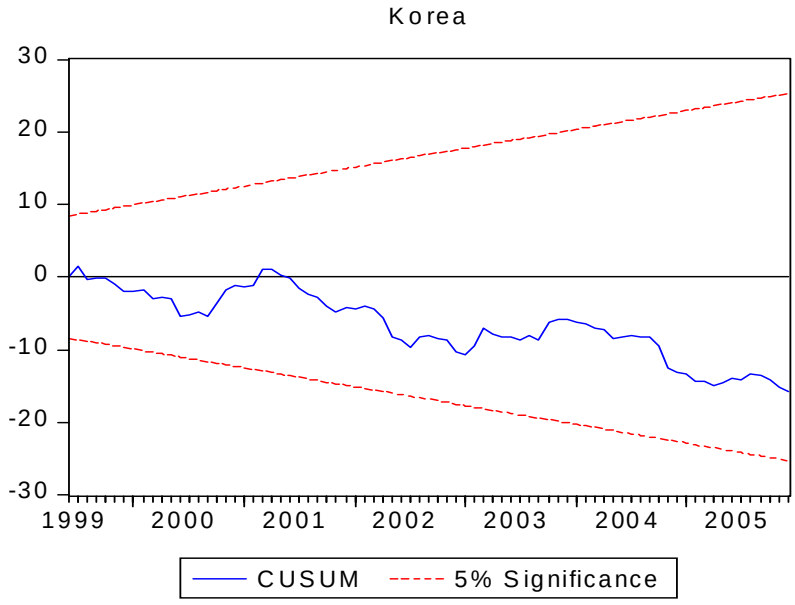
Appendix 2.2 CUSUM Tests for the Post-crisis Period



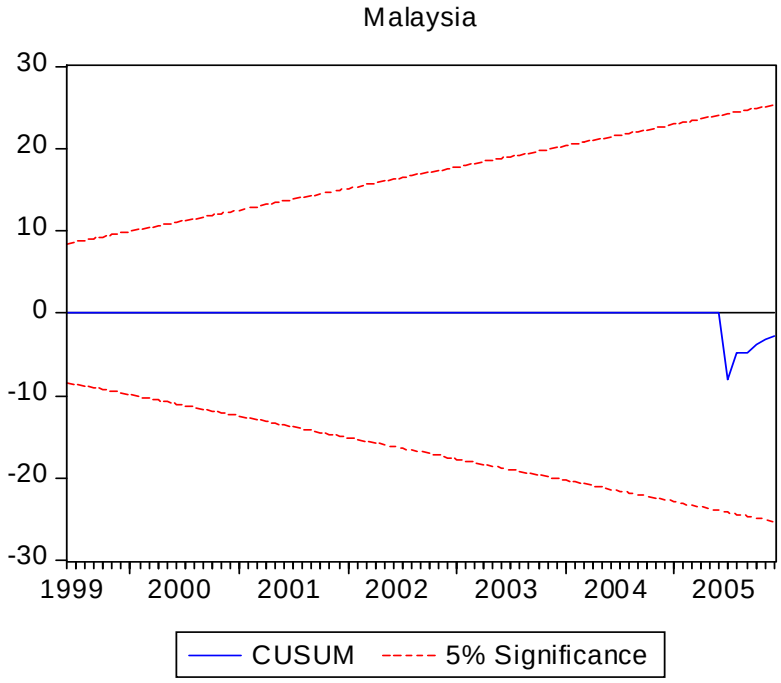


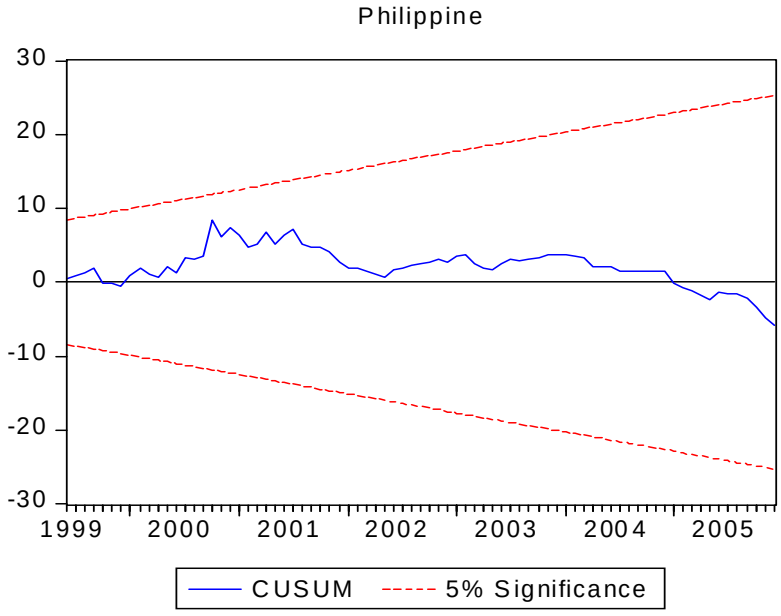
(Continued) Appendix 2.2 CUSUM Tests for the Post-crisis Period





(Continued) Appendix 2.2 CUSUM Tests for the Post-crisis Period





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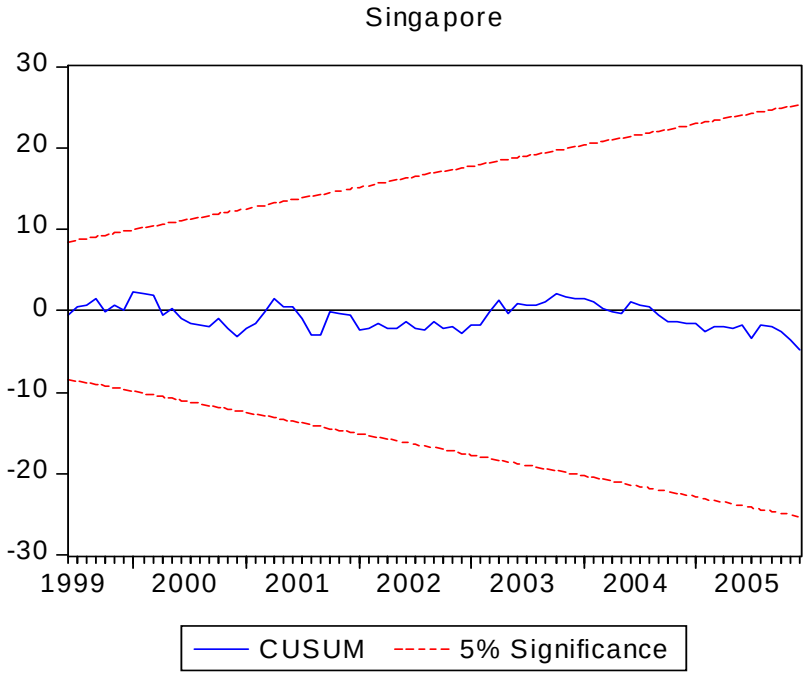
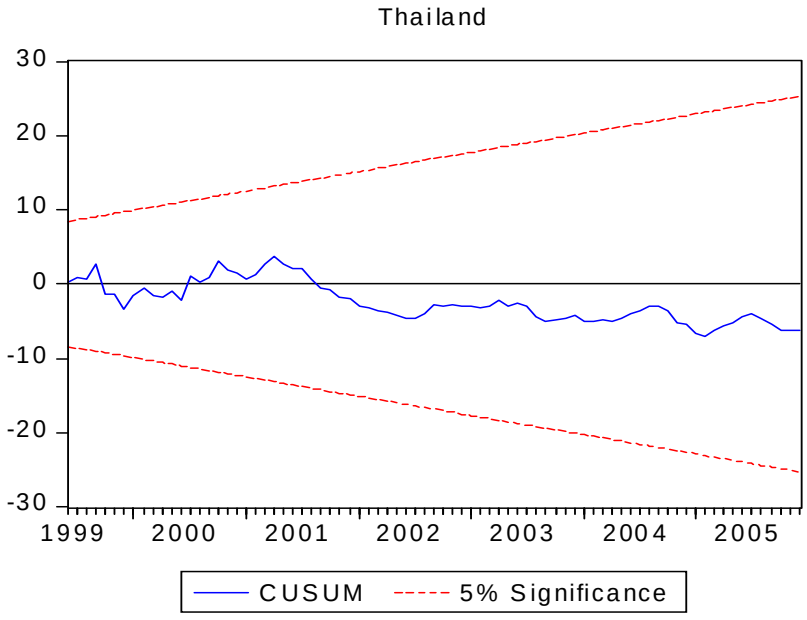




Chapter 3

Exchange Rate Regimes and Monetary Independence: the Transmission of Interest rates in East Asia

3.1 Introduction

The choice of exchange rate regime – fixed, floating, or intermediate – has been an important question in international monetary economics. As one of the most fundamental policy issues in open economies, the advantages and disadvantages of different exchange rate regimes have been extensively discussed and debated. It is well known that the fixed exchange rate regime, worked as a credible anchor for monetary policy, can reduce transaction costs and exchange rate risk. On the other hand, the flexible exchange rate allows monetary authorities to retain domestic interest rates as policy instrument used for other macroeconomic goals, such as long-term growth, full employment, or price stability, which suggest an independent monetary policy[10]. Therefore, the decision of whether to peg or not may determine the options of monetary policy and the ability to maintain open capital markets.

From the perspective of theoretical predictions, with a pegged exchange rate under free capital movements, monetary policy is committed to the single goal of maintaining the exchange rate at its announced level and domestic interest rates cannot be set independently. According to the theory of "impossible trinity", without restrictions on capital flows, monetary authority that wishes to retain domestic interest rate as a policy instrument must adopt a flexible exchange rate arrangement. Hence, theoretically, domestic interest rates will follow closely changes in foreign (U.S.) interest rates, and are highly sensitive to foreign (U.S.) monetary policy under a pegged exchange rate regime. In contrast, economies with floating exchange rate regime can in principle accommodate international interest rate shocks by allowing the exchange rate to adjust.

[10] For a more complete exposition of the advantages and disadvantages of alternative exchange rate regimes, see Frankel *et al.*, (2002).

Actually, the extent to which domestic interest rates react should depend on the monetary policy framework adopted by one country. For instance, under inflation targeting, if an increase in U.S. interest rate causes the domestic currency to depreciate significantly, the central bank is likely to tighten monetary policy to temper the increase in inflation resulting from the pass-through of the depreciation into domestic prices. Thus, the overall effect of the increase in U.S. interest rates will be some increase in domestic interest rates and some exchange rate depreciation, whereas the effect should be felt fully by domestic interest rates in a pegged regime.

Despite these predictions, we may encounter the possibility of tightly integrated capital markets and the non-pegged countries are also short of monetary freedom. This "could occur if any interest rate policy, other than following the base interest rate, generated immediate exchange rate fluctuations beyond the amount most countries are willing to tolerate" (Shambaugh, 2004, p. 1). Indeed, the concept of "fear of floating" is proposed as an alternate view to explain countries with *de jure* flexible regimes do not allow their exchange rates to move freely (Hausmann *et al*., 2001 and Calvo and Reinhart, 2002). These authors pointed out factors like lack of credibility, exchange rate pass-through, and foreign-currency liabilities prevent countries from pursuing an independent monetary policy, regardless of their announced regimes. Shambaugh (2004) further suggests in this case, there is an open economy dilemma, not trilemma: the choice is to have monetary freedom or open capital markets. Since most countries have liberalised capital flows, or are in the process of doing so, this would suggest that only few countries have monetary freedom in today's world. Under this scenario, all countries would display a tight connection to the relevant base economy. There would be no difference between countries adopting pegged and non-pegged exchange rate regimes.

In addition, recent studies argue that the standard proposition that flexible exchange rate arrangements allow a country to retain its monetary independence so that domestic interest rates can be used as an economic policy instrument does not hold for emerging markets. Due to credibility problems, strong inflation pass-through of exchange rates, or wide-spread currency substitution, emerging countries cannot utilise interest rates and

nominal exchange rates effectively to absorb shocks from abroad. For example, Frankel *et al*. (2002) point out the developing countries with a flexible exchange rate policy suffer from having to pay risk premia[11]. Since risk premia could be affected by international interest rates, the interest rates in developing countries adopting a flexible exchange rate policy might be sensitive to the U.S. more than those adopting a fixed exchange rate policy. The emerging market economies subject to sharp changes in international investor confidence cannot benefit from the use of the interest rate instrument, and would in fact be worse off by leaving that possibility open (see, Hausmann *et al*., 2001; Calvo and Reinhart, 2002).

Motivated by the above theoretical issues discussed in the current literature, this chapter aims to examine whether the adoption of new exchange rate regime has affected monetary autonomy in the context of East Asian economies, concerning the sensitivity of domestic interest rates to international interest rates under different currency regimes during 1994-2004. As mentioned in Chapter 1, the regimes adopted by the emerging East Asian countries in the wake of the 1997/98 financial crisis have varied significantly. Some officially adopted for fixed exchange rate regimes, either in a hard peg currency board system (Hong Kong, Malaysia) or a combined form with restriction on capital flows (China), while others especially for most crisis-affected East Asian economies including Indonesia, Korea, Philippines and Thailand have shifted their exchange rate regimes from *de facto* U.S. dollar pegs to floating ones. It is argued that East Asian central banks have intervened heavily in foreign exchange rate markets in order to prevent the appreciation of their currencies for the pursuit of an "export-led growth strategy" (Dooley *et al*., 2003). Then we come to the following questions: Has the adoption of a new exchange regime in the post-crisis period have enabled East Asian countries to retain their monetary autonomy? How did local interest rates of East Asian economies react to foreign rates such as U.S. interest rates under their different regimes of exchange rate in the pre-crisis and post-crisis periods?

[11] The risk premia can be both currency premia to compensate for devaluation risk and country premia to compensate for default risk.

This study will take the short-term interest rate as a measure for monetary policy and assume autonomy or independence of monetary policy can be measured by movements in short-term interest rates. We then seek to understand the effect of exchange rate regimes on monetary policy by establishing the extent to which local interest rates follow base country's interest rates, and whether this is any different for countries with different exchange rate arrangements. Eight East Asian economies (Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore and Thailand) with typical exchange rate arrangements and their monetary independence for the pre-crisis and post-crisis period have been examined accordingly. The methodology for empirical investigation in this chapter follows closely to the previous work, while extending the literature in three aspects. First, considering the classification of exchange rate regime might be sensitive to results, this study employs the Reinhart and Rogoff (2004) coding as an alternative instead of official or *de jure* classification of exchange rate regime to test the robustness of results. Second, the choice of the sample period in this study depends on the possibility of contrasting the alternative exchange rate regime. Third, this study adopts the Generalised Method of Movements (GMM) technique developed by Hansen (1982) in order to control for the endogeneity problem of international interest rate shocks as well as heteroskedasticity of unknown form in the disturbance terms.

This reminder of chapter is organised as follows: Section 3.2 discusses the effects of exchange rate regime on monetary autonomy. Section 3.3 provides a review of literature and empirical evidence. Section 3.4 explains the empirical framework and methodology. Section 3.5 discusses the empirical results and Section 3.6 concludes this chapter by providing the implication of results.

3.2 Effects of Exchange Rate Regime on Monetary Autonomy

In principle, with a pegged exchange rate under free capital movements, monetary policy is committed to the single goal of maintaining the exchange rate at its announced

level. Therefore, the monetary authority conducts interventions in the foreign exchange markets to assure exchange rate stability. The domestic interest rates cannot be set independently. By contrast, under a flexible exchange rate arrangement, the domestic interest rate should be less sensitive to changes in international interest rates, if other things equal. Changes in the exchange rates would absorb the shocks of international interest rate and thereby provide "insulation" for domestic interest rates. Countries with intermediate regimes should also display less sensitivity to international interest rates than countries with firm pegs. The argument in favor of monetary independence pointed out that monetary policy is always diverted, at least to some extent, in dealing with the balance of payments under fixed exchange rate. Under the combination of fixed exchange rate and complete integration of financial markets, monetary policy becomes completely powerless. In contrast, under floating exchange rate, the country can respond to a recession by means of monetary expansion and depreciation of the currency. This stimulates the demand for domestic products and returns the economy to desired levels of employment and output more rapidly than the case under a fixed exchange rate. The aforementioned issues are actually involved in a basic proposition of international macroeconomics, the notion of the open economy trilemma. This notion suggests an "impossible trinity" scenario: countries can pursue two of three options—fixed exchange rates, domestic monetary autonomy, and capital mobility. Thus, without capital controls, the monetary authority that wishes to retain domestic interest rate as a policy instrument must adopt a flexible exchange rate arrangement.

In order to explain the way that foreign interest rates affect local rates under different exchange rate regimes, here we can employ the interest rate parity equation:

$$r_t = r_t^* + E_t\left[e_{t+1} - e_t\right] + \pi_t \tag{3.1}$$

where r_t denotes the domestic interest rate, r_t^* is the foreign interest rate, $E(e_{t+1} - e_t)$ denotes the expected value of a change in log nominal exchange rate, and

π_t denotes the country risk premium. With perfect capital mobility, this equation provides the following predictions: In case of the credibly pegged exchange rate, that is, when $E(e_{t+1} - e_t)$=0, local interest rate is equal to the foreign interest rate plus a risk differential. If investment opportunities in two countries are equally risky, then π_t is zero and the interest rate differential should be equal to the expected change in the exchange rate. If the risk differential is extremely small or does not change with the change in interest rates, the local interest rate changes with the base interest rate. Furthermore, the previous work by Frankel and Froot (1987) suggest that most of the bias in a forward market or any difference in domestic and foreign interest rates can be better explained by expectations, not a risk premium. Their suggestion provides a justification for the assumption that local rate changes with the base rate.

Based on the above assumptions and concerns, we could come to the following equation where the domestic interest rate follows changes in the foreign interest rate:

$$\Delta r_t^{lc} = \alpha + \beta \Delta r_t^* + u_t \tag{3.2}$$

The standard theory suggests that countries with non-pegged exchange rate should have more monetary autonomy than those with fixed exchange rate. According to the Equation (3.2), the β coefficient for countries with pegged exchange rate should be significantly larger than those of countries with fixed exchange rate. If a peg is rigid and perfectly credible, capital markets are open and arbitrage costless, risk premiums are constant, and investors are optimistic, we would expect the coefficients to be 1. Under a fully flexible exchange rate regime, the local interest rate does not have to respond to changes in the expectations, but can instead allow the exchange rate to adjust immediately so that the expected change in the exchange rate is equal to any interest rate differential that develops. Thus, there is no reason for the local interest rates to react to the base rates or to expectations or to the risk premium, and standard theory would imply a lower β driven by the correlation of shocks. In the intermediate case—when

exchange rates are allowed to move within a certain limit—a less flexible exchange rate regime is associated with a larger transmission of external shocks into domestic interest rates.

Note that the above discussion rests on capital mobility. The open-economy trilemma suggests that countries with open capital markets cannot pursue domestically oriented monetary policy and fixed exchange rates at the same time. Thus, we expect these results to hold only for countries with open capital markets. Nevertheless, some authors suggest that the effectiveness of controls for capital inflows and outflows is very limited, at least on a sustained basis (see, for example, Ariyoshi *et al*., 2000). Considering the rapid process of financial deepening and innovation also may reduce the effectiveness of capital control, the traditional trinity dilemma is usually reduced to the two options or a monetary policy-exchange rate stability trade-off.

Recent literature has also identified other factors that could affect the correlation between domestic and foreign interest rates. For example, Frankel *et al*. (2002) point out factors such as the degree of financial integration, the degree of real international integration, and the common shocks could determine the degree of co-movement of local and foreign interest rates. In fact, in the presence of barriers to international capital flows, the response of local interest rates to changes in foreign interest rates can be dampened. If the same exchange rate arrangements had been maintained, an increase in the degree of capital account liberalisation would have reduced monetary independence. If business cycles are highly synchronised across countries, we may expect domestic and foreign interest rates are highly correlated. In addition, common shocks[12] might affect many countries simultaneously and could lead a high correlation between interest rates for given degrees of international and financial integration. Nevertheless, the focus of this study is not to explore the role of the above factors but examine the link between local and foreign interest rates under alternative exchange rate regimes. The estimation of the long-run relationship between domestic and foreign interest rates, and the

[12] Unlike country specific idiosyncratic shocks, common shocks such as financial and climatic ones can affect many countries simultaneously, which tend to be reflected in closer correlation of interest rates.

monetary independence hypothesis under different exchange rate regimes across the studied sample period will be addressed in this chapter.

3.3 Literature Review

Recently, several studies has formally investigated the impacts of the currency regimes on the independence of monetary policy (Frankel, 1999; Hausmann *et al*., 2001; Borensztein *et al*., 2001; Frankel *et al*., 2002; Kim and Lee, 2004; Shambaugh, 2004). By estimating the sensitivity of local interest rates to changes in foreign (base) interest rates, these researchers attempted to examine whether local rates are less sensitive to foreign interest rate changes under a floating exchange rate regime than under a pegged one.

Frankel (1999) find that, at first glance, pegged countries follow the base more than intermediate or floating countries. However, their early version of regressions on individual Latin American countries in the 1990s suggests the possible existence of unit roots in the data. The regression analysis on first-differences does not support the intuition. Apply the PSS technique (see Pesaran *et al*., 2001), Frankel *et al*. (2002) examine twenty developing and industrial countries in the 1990s to see if there is a consistent levels relationship and test the speed of adjustment to foreign interest rate shocks. They find full transmission of interest rates cannot be rejected in the long run in most cases, even for countries with floating regimes. However, short-run effects differ across regimes. They point out that interest rates of countries with more flexible regimes adjust more slowly to changes in international rates, suggesting some capacity for monetary independence.

Focusing on some countries whose exchange rate regimes can be clearly defined as either currency boards or floating regimes, Borensztein *et al*. (2001) find evidence supporting the traditional view that local rates are less sensitive to base interest rate changes under floating exchange rate regimes than under pegged regimes. In order to

avoid the problem of spurious correlation, they consider the changes in local interest rates and examine them in response to estimated monetary policy shocks in the base rates. Their paper tests autonomy in the face of certain types of shocks but does not answer the question of whether credible fixed exchange rate regimes enforce interest rate equal the interest rate of the base economy as theory says it should.

On the other hand, evidence during 1997-1999 reported in Hausmann *et al*. (1999) is consistent with an alternative view. They point out that Argentina with peg regime reacts the least to U.S. interest rate changes, Mexico (the float) the most, with Venezuela (a weak peg) in the middle and concluded that the monetary freedom associated with floating exchange rates does not exist for all countries. In addition, they examine real interest rate reactions for eleven countries and find that pegged countries react to U.S. real interest rates less or equal to floating countries. Nevertheless, their regressions are run on levels rather than first differences leaving the interpretation unclear.

Shambaugh (2004) includes both the base currencies and the U.S. dollar in his study. He examines the impact of capital controls, as well as other control variables. He also considers the time series properties of the data and uses cointegration and other levels-relationship analysis to provide additional insights. The general conclusion of his paper is that fixed exchange rates do in fact force countries to follow the monetary policy of the base country more closely than floating rate countries. He suggests that, in general, the trilemma presents a sensible framework for policy analysis. Hard pegs are not a panacea; they come with costs. In particular, this chapter demonstrates that fixed exchange rates involve a loss of monetary policy autonomy.

Focusing on the East Asian countries, however, the previous studies provide inconclusive evidence. Consistent with the theoretical prediction, Borensztein *et al*. (2001) show that interest rates in Hong Kong, which has a fixed exchange rate regime, is much more sensitive to U.S. interest rates than interest rates in Singapore, which has a floating exchange rate regime. In contrast, Frankel *et al*. (2002) find that local interest rates are adjusted fully to international interest rates in the long run regardless of the

exchange rate regime for Hong Kong, Singapore, Philippines and Thailand. But their study does not consider the change of the regimes after the crisis explicitly. Kim and Lee (2004) employ a regime-switching model that allows for the possibility of a structural break in the sensitivity of local interest rates to changes in international interest rates over the sample period. They take into account the possibility that the timing of actual structural break in the degree of monetary independence and the timing of *de jure* exchange rate regime change may not coincide. Their empirical findings suggest that greater exchange rate flexibility offers a higher monetary independence for East Asian economies, which supports the conventional predictions.

Although these results from existing studies are suggestive, they raise questions about robustness, in particular to the way in which the regressions are specified and the relationship between domestic and international interest rates is captured. In addition, the classification of exchange rate regime, the estimation technique applied, as well as the specific sample period focused might contribute to the regression outcome. Focusing on eight East Asian economies with typical exchange rate arrangements and their monetary policies spanning 1994 to 2004, this study provides a further investigation on the relationship between local interest rates and foreign interest rates under different exchange rate arrangements. In particular, we take both pre-crisis and post-crisis periods into account to assess the conventional theory regarding the impact of exchange rate regime on the independence of monetary policy. The strategy that we followed will be discussed in the next section.

3.4 Methodology Description

3.4.1 Basic Model Specification

As mentioned in Section 3.2, the primary concern of this study is to empirically examine the relationship between domestic and foreign interest rates under different exchange rate regimes. Frankel *et al*. (2002) suggest countries could temporarily isolate

themselves from fluctuations in world interest rates, and the length of time until full adjustment of the local interest rates to its based foreign interest rates can be a measure of the degree of monetary autonomy. As an efficient way to test the conventional view using time series data, it is likely to require a full dynamic specification, in the sense of allowing for lags in the dependent variables. In this study, we pay particular attention to the reaction of local rates to the foreign rates and its lagged form. Thus the following equation will be estimated to combine the long-run relation between local and international interest rates and to capture the dynamic of interest rate adjustment:

$$\Delta r_t^{lc} = \alpha + \beta \Delta r_t^{*} + \sum_{i=1}^{i=m} \rho_i \Delta r_{t-i}^{lc} + e_t \qquad e_t \sim (0, \sigma_t^2) \tag{3.3}$$

where Δr_t^{lc} represents the changes of domestic nominal interest rate in the local currency of each country at time t; α is a intercept term, which could be interpreted as a risk premium; r_t^{*} is the international interest rate; β represents the sensitivity of the local interest rates to foreign rates. We assume that the error term e_t has a mean of zero and is independently distributed across countries, but is possibly heteroskedastic and serially correlated. In this model, the parameter $\sum_{i=1}^{i=m} \rho_i$ (henceforth, $\delta = \sum_{i=1}^{i=m} \rho_i$,) captures the country heterogeneity in adjustment speed. Thus the speed of adjustment of domestic interest rates towards the long-run equilibrium is defined as $1-\delta$, and the long-run adjustment of local interest rates to international interest rates is measured by $\beta / 1-\delta$.

As aforementioned, although other variables may enter the relationship between the local interest rate and a base (foreign) interest rate, our primary interest is the coefficient on the base rate, β. The size of the coefficient β can be used to classify degrees of floating/pegged exchange rate regimes both across countries and across time within a country. We estimate the dynamic specification in Equation (3.3) for each sampled

country-currency regime episode separately rather than pooling the data[13]. The parameter β will be compared across economies and across time within a country in order to assess whether the monetary independence is influenced by the choice of currency regime. According to the conventional view, more flexible exchange rate regimes should allow countries additional room to pursue their monetary policy. Hence, the sensitivity of local interest rates to international rates should increase with the rigidity of the exchange rate regime. For a given degree of capital mobility, real integration and other factors, we would expect $\beta_{Fixed} > \beta_{Intermediate} > \beta_{Floating}$.

In a fixed exchange rate regime with full capital mobility, β_{Fixed} is expected to be 1. In the case of intermediate regime, including "dirty floating" arrangement, the exchange rate absorbs little of the international shocks, so local interest rates have a relatively high correlation with those abroad. Thus, we would expect $\beta_{Fixed} > \beta_{Intermediate}$. As for countries with similar exchange rate regimes, the sensitivity of the local interest rates to the foreign rates increases with the degree of capital account liberalisation. We might expect "fear of floating" scenario for non-pegs as recent arguments suggest. This is because the exchange rate policy may lack credibility and we thereby could see a case where floats react to the base rate more than pegs. As suggested by Shambaugh (2004), the non-zero β coefficient can be generated by other reasons causing foreign and local interest rates to be correlated. Exchange rates could be one of the factors driving domestic inflation and thereby could be a part of most monetary rules. Hence, it is likely that countries without any international exchange rate policy will still respond to changes in the exchange rates. Svensson (2000) also shows that depending on the type of inflation targeting pursued, the reaction function of the coefficient on the foreign interest rate could be quite close to one. In addition, Parrado and Velasco (2002) argue that optimal exchange rate policy implies a dirty float which means foreign interest rate shocks are met partially by adjusting home interest rates and partially by allowing the

[13] Frankel *et al.* (2002) suggest that heterogeneity in the adjustment dynamics may exist among countries with similar exchange rate regimes due to factors such as the degree of development of the financial system and the openness of the capital account. Pooled estimation of Equation (3.3) would yield inconsistent estimates.

exchange rate to move. Thus, many floaters also might show some reaction to foreign shocks and they might not appear to pure floats. Under this circumstance, an estimate of β would simply equal the correlation of base and local shocks.

We also expect that, all other factors being equal, the adjustment speed is higher (i.e., a lower value of δ) in fixed exchange rate regime but lower in floating exchange rate regime. With no barriers to capital movements we should find $1-\delta \to 1$ (that is, $\delta \to 0$) under fixed exchange rates. Conversely, in the limit, with flexible exchange rates and full monetary independence policy we would expect to find $1-\delta \to 0$, so that the local interest rate does not revert to a long-run equilibrium relation with the foreign interest rate.

3.4.2 Estimation Technique

There have been some important issues in the estimation of the basic equation. Previous studies (for example, Frankel *et al*., 2002) often view the foreign interest rates as exogenous variables and thereby assume the changes in foreign interest rates are contemporaneously uncorrelated with the error term. However, as suggested by Kim and Lee (2004), this assumption ignores a potential endogeneity problem between U.S. and domestic interest rates due to the fact that East Asian economies are highly linked to the U.S. in trade. We may expect shocks to U.S. activities are likely to affect the outputs of Asian economies, leading to co-movements of the U.S. and domestic interest rates (Borensztein *et al*., 2001). When the error distribution cannot be considered independent of the regressor's distribution, the application of the instrument variables (IV) is usually called for. However, the conventional IV estimator (though consistent) is inefficient in the presence of heteroskedasticity. In order to account for aforementioned endogeneity problem as well as heteroskedasticity of unknown form of in the disturbance term, Generalised Methods of Moments (GMM) technique introduced by Hansen (1982) can be employed in this kind of estimation.

GMM has been an effective approach which makes use of the orthogonality conditions to allow for efficient estimation in the presence of heteroskedasticity of unknown form. The GMM estimator can be viewed as a class of estimators known as M-estimators that are defined by minimising a criterion function. It is based upon the assumption that the disturbances in the equations are uncorrelated with a set of instrumental variables. As a robust estimator, it does not require information of the exact distribution of the disturbances. By appropriately choosing the weighting matrix in the criterion function, GMM can be made robust to heteroskedasticity and/or autocorrelation of unknown form. The theoretical relations that the parameters should satisfy are usually orthogonality conditions between a possibly non-linear function of the parameters $f(\theta)$ and a set of instrument variables z_t (Hansen, 1982):

$$E(f(\theta)'Z) = 0 \tag{3.4}$$

where θ are the parameters to be estimated. The GMM estimator selects parameter estimates so that the sample correlations between the instruments and the function f are as close to zero as possible, as defined by the criterion function (Hansen, 1982):

$$J(\theta) = (m(\theta))'Am(\theta) \tag{3.5}$$

where $m(\theta) = f(\theta)'Z$ and A is a weighting matrix. The weighting matrix determines how each moment condition is weighted in the estimation. The principle is that more accurate moment conditions should be weighted more than less accurate ones. Any symmetric positive definite matrix A will yield a consistent estimate of q. However, it can be shown that a necessary (but not sufficient) condition to obtain an (asymptotically) efficient estimate of q is to set A equal to the inverse of the covariance matrix of the sample moment m. Therefore, in this study, a vector of instrumental variables z_t is introduced, which is required to correlate with Δr^* but

not with e_t. Then, Equation (3.3) implies the following orthogonality conditions:

$$E\left[\left(\Delta r_t^{lc} - \alpha - \beta\Delta r_t^{*} - \sum_{i=1}^{i=m}\rho_i \Delta r_{t-i}^{lc}\right)\cdot z_t\right] = 0 \qquad (3.6)$$

which is used as the basis for the GMM estimation of the parameters of the model.

3.5 Empirical Analysis of Monetary Independence in East Asia

3.5.1 Data, Regime Classification and Statistics

Data

Monthly data are drawn from the IMF International Financial Statistics database covering the period from 1994 to 2004. This study employs (90-days) money market rates as local interest rates since they can reflect market forces better than deposit rates. The latter ones, however, are often subject to administrative controls and in many cases display little movement over prolonged periods, which do not suit the purpose of this study. The 90-day U.S. T-bill rates are used as foreign interest rates. It makes sense to split the whole sample into sub-periods and treat the pre-crisis and post-crisis periods as separate regime. We define the pre-crisis period as starting from January 1994 to June 1997, and the post-crisis period as starting from January 1999 to December 2004. Note that the crisis period (July 1997-December 1998) has been excluded in the regression in order to eliminate the large uncertainty in the interest rate differentials. We also assume that a structural break in Equation (3.3) occurred during the crisis period. Such a choice for the baseline sub-sample periods and assumption of structural break can be justified by the fact that, for the countries under investigation with either *de jure* or *de facto* exchange rate regime changes, the dates of the changes fall within the crisis period.

In addition, the degree of interest rate interdependence could be influenced by changes in the stringency of capital controls. It is likely that monetary policy cannot remain the same across varying degrees of capital control. In this vein, a proxy of capital control variable which could interact with the base rate would be demanded. However, our study mainly deals with the monthly data and there is no index for capital control available at the monthly frequency. Moreover, considering that the effectiveness of controls for capital inflows and outflows is very limited (at least on a sustained basis) in East Asia, our primary concern of this study is not to explore the effect of capital controls on the interdependence of interest rates. Instead, we aim to examine the role of currency regime on the monetary independence.

Regime Classification

An assessment of the impact of a country's exchange rate regime on its monetary performance must firstly settle on definitions for alternative regimes. The *de jure* classification system has been the typical method used for coding currency regime. Recently, though, some researchers have started to examine the *de facto* behaviour of countries rather than their declared intent because many countries do not characterise their behaviour accurately. Different from the *de jure* IMF classification that relies exclusively on each government's own declaration of its exchange rate regime, Reinhart and Rogoff (2004) classification together with the recent studies such as Levy-Yeyati and Strurzenegger (2005) highlight the contrast between the actual practice of exchange rate polices and the countries' official declarations. These studies classify the exchange rate regimes in terms of the way one country actually conducts exchange rate policy.

Our study makes a case for using Reinhart and Rogoff (2004) *de facto* coding or "natural" classification for characterising true regimes. In building up their comprehensive "natural" classification scheme, Reinhart and Rogoff (2004) seek to address the potential misclassification by separating episodes of macroeconomic instability that are characterised by very high inflation rates into a "freely falling" category. Their classification also employs a rolling five-year horizon to measure true

flexibility of regime which helps distinguish between longer-term "regimes" and shorter-term "spells" within a regime, such as the widening of a horizontal band or a one-time devaluation followed by a re-peg. Appendix 3.1 (A and B) reports the *de jure* and *de facto* classifications of currency regimes for East Asian countries, respectively.

Comparison of regime classifications across the *de jure* and *de facto* (natural) classifications not only renders similar conclusion in terms of broad categories, but also highlights some divergence between the regimes countries say they have and those they actually operate in terms of narrow categories. As Appendix 3.1 (A and B) illustrated, both the *de jure* and *de facto* definitions seem to have reflected changes of exchange rate regime in the post-crisis East Asian countries. Specifically, if we look at in terms of three broad categories - fixed, intermediate and floating regimes, we can find that there are similar classifications of exchange rate regime for each of the East Asian using both two classifications in 1990s. Philippines is the only exception which defined the country's exchange rate regime as floating since October 1984 based on the IMF *de jure* classification, while the *de facto* one was deemed as intermediate before August 1995, fixed between September 1995 and June 1997, and intermediate from December 1997 until 2002. Another distinctive aspect of the *de facto* one that different from the *de jure* one is the presence of "freely falling" category which stresses the episodes of macroeconomic disturbances or instability characterised by high inflation rates that often reflected in high and frequent exchange rate depreciation.

Statistics

Figure 3.1 plots the local interest rate against the U.S. interest rate for each East Asian economy. The bilateral exchange rates against U.S. dollar are plotted together as well. The exchange rate regimes that we denote in this figure are *de facto* regimes reported by Reinhart and Rogoff (2004). According to this classification, Hong Kong, Japan and Singapore have never changed their exchange rate regimes while Indonesia, Korea, Malaysia, Philippines, and Thailand have changed their exchange rate regimes at least once during the whole sample period (1994-2004).

Table 3.1 displays a summary of statistics of monthly interest rates for sample countries. The means of the short-term interest rates in seven East Asian economies (Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand) increased significantly in 1997 and then continued at the high level until 1998. In the case of Indonesia, the mean even reached a much higher level in 1998 where it rose by around 200 percent from the mean in 1997. In order to prevent a collapse of the currency values or defend exchange rate, these countries were forced to raise domestic interest rates to exceedingly high levels. Obviously, the tight monetary policy through maintaining high short-term interest rates has been adopted by many crisis-affected countries during the crisis period, and such tight monetary policy has been supported by IMF and Fischer (1999). Since 1999, the short-term interest rates for these countries in sample have moved toward lower levels. As for the standard deviations of the short-term interest rates, most East Asian economies (except Japan) also increased sharply and reached peaks either in 1997 or 1998, but dropped down after the crisis. However, Indonesia still maintained a relatively high level of standard deviations of the short-term interest rates among the sample countries. In Japan, there was a significant decrease in interest rate since 1996 and the zero interest rates policy was adopted by central bank in 2001 to hold back deflation. The money rates of Japan kept at extremely low level with quite small standard deviation.

3.5.2 Stationarity Analysis

As with many time series of macroeconomic data, interest rates data are usually treated as if the series have a unit root[14]. This study conducts Augmented Dickey-Fuller unit root tests on interest rates variables prior to carrying out the estimation. The results reported in Table 3.2 indicate a failure to reject the null of a unit root for each variable for levels but accept stationarity for first differences for both pre-crisis and post-crisis periods at the 1% significance level[15]. Furthermore, the stationarity for all series in the

[14] See Wu and Zhang (1997) and citations therein.
[15] For the pre-crisis period, 1% critical value of ADF unit root test is -4.19 for levels, and -4.21 for first differences for all variables. For post-crisis period, 1% critical value is -4.09 for levels, and -4.10 for first differences for all variables.

first-differenced form cannot be rejected from a KPSS test (Kwiatkowski, Phillips, Schmidt, and Shin, 1992) for both of the two sub-sample periods, confirming the fact that variables of basic model are specified in the first-differenced manner.

3.5.3 Analysis of Estimation Results

In the next stage, we apply GMM technique to estimate the dynamic specification in Equation (3.3) for the eight East Asian economies in each sub-sample period. Based on the Akaike Information Criteria (AIC), as well as the J-statistics testing the validity of overidentifying restrictions from GMM estimation[16], the instrument variables employed in GMM estimation are the four lags of domestic and U.S. interest rates ($\Delta r_{t-1}^{lc}, \Delta r_{t-2}^{lc}$, $\Delta r_{t-3}^{lc}, \Delta r_{t-4}^{lc}, \Delta r_{t-1}^{*}, \Delta r_{t-2}^{*}, \Delta r_{t-3}^{*}, \Delta r_{t-4}^{*}$).

Table 3.3 and Table 3.4 report a summary of GMM estimation results, using three broad categories of currency arrangements. For each country, we report the parameter α, β, and δ, as well as the p-value from the Wald test on the full long-run adjustment (the null hypothesis is $\beta = 1$). Table 3.3 presents the estimation results for three economies (Hong Kong, Japan and Singapore) which have never changed their exchange rate regimes throughout the whole sample period. By comparing the β coefficients across sample countries in the post-crisis period, the estimate of sensitivity (β) is 1.35 (s.e.= 0.21)[17] for Hong Kong, 0.47 (s.e.= 0.19) for Singapore, and -0.01 (s.e.= 0.01) for Japan. The estimate of the contemporaneous response of local interest rates to U.S. rates is the largest and statistically significant in Hong Kong (fixed regime). It is still statistically significant but smaller in Singapore (intermediate regime), but not significantly different from zero in Japan (floating regime). The estimates of β for pre-crisis period

[16] See Newey and West (1987) for the J-statistic used to carry out hypothesis tests from GMM estimation; a simple application of the J-statistic is to test the validity of over-identifying restriction when you have more instruments than parameters to estimate. The J-statistic times the number of observations is asymptotically distributed with chi square with degree of freedom equal the number of over-indentifying restrictions.

[17] s.e. denotes the standard error.

exhibit a similar pattern among these three countries, with the exception that the β coefficient is found to be insignificant in Singapore. These findings confirm conventional predictions: interest rates in Hong Kong, which has maintained a fixed exchange rate regime, react more to changes in the U.S. interest rate than interest rates in Singapore with intermediate regime, and far more than interest rates in Japan with free floating regime.

As defined in Section 3.4.1, the parameter δ captures the country heterogeneity in adjustment speed. We expect that, all other factors being equal, the speed of adjustment of domestic interest rates towards the long-run equilibrium would be high (i.e., a low value of δ) under a fixed exchange rate regime, but low under a floating one. The estimates of δ are found to be the lowest in Hong Kong (-0.57) but the largest in Japan (0.35) for the pre-crisis period, and similar pattern is also found in the post-crisis period. These findings imply the highest adjustment speed under pegged regime like Hong Kong, while under fully flexible regime like Japan—the local interest rate does not revert to a long-run equilibrium relation with the U.S. interest rates.

In order to test the full long-run adjustment of local interest rates to U.S. interest rates, we also conduct Wald Test with the null hypothesis of the unity of long-run slope coefficient, that is β=1. As for Hong Kong with the pegged currency regime, the null hypothesis cannot be rejected at 5 percent significance level (*p*-value equals 0.08 for the pre-crisis period, and 0.10 for the post-crisis period), indicating a full adjustment of its local interest rate to the U.S. interest rate in both sub-sample periods. As for Singapore with intermediate regime, the null hypothesis of full long-run adjustment is accepted in the pre-crisis period but rejected in the post-crisis period. In the case of Japan, the null hypothesis is always rejected for both sub-sample periods.

Table 3.4 displays the regression results for the other five countries, namely Indonesia, Korea, Malaysia, Philippines, and Thailand, which have changed their exchange rate regime at least once during the whole period (note that the exchange rate regimes in

these five countries were not changed during the crisis period). By examining the β parameter in each country across the sub-sample periods, we find the interest rates in Indonesia, Korea, Philippines and Thailand, are consistent with the theory that the sensitivity of local interest rates to international rates should increase with the rigidity of the exchange rate regime: the estimates of sensitivity turn out to be large and statistically significant in the pre-crisis period when the countries adopt intermediate or *de facto* pegged regimes. For instance, the estimate of β is 3.35 (s.e.= 1.42) for Indonesia, 7.82 (s.e.= 2.31) for Korea, 3.57 (s.e.= 1.02) for Philippines, and 7.54 (s.e.= 2.72) for Thailand, respectively. As expected, the β estimates become smaller, close to zero for Indonesia and Korea in the post-crisis period when these countries adopt a floating exchange rate regime subsequently. The estimates of β in Philippines and Thailand are found to be still statistically significant in the post-crisis period, but the magnitudes of β estimates become smaller than those in the pre-crisis period as well, which confirm the traditional prediction, that is, $\beta_{Fixed} > \beta_{Intermediate} > \beta_{Floating}$.

In contrast to the conventional view, local interest rates in Malaysia do not become more sensitive to foreign rates after its adoption of pegged exchange rate regime in the post-crisis period. The observed β coefficient is not statistically significant despite its large magnitude in the post-crisis period. One possible explanation for this could be the tight capital controls adopted by the Malaysian government after the crisis. The imperfect capital mobility might prevent full adjustment of local interest rates in the long run, and higher capital mobility could exhibit a relatively high degree of interest rate adjustment.

The parameter δ tells the same story that a relatively higher adjustment speed can be found in the intermediate regime than that in the floating regime. The magnitudes of δ become larger for most countries after they adopt floating regime in the post-crisis period, confirming a lower adjustment speed in the floating arrangement than in the

intermediate one. The Wald Test with null hypothesis of full long-run adjustment is only accepted for Indonesia in both two sub-sample periods, and for Philippines in the pre-crisis period at the 5 percent significance level. As for the other countries, the null hypothesis has been always rejected for both sub-sample periods.

3.6 Concluding Remarks

The impact of the exchange rate regimes on the independence of monetary policy is an important question in the context of the debate on the choice of currency regime. Under floating exchange rate regimes, countries are free to choose the optimal levels of inflation and interest rates. Under fixed exchange rate regimes, countries are forced to import monetary policy from abroad. Obviously, the desirable feature of a floating exchange rate regime is that it allows for monetary policy independence and resilience to large external shocks.

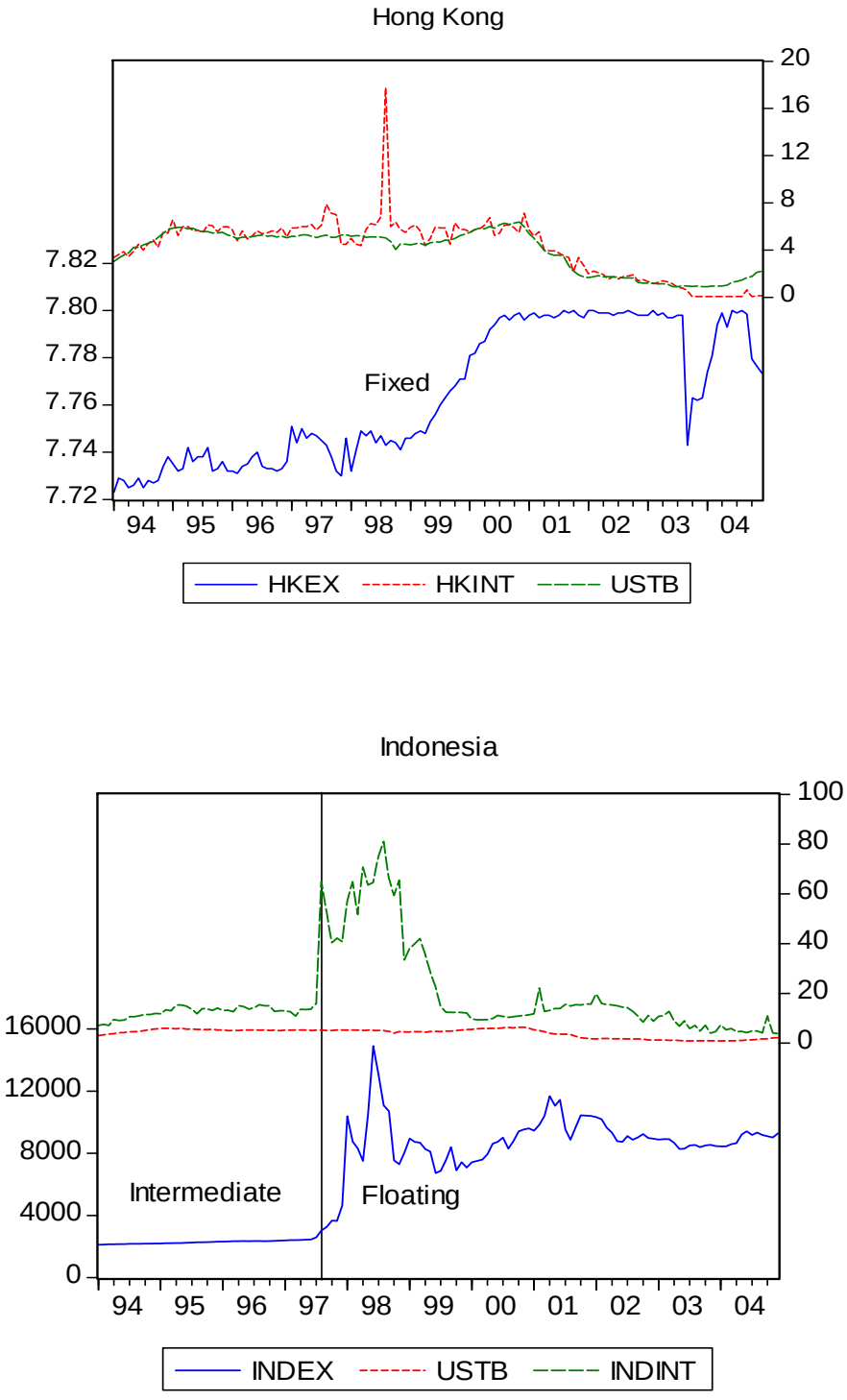
This chapter aims to examine the influence of exchange rate regime choices on the monetary independence from a representative mixture of East Asian economies before and after the 1997/98 currency crisis. We take the short term interest rate as a measure for monetary policy and attempt to determine the degree of international interest rates interdependence for East Asian local interest rates. The empirical findings of this study are broadly consistent with the traditional view and prediction theory. The observed sensitivity of local interest rates to U.S. interest rates has declined for most studied countries (Indonesia, Korea, Philippines, Thailand) since they adopted floating exchange rate regimes in the post-crisis period. We also find that countries with more floating exchange rate regimes such as Japan had greater independence in monetary policy than intermediate regime such as Singapore, and far more than economies with pegged regimes such as Hong Kong. This finding is broadly consistent with the study by Kim and Lee (2004). In contrast, due to imperfect capital mobility, the local interest rates in Malaysia do not become more sensitive to foreign rates after its adoption of pegged exchange rate regime in post-crisis period. In addition, the higher long-run

adjustment can be observed under pegged regime, while floating regime witnessed lower interest rates adjustment.

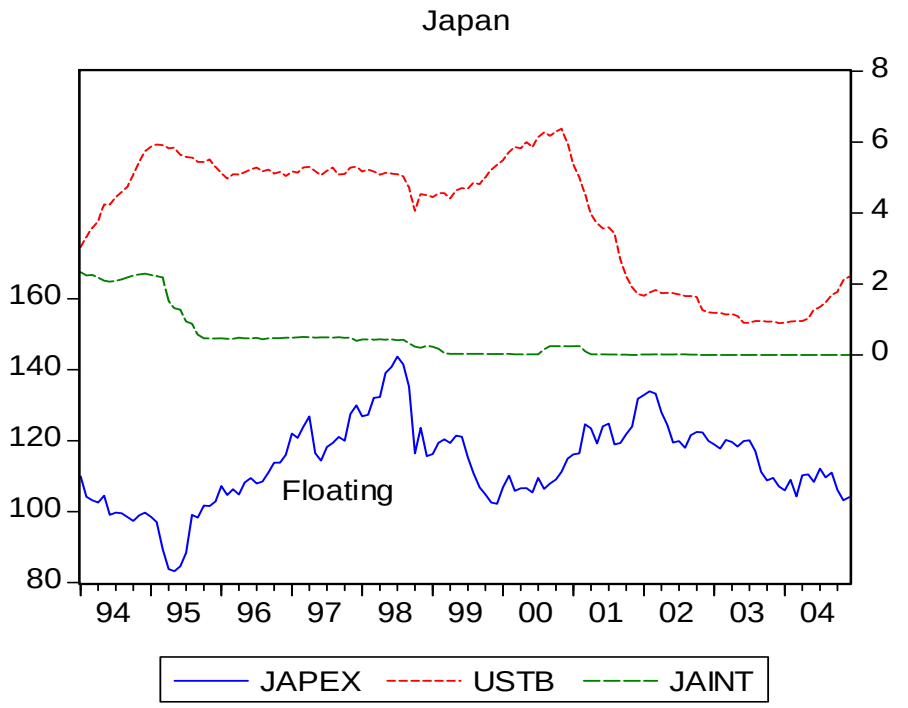
In summary, this study highlights the role of exchange rate regime in the autonomy of monetary policy: floating exchange rate regimes indeed offer East Asian countries a considerable degree of monetary independence. Our findings confirm the effectiveness of traditional doctrine of impossible trinity or trilemma. A country that tries to simultaneously achieve the three goals including fixed exchange rates, domestic monetary autonomy, and capital mobility will suffer from policy inconsistency, which could lead to a currency crisis. This was what encountered by East Asian economies in the event of the 1997/98 financial crisis. Especially, the 1997/98 financial crisis has taught East Asian economies the lesson that the pace and scope of capital account liberalisation must be approached with great caution. With the development of globalisation, broad-ranging capital controls will gradually disappear and East Asian countries will eventually continue to move towards full financial integration. This will leave East Asian with two options: that is, either to achieve both exchange rate stability and financial integration sacrificing monetary independence or aim for monetary independence and financial integration. Therefore, before moving on to full capital account convertibility, East Asian economies should effectively manage the forces of financial globalisation, and strengthen monitoring of capital flows and exchange market developments and supervision over domestic financial systems. They also need to make efforts to promote the regional financial cooperation and prevent crises.

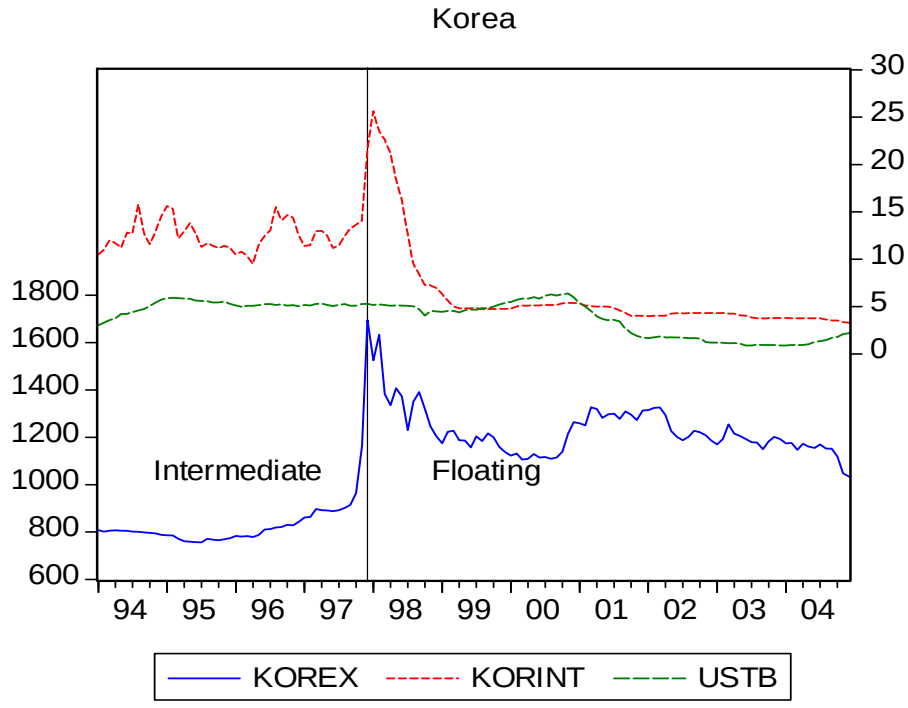
Figures:

Figure 3.1 Exchange Rates and Interest Rates in East Asia

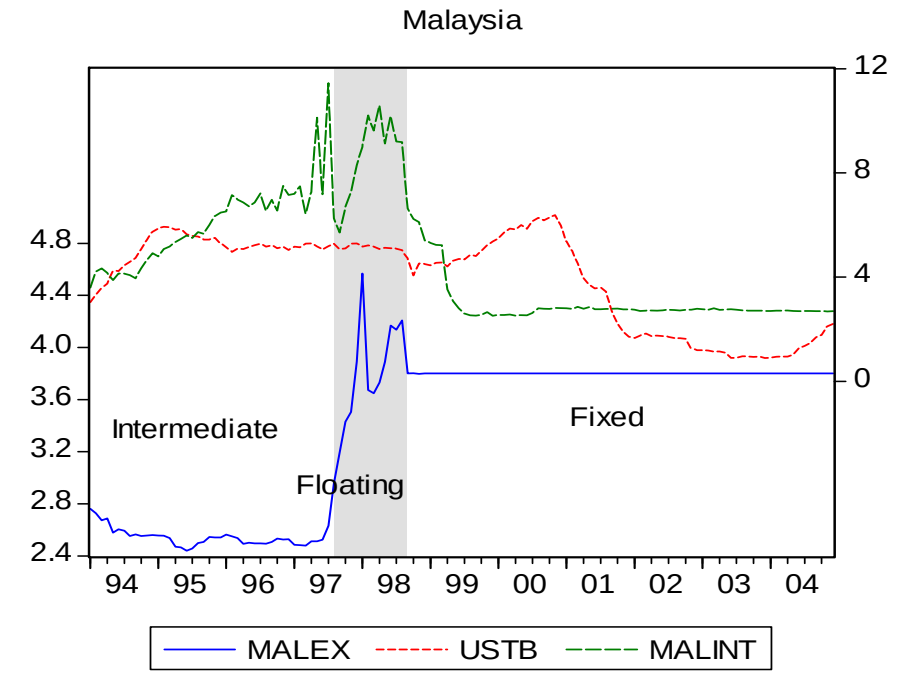


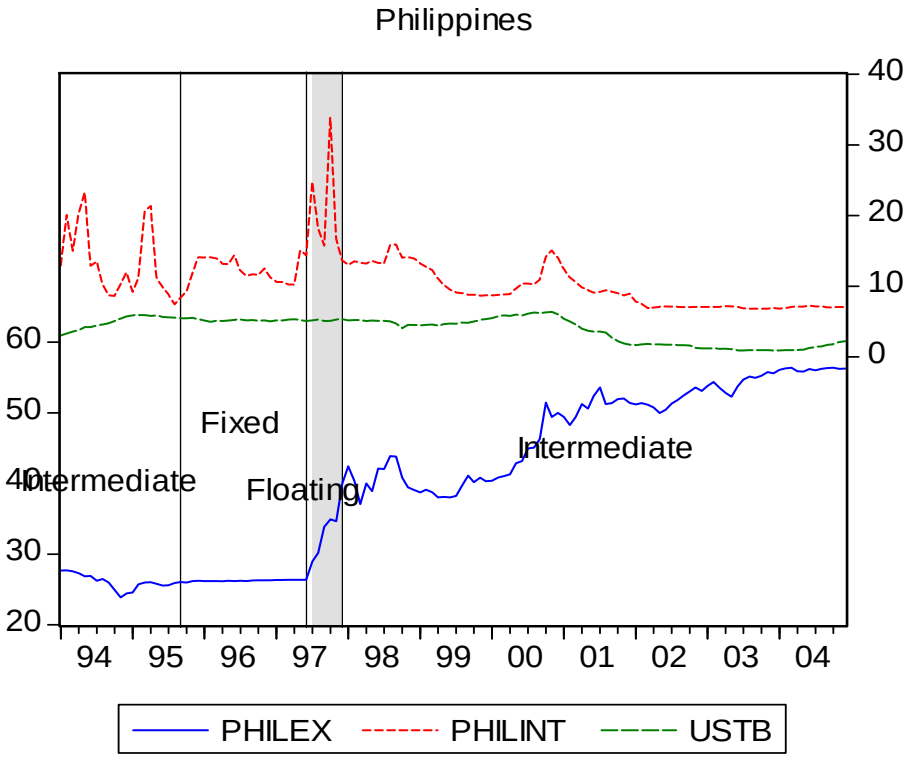
(Continued) Figure 3.1 Exchange Rates and Interest Rates in East Asia



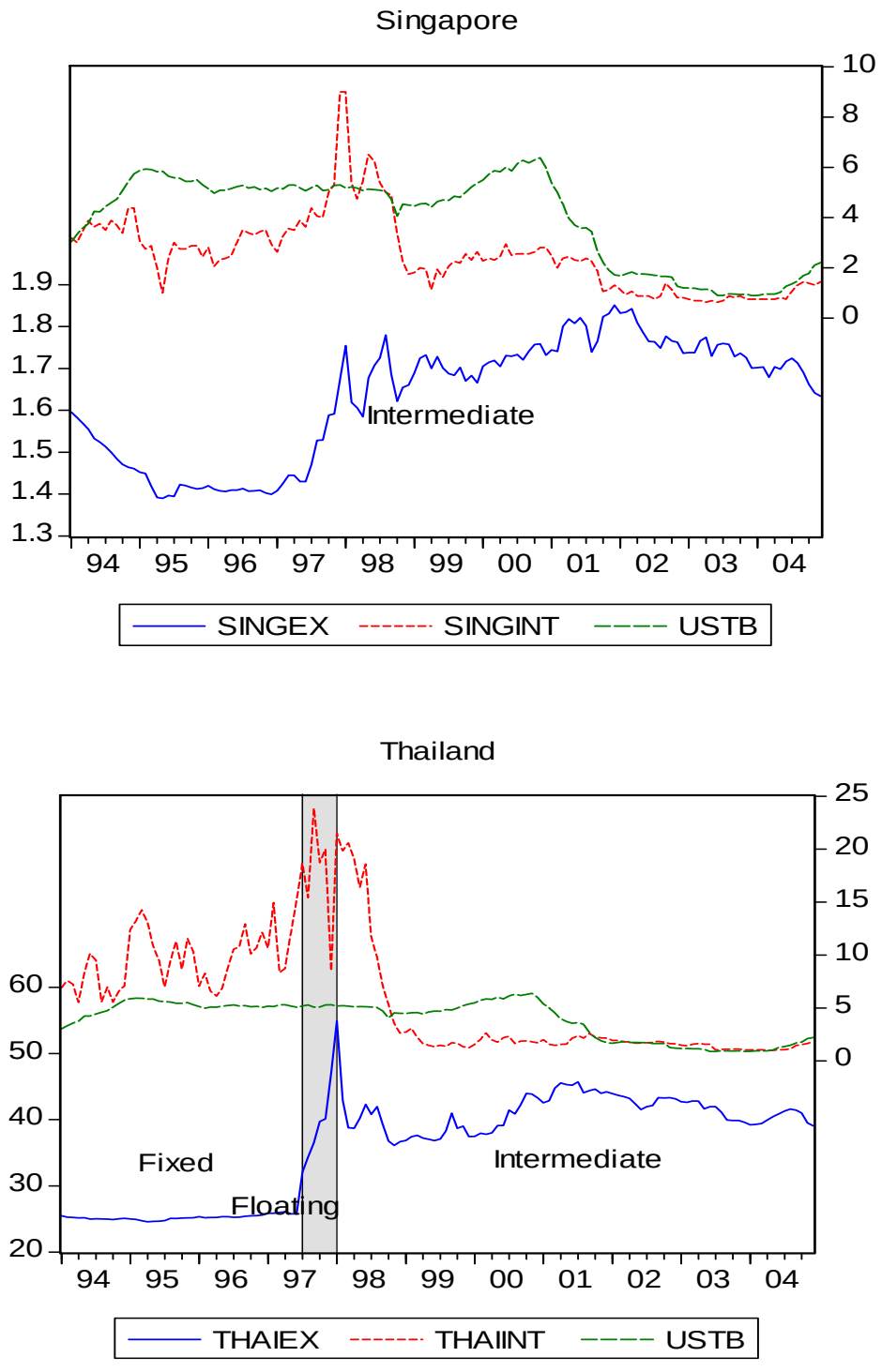


(Continued) Figure 3.1 Exchange Rates and Interest Rates in East Asia





(Continued) Figure 3.1 Exchange Rates and Interest Rates in East Asia



Note: In each figure, EX line denotes the exchange rates, INT line denotes the interest rates, and USTB line denotes the U.S. T-bill rates.

Tables:

Table 3.1 Summary Statistics of Monthly Interest Rates (Money Market Rates)

Years	Hong Kong		Japan		US		Indonesia	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
1994	4.28	0.72	2.20	0.09	4.35	0.83	9.74	1.74
1995	5.86	0.36	1.21	0.70	5.65	0.21	13.64	1.15
1996	5.40	0.32	0.47	0.01	5.14	0.09	13.96	1.01
1997	6.06	0.97	0.48	0.03	5.20	0.09	27.82	19.11
1998	6.68	3.56	0.37	0.09	4.90	0.37	62.79	12.08
1999	5.59	0.62	0.06	0.07	4.77	0.30	23.58	12.42
2000	5.95	0.55	0.11	0.11	6.00	0.26	10.32	0.74
2001	3.93	1.08	0.06	0.09	3.48	1.17	15.03	2.56
2002	1.78	0.25	0.01	0.01	1.63	0.20	13.54	3.25
2003	0.83	0.52	0.00	0.00	1.02	0.12	7.76	2.77
2004	0.13	0.16	0.00	0.00	1.39	0.47	5.38	1.98

Years	Korea		Malaysia		Philippines		Singapore		Thailand	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
1994	12.45	1.50	4.20	0.34	13.99	4.82	3.68	0.42	7.25	1.48
1995	12.57	1.58	5.60	0.50	11.93	4.58	2.56	0.58	10.96	2.11
1996	12.44	1.95	6.92	0.30	12.77	1.16	2.93	0.52	9.23	2.28
1997	13.24	2.79	7.61	1.65	16.16	6.99	4.35	1.64	14.59	5.06
1998	14.98	7.13	8.46	1.83	13.90	0.97	5.00	1.93	13.02	7.12
1999	5.01	0.49	3.38	1.17	10.16	1.71	2.04	0.41	1.77	0.60
2000	5.16	0.17	2.66	0.13	10.84	2.30	2.57	0.21	1.95	0.31
2001	4.69	0.48	2.79	0.03	9.75	1.12	1.99	0.53	2.00	0.37
2002	4.21	0.14	2.73	0.02	7.15	0.25	0.96	0.18	1.76	0.11
2003	4.00	0.23	2.74	0.03	6.97	0.15	0.74	0.08	1.31	0.25
2004	3.65	0.18	2.70	0.01	7.05	0.11	1.04	0.31	1.23	0.29

Note: Std = Standard Deviation

Table 3.2 Unit Root Tests

Variables	Sub-sample periods	Augmented Dickey-Fuller Statistics (Trend and Intercept)		KPSS Statistics (Trend and Intercept)
		Level	1st difference	1st difference
r^{HK}	Pre-crisis	-2.110	-11.804***	0.101
	Post-crisis	-1.870	-9.485***	0.115
r^{INDO}	Pre-crisis	-2.627	-8.564***	0.107
	Post-crisis	-2.713	-15.470***	0.081
r^{JAP}	Pre-crisis	-2.210	-4.628***	0.108
	Post-crisis	-3.074	-5.608***	0.059
r^{KOR}	Pre-crisis	-2.969	-6.477***	0.034
	Post-crisis	-3.027	-4.980***	0.108
r^{MALA}	Pre-crisis	-2.250	-9.045***	0.080
	Post-crisis	-2.508	-4.678***	0.106
r^{PHIL}	Pre-crisis	-2.524	-5.620***	0.040
	Post-crisis	-3.054	-5.420***	0.066
r^{SINGA}	Pre-crisis	-2.480	-6.491***	0.058
	Post-crisis	-2.170	-10.815***	0.105
r^{THAI}	Pre-crisis	-3.040	-7.225***	0.008
	Post-crisis	-3.044	-9.064***	0.072
r^{US}	Pre-crisis	-2.528	-4.605***	0.054
	Post-crisis	-1.378	-4.195***	0.108

Notes: *** denotes rejection of the null of unit root for the ADF test at the 1% significance level with critical values taken from MacKinnon (1996). For the pre-crisis period, 1% critical value of ADF unit root test is -4.19 for levels, and -4.21 for first differences for all variables. For post-crisis period, 1% critical value is -4.09 for levels, and -4.10 for first differences for all variables. The lengths of lags were chosen by the Schwarz information criterion. The Asymptotic critical values for KPSS statistics in first difference are: 0.216 for 1% level, 0.146 for 5% level, and 0.119 for 10% level.

Table 3.3 Estimation Results for Countries with One Exchange Rate Regime

A. Pre-crisis period

Country	Exchange Rate Regime	1994.1-1997.6			
		α	β	δ	Test for long-run slope =1
Hong Kong	Fixed	0.03 (0.05)	2.93*** (0.68)	-0.57*** (0.12)	0.08
Japan	Floating	0.00 (0.00)	-0.01 (0.04)	0.35*** (0.02)	0.00
Singapore	Intermediate	-0.00 (0.04)	0.55 (0.77)	-0.02 (0.10)	0.56

Notes: Standard errors of the estimated coefficients are in parentheses. Level of significance indicated by asterisks, *** 1 percent, ** 5 percent and * 10 percent. The column of the test for long-run slope shows the p-value for the significance level associated with the test for the hypothesis that the long-run response of local to U.S. interest rats is one.

B. Post-crisis period

Country	Exchange Rate Regime	1999.1-2004.12			
		α	β	δ	Test for long-run slope =1
Hong Kong	Fixed	-0.07** (0.03)	1.35*** (0.21)	-0.41*** (0.10)	0.10
Japan	Floating	-0.00 (0.00)	-0.01 (0.01)	0.06 (0.05)	0.00
Singapore	Intermediate	0.02* (0.01)	0.47*** (0.19)	-0.38*** (0.08)	0.01

Notes: Standard errors of the estimated coefficients are in parentheses. Level of significance indicated by asterisks, *** 1 percent, ** 5 percent and * 10 percent. The column of the test for long-run slope shows the p-value for the significance level associated with the test for the hypothesis that the long-run response of local to U.S. interest rates is one.

Table 3.4 Estimation Results for Countries with an Exchange Rate Regime Change

A. Pre-crisis period

Country	Exchange Rate Regime	1994.1-1997.6			
		α	β	δ	Test for long-run slope=1
Indonesia	Intermediate	0.11 (0.15)	3.35*** (1.42)	-0.42*** (0.09)	0.11
Korea	Intermediate	0.08 (0.14)	7.82*** (2.31)	0.07 (0.13)	0.01
Malaysia	Intermediate	0.17 (0.05)	-0.34 (0.59)	-0.85 (0.11)	0.03
Philippines	Intermediate /Fixed	-0.13 (0.24)	3.57*** (1.02)	0.07 (0.04)	0.21
Thailand	Fixed	0.01 (0.30)	7.54*** (2.72)	-0.02 (0.14)	0.02

Notes: Standard errors of the estimated coefficients are in parentheses. Level of significance indicated by asterisks, *** 1 percent, ** 5 percent and * 10 percent. The column of the test for long-run slope shows the p-value for the significance level associated with the test for the hypothesis that the long-run response of local to U.S. interest rats is one.

(Continued) Table 3.4 Estimation Results for Countries with an Exchange Rate Regime Change

B. Post-crisis period

Country	Exchange Rate Regime	1999.1-2004.12			
		α	β	δ	Test for long-run slope=1
Indonesia	Floating	-0.43**	-0.28	-0.15***	0.37
		(0.22)	(1.43)	(0.05)	
Korea	Floating	-0.01	0.07	0.50***	0.00
		(0.01)	(0.06)	(0.08)	
Malaysia	Fixed	0.00	0.02	0.17	0.00
		(0.00)	(0.03)	(0.05)	
Philippines	Floating	-0.02	0.36***	0.49***	0.00
		(0.03)	(0.15)	(0.06)	
Thailand	Intermediate	0.01	0.55***	-0.06	0.02
		(0.02)	(0.19)	(0.09)	

Notes: Standard errors of the estimated coefficients are in parentheses. Level of significance is indicated by asterisks, *** 1 percent, ** 5 percent and * 10 percent. The column of the test for long-run slope shows the p-value for the significance level associated with the test for the hypothesis that the long-run response of local to U.S. interest rates is one.

Appendix 3.1 Exchange Rate Regimes in East Asia

A. *De jure* Regime (Official Classification by the IMF)

Country	Period		Exchange rate regime classification	
	From	To	Narrow	Broad
Philippines	Oct81	Jun82	Limited flexibility wrt U.S. dollar	Intermediate
	Jul82	Sep84	Managed floating	
	Oct84	Jan02	Independently floating	Floating
Singapore	Jun73	Jun87	Limited flexibility wrt. a basket	Intermediate
	Jul87	Jan02	Managed floating	
Thailand	Jan77	Feb78	Peg to U.S. dollar	Fixed
	Mar78	Jun81	Limited flexibility wrt a basket	Intermediate
	Jul81	Mar82	Managed floating	
	Apr82	Oct84	Limited flexibility wrt U.S. dollar	
	Nov84	Jun97	Limited flexibility wrt a basket	
	Jul97	Jun98	Managed floating	
	Jul98	Jan02	Independently floating	Floating
Hong Kong	Jul72	Oct74	Peg to U.S. dollar	Fixed
	Nov74	Oct83	Independently floating	Floating
	Oct83	Jan02	Peg to U.S. dollar	Fixed
Indonesia	Nov78	Jul97	Managed floating	Intermediate
	Aug97	Jan02	Free floating	Floating
Japan	Dec71	Jan73	Peg to U.S. dollar	Fixed
	Feb73	Jan02	Independently Floating	Floating
Korea	Aug76	Jan80	Peg to U.S. dollar	Fixed
	Feb80	Nov97	Managed floating	Intermediate
	Dec97	Jan02	Independent floating	Floating
Malaysia	Sep75	Mar93	Limited flexibility wrt U.S. dollar	Intermediate
	Apr93	Aug98	Managed floating	
	Sep98	Jan02	Pegged to U.S dollar	Fixed
China	Mar81	Jul87	Pegged to a basket	Intermediate
	Aug87	Aug98	Managed floating	
	Sep98	Jan02	Limited flexibility wrt U.S. dollar	Fixed

Source: Frankel *et al*. (2002) and IMF annual report on exchange arrangements and exchange restriction.

Note: This classification of exchange rate regimes is based on a quarterly database from the IMF which encompasses a total of ten regime categories, based on officially reported exchange arrangements.

(Continued) Appendix 3.1 Exchange Rate Regimes in East Asia

B. *De facto* Regime (Reinhart and Rogoff, 2004)

Country	Period		Exchange rate regime classification	
	From	To	Narrow	Broad
Philippines	Dec72	Sep83	De facto crawling band around US	Intermediate
	Oct83	Feb85	Managed floating	
	Mar85	Apr92	De facto crawling peg to US dollar	
	May92	Aug95	De facto band around US dollar	
	Sep95	Jun97	De facto peg to US dollar	Fixed
	Jul97	Dec97	Freely floating/Free falling*	Floating
	Dec97	Dec01	Managed floating	Intermediate
Singapore	Jun72	Jun73	Peg to US dollar	Fixed
	Jun73	Nov98	De facto moving band around US$	Intermediate
	Dec98	Dec01	Managed Floating	
Thailand	Oct63	Mar78	Peg to US dollar	Fixed
	Mar78	Jul97	De facto peg to US dollar	
	Jul97	Jan98	Freely floating/Free falling*	Floating
	Jan98	Dec01	Manage floating	Intermediate
Hong Kong	Aug62	Jul72	Peg to pound sterling	Fixed
	Jul72	Oct83	De facto moving band around US $	Intermediate
	Oct83	Dec01	Currency board system/Peg to US$	Fixed
Indonesia	Dec70	Aug71	Peg to US dollar	Fixed
	Aug71	Oct78	De facto crawling band to US dollar	Intermediate
	Nov78	Jul97	De facto crawling peg to US dollar	
	Aug97	Jan02	Freely floating/Free falling*	Floating
	Apr99	Dec01	Freely floating	
Japan	Aug71	Dec71	Managed floating	Intermediate
	Dec71	Jan73	Bretton Woods Basket Peg	Fixed
	Feb73	Nov77	De facto moving band around US	Intermediate
	Dec77	Dec01	Independently Floating	Floating
Korea	May74	Feb80	Peg to US dollar	Fixed
	Feb80	Nov94	Pre announced crawling band	Intermediate
	Nov94	Nov97	De facto crawling peg to US dollar	
	Dec97	Jun98	Freely falling*	Floating
	Jul98	Dec01	Freely floating	
Malaysia	Jun67	Aug75	Peg to pound sterling	Fixed
	Sep75	Jul97	Limited flexibility wrt US dollar	Intermediate
	Aug97	Sep98	Freely floating/Free falling*	Floating
	Sep98	Dec01	Pegged arrangement	Fixed
China	Mar81	Jul92	Managed floating	Intermediate
	Aug92	Jan94	De facto crawling band around US$	
	Jan94	Dec01	De facto peg to US dollar	Fixed

Source: Reinhart and Rogoff (2004).

Note: Free falling is a new separate category for countries whose twelve – month rate of inflation is above 40%.

Chapter 4

Exchange Rates Volatility and Its Contagion/Spillover Effect from the Evidence of East Asia

4.1 Introduction

A distinct aspect of the crises in the 1990s was their occurrence across several countries and fast regional spread. For instance, the Asian financial crisis started with the collapse of the Thai baht on 2 July 1997. The sharply declined baht was quickly followed by pressure on the currencies of Indonesia, Malaysia, Korea and Philippines. The collapse of the currency markets also affected the stock market within and across the Asian region, leading to the collapse of several commercial banks, large securities and companies. In October 1997, equity prices collapsed in Hong Kong which led to a second round of turbulence in Asian markets. Not only restricted to the East Asian region, this second round of collapse of Asian markets was so massive that it resulted in a significant fall in stock prices throughout the world including Western markets. In fact, not only for the case of Asia, the crises in Latin America (1994) and Russia (1998) are also examples of such shocks spreading from one region to another. The significant increase in the number of financial crises and financial market collapses in various regions around the globe has provoked a growing concern among researchers and policy markers to investigate the cause and effect of such crises. Hence, there is a growing body of literature on the issue of "contagion" or "spillover effect", which is the transmission of a crisis across countries. Such studies have most often been associated with high frequency events and contagion/spillover effect is usually measured on stock market returns, interest rates, exchange rate or linear combinations of them.

Most of the existing research (see Eichengreen *et al*., 1996; Glick and Rose, 1999; Kaminsky and Reinhart, 2000, among others) in general aim to identify the linkages and transmission mechanisms across countries. These studies mainly examine whether the

occurrence of a currency crisis in one country or group of countries increases the probability of a crisis in another country. The tranquil periods and crisis periods, however, are not distinguished clearly. More recent studies make a distinct difference between normal interdependence and contagion (see, for example, King and Wadhwani, 1990; Baig and Goldfajn, 1998; Forbes and Rigobón, 2002). The former one is also often referred to spillovers, which is the propagation of shocks due to fundamental real and financial linkages that are also prevalent during tranquil periods. Contagion, on the other hand, implies a regime change in the factors driving the transmission of negative shocks.

The objective of this chapter is to provide an empirical investigation on the exchange rate volatility and its cross-country transmission effect for a group of East Asian economies in the context of the 1997/98 Asian financial crisis[18] and the period afterwards. Our concern is not to judge channels through which the crisis is transmitted across countries as extensive empirical literature did. Instead, we restrict our attention to the volatility of East Asian currencies, and aim to answer the following questions: Did volatility of one exchange rate market transmit to others in some way? If so, to what extent did this volatility contagion/spillover effect work during the specific time period? We address two types of volatility transmission: the contagion effect for the crisis period, and the spillover effect for the tranquil period. In order to identify the presence of contagion/spillover effect in the exchange rate volatility, particular interests of this chapter are to look into the possible exchange rate volatility transmission from Korea, a crisis-affected country, to other regional markets during the crisis period; and from Hong Kong to other regional markets over the tranquil period. Daily exchange rates (expressed as local currency per U.S. dollar) covering the period since 4 January 1997 until 31 December 2002 have been used in this study in order to sharpen our analysis. The problem of using a low frequency data (semi-annual, quarterly, and monthly), on which many previous literature are based, lies in that it smoothes out a lot of shorter duration interactions between the financial markets. The small but important events in

[18] Adding to the existing literature, this chapter examines volatility and contagion/spillover in the foreign exchange market, which has, in contrast to stock and bond markets contagion/spillover, received limited attention.

the sample period are not easily to be captured by low frequency data. In this study, the GARCH-type techniques are applied to high frequency data, and the long memory characteristics of exchange rates and the nature of their volatility have been thoroughly examined. Financial return time series often exhibit some well-known characteristics. For instance, volatility clustering has been identified in financial returns data. Large changes tend to be followed by large changes and small changes tend to be followed by small changes. Financial time series also often exhibit leptokurtosis which implies that the distribution of their returns is fat-tailed (Mandelbrot, 1963; Fama, 1965). In addition, changes in asset prices tend to be negatively correlated with changes in volatility (i.e. volatility is higher after negative shocks than after positive shocks of same magnitude. This has been called "leverage effect" by many empirical studies (see, for example, Black, 1976; Nelson, 1991). The ARCH models introduced by Engle (1982) and generalised as GARCH by Bollerslev (1986) and Taylor (1986) have proven success in capturing the above characteristics. The GARCH-type techniques are widely used in financial econometrics, especially in financial data series volatility modeling and forecasting.

This chapter is organised in the following manner. Section 4.2 provides a brief review of the existing literature on the currency crises and financial market contagion/spillover. Section 4.3 discusses data issues and presents the preliminary analysis. Section 4.4 describes the empirical frameworks and their implications. Section 4.5 gives the interpretation of the empirical results. Finally, the conclusion remarks and implications are drawn in Section 4.6.

4.2 A Review of Literature

4.2.1 Theoretical Perspective on Financial Market Contagion

When it comes to the interpretation of currency instability, the fundamental and self-fulfilling views of currency crises are two main analytical and conceptual

frameworks in the literature. The first generation of models viewed crises as the unavoidable result of unsustainable polices or fundamental imbalances. As suggested by Krugman (1979), the expansionary monetary policy combined with a fixed exchange rate leads to external imbalances. In second generation models, the costs and benefits of the maintenance of a peg have been taken into account in the political choice which decides whether a fixed exchange rate should be abandon or not. The second generation of models stresses the possibility of self-fulfilling exchange rate crises. The interaction between investors' expectations and actual policy outcomes can cause self-fulfilling crises (see Obstfeld, 1986, 1994, 1996; Cole and Kehoe, 1996, 1998; Chang and Velasco, 1998, and others for studies on self-fulfilling crises). When private agents expect a devaluation, the policy measures required to maintain the peg make such an outcoming maintenance more costly. Hence, devaluation expectations become self-fulfilling. However, it has been argued that these two traditional models provide a partial explanation but they cannot account for the severity of the crisis (Pesenti and Tille, 2000). Several features played central roles in the turmoil of the 1990s, especially for the Asian crisis, have been emphasised in the post-Asia crisis literature. Among them, the role of mechanisms of crisis transmission across countries, or contagion has been one of the distinct features explored by extensive empirical literature.

A variety of explanations for the channels of contagion have been documented by theoretical literature (see, for instance, Eichengreen *et al*., 1996; Glick and Rose, 1999; Buiter *et al*., 1998; Van Rijckeghem and Weder, 1999; Ahluwalia, 2000; Kaminsky and Reinhart, 2000, and among others). First, the common shocks can contribute to a financial crisis that spreads from one country to another. Common shocks often refer to the factors that may affect exchange or stock markets of several countries simultaneously (Khalid and Rajaguru, 2006). Second, the strong trade linkage is viewed as one of the important causes of currency crisis, particularly of its rapid transmission. Due to the speculative attacks on country A, there would be a real depreciation of country A's currency. The currency depreciation of country A would enhance its export competitiveness which in turn would lead to a trade deficit for its corresponding competitor, country B. Therefore, we may expect a loss of foreign exchange reserves in

country B. Thus, the probability of speculative attacks on the currency of country B will be increased. Third, strong financial linkages are another major cause of contagion. A crisis in one country will drive investors to alter their portfolio and consequently lead capital flight in countries closely financial linked, even if no significant changes of economic fundamentals can be found in these countries. Moreover, Khalid and Rajaguru (2006) point the shift in investor's sentiment is another possible reason for the crisis which spread from one country to another. They further suggest countries with weak financial fundaments are more vulnerable to speculative attacks and more likely to suffer from adverse shocks.

It should also be noted that the concept of "contagion" varies from author to author. For one case, a currency crisis can be considered as being contagious if it spreads from the initial crisis country to another. Masson (1999) argues based on a multiple equilibria model that crisis contagion can be referred as an equilibrium switch under some economic fundamental conditions. The contagion effect can also be viewed as an increase in the probability of a speculative attack on the domestic currency (see, for example, Eichengreen *et al*., 1996). In particular, a distinct difference between normal interdependence and contagion has been emphasised by a group of recent studies that focus on transmission effect (see King and Wadhwani, 1990; Baig and Goldfajn, 1999; Forbes and Rigobón, 2002; among others). According to these studies, the former one, namely normal interdependence often refers to spillovers. It is the propogation of shocks due to fundamental real and financial linkages that are also prevalent during tranquil time. The latter one, contagion, implies a regime change in the factors driving the transmission of negative shocks. For the purpose of this study, the contagion and spillover effect are considered as two different concepts: the notion of contagion is defined as the spread of a shock from one country to another during the "crisis" period. The spillover effect is defined as the spread of a shock from one country to another during the "tranquil" period.

4.2.2 Empirical Evidence on Currency Crises and Contagion

There is a growing literature on the large scale speculative attacks and currency crisis episodes in the 1990s. For recent related studies in this field, see, for example, Eichengreen and Wyplosz (1993) and Buiter *et al*. (1998) on the European Monetary System crisis of 1992-93; Sachs *et al*. (1996) and Calvo and Mendoza (1996) on the Mexican peso crisis of 1994; and Corsetti *et al*. (1998, 1999), Mishkin (1999) and Radelet and Sachs (1998a, 1998b) on the Asia crisis of 1997-98. Here we briefly survey the empirical studies focusing on contagion. Specifically, the possible channels or causes of contagion have been identified by a group of studies. For instance, Eichengreen *et al*. (1996) and Glick and Rose (1999) identify trade links as an important channel for contagion. Van Rijckeghem and Weder (1999) highlight financial market linkages as the source of spillovers from one country to others in the region. Ahluwalia (2000) suggests common macroeconomic weaknesses to important similarities between countries as a channel for contagion. Kaminsky and Reinhart (2000) find the evidence of the existence of the common creditor channel when they examine the Mexican, Asian and Russian crisis.

Regarding measuring the presence of contagion, several methodologies have been applied in the literature which can be broadly divided into four groups. The first group usually employs probit/logit approach to examine whether the possibility of a crisis in a specific country increases when another country (or a group of countries) is hit by a crisis (see, for example, Eichengreen *et al*., 1996; Glick and Rose, 1999; De Gregorio and Valdés, 2001). The second group of studies conducts the correlation analysis to test whether correlation coefficients, regarding stock prices, exchange rates, or interest rates, change during a financial crisis. In this literature, a significant increase in correlation is considered the evidence of contagion. The related papers of this group can be found in Calvo and Reinhart (1996); Frankel and Schmukler (1996); Baig and Goldfajn (1999); Forbes and Rigobón (2002), and among others. The third group of papers study contagion within a region applying Granger causality based on a VAR model (see, for example, Fratzscher, 1998; Khalid and Kawai, 2003; Hernández and Valdés, 2001).

It is to be noted most of the existing literature from the above discussion heavily emphasised how the exchange rates (or stock price returns) in one country affects the exchange rates (or stock price returns) of others under the assumption that the variance of studied variable is constant overtime. However, for the time series research, the assumption of a constant variance might ignore important information especially using high frequency data such as daily observations over the crisis period. Recently the GARCH-type approach is applied by a few of studies to examine the issue of contagion, which can be deemed as the fourth group of studies. This set of studies focus on the volatility analysis of contagion, that is, to estimate whether conditional variances of financial variables are related to each other among markets in different countries during the crisis period. In the following section, we mainly provide an overview of recent empirical evidence based on the GARCH models.

In order to test whether volatility is transmitted between countries, Chou *et al*. (1994) and Hamao *et al*. (1990) find evidence of significant spillovers across markets after the U.S. stock market crash in 1987. By comparing the behaviour of short-term interest rate volatility in Argentina and Chile during the period of 1992-1998, Edwards (1998c) identifies a different effect of Mexico's volatility spillovers in these two countries. Habib (2002) investigates the impact of external factors on the behaviour of interest rates and exchange rates in Central and Eastern Europe. By modelling and comparing the time-varying volatility of both interest rates and exchange rates, he tests for the significance of additional regressors in the conditional variance equation. Using a mean-exponential generalised autoregressive conditional heteroskedasticity (M-EGARCH) model for five different future contract lengths and six developed economies, Aguirre and Saidi (1998) find that an M-EGARCH (1,1) model effectively describes the exchange rate future's daily dynamic behaviour, which sheds light on the determinants of both the mean and the volatility of exchange rate futures.

Fernandez-Izquierdo and Lafuente (2004) employ a GJR-GARCH model to examine the dynamic linkages between international stock market volatility during the Asian crisis and find a support for contagion. Using the daily data for the period of Asian

Currency Crises, Ito and Hashimoto (2004) examine high-frequency contagion among Asian countries. By distinguishing the "origin" and "affected" countries in the causality relationship, they find the evidence of statistically significant high-frequency contagion effect among Asian countries in both the exchange rate and the stock prices. They also find that the spillover effect in stock markets has been intensified after the crisis in most of the Asian countries. Their study further points out the important role played by the bilateral trade linkage in the transmission of financial pressures across international borders. Using a GARCH approach and data from Istanbul stock exchange (ISE), Alper and Yilmaz (2004) find support for volatility contagion from stock markets. Using high frequency data and a Granger causality tests within a multivariate GARCH framework, Khalid and Rajaguru (2006) investigate the spread of contagion in the Asian financial markets during the 1997/98 Asian crisis. They find evidence of strong intermarket linkages within Asian currency markets during the crisis and post-crisis periods, but not look into volatility transmission.

This study follows the fourth approach mentioned above and uses GARCH-type models which allow the variance to vary across the time, and hence explicitly account for conditional volatility in the time series data. Our aim is thus to test whether volatility is transmitted across countries. Two types of volatility transmission-the contagion effect over the crisis period and the spillover effect over the tranquil period, are of particular interest in this study. To be specific, applying the GARCH approach on high frequency data, we firstly examine the long memory characteristics of the exchange rates and then use a time–variance specification to identify the possible contagion/spillover effect within a sample of selected East Asian countries. If this is the case, then the volatility of one exchange rate market should be in some way correlated with the volatility of other foreign exchange markets in the region.

4.3 The Data and Preliminary Analysis

4.3.1 Data Description and Statistics

Many previous studies based on monthly or quarterly data (even weekly data), may limit analytical capability of crisis correlations among countries during a specific period (especially for the crisis period). To overcome this problem, the daily data of the nominal exchange rate (vis-à-vis U.S. dollar) from 4 January 1997 to 31 December 2002 have been used as a full sample in this study. Forward market rates should help to isolate the central bank intervention in the foreign exchange market, and can reflect the true movements of the exchange rate. However, forward rates are not available for most of the sample countries. We therefore use the spot exchange rates expressed as local currency per U.S. dollar, obtained from the Datastream database. According to Bollerslev's (1990) study, the log difference of exchange rates are adequately modeled with a simple (1) martingale process. This is described below:

$$R_{i,t} = \log(\frac{s_{i,t}}{s_{i,t-1}}) = \mu_i + \varepsilon_{i,t} \qquad (4.1)$$

where:

$R_{i,t}$ = the return on currency *i* between *t*-1 and *t*,

$s_{i,t}$ = the spot rate of currency *i* at time *t* (expressed against the U.S. dollar),

μ_i = a long-term drift coefficient,

$\varepsilon_{i,t}$ = the error term for currency *i* at time *t*.

Therefore, the daily return of exchange rates is log differenced to convert them into continuously compounded returns for Hong Kong (HKD), Indonesia (IDR), Malaysia (MYR), Singapore (SGD), Philippines (PHP) and Thailand (THB).

Figure 4.1 and Figure 4.2 plot the daily frequency of spot exchange rates returns against U.S. dollar for the two sub-periods: the crisis period (July 2, 1997--Aug 31, 1998) and the post/non-crisis period (Jan 4, 1999--Dec 31, 2002), respectively. It is obvious that the volatility of all variables changes over time. The graph of the return series clearly shows the presence of volatility clustering. Note that all of the variables exhibit greater volatility in the crisis-period, as shown in Figure 4.1, indicating the possibility of volatility contagion during the crisis period. The post-crisis exchange rates movements, as depicted in Figure 4.2, reflect different characteristics: the volatility of Hong Kong dollar and Malaysia ringgit are smaller, with the fixed exchange rate arrangement adopted by both countries; while volatile exchange rates movements are identified in Indonesia, Korea, Philippines, Singapore and Thailand, confirming the fact that these countries conduct managed/free floating exchange rate regime after the financial crisis.

Table 4.1 provides a summary of statistics for all daily exchange rates. Commonly for financial time series, all currencies at daily frequency exhibit excess kurtosis, indicating that the distribution is characterised by leptokurtosis. Jarque-Bera statistic is used to test whether the standardised residuals are normally distributed or not. If the standardised residuals are normally distributed, the Jarque-Bera statistic should not be significant. The calculated Jarque-Bera statistics provide clear evidence to reject the null hypothesis of normality for the unconditional distribution of the daily exchange rate changes. Table 4.1 also reports the standard deviation of the variables in sample. Most exchange rates across crisis-affected countries present higher volatility in the crisis period. Regarding the comparison of volatility across countries, exchange rates of Indonesia present the highest volatility, while Hong Kong as non-crisis affected region, its exchange rates present the least volatility. During the post-crisis period, as expected, the Hong Kong dollar and Malaysia ringgit witnessed the lowest volatility due to the dollar pegged regime adopted by both economies.

4.3.2 Preliminary Volatility Correlation Analysis

A simple way to quantify the degree of co-movement among the volatility of these currencies is to calculate their correlations. As a preliminary analysis before conducting the regression, we calculate the sample standard deviation for each currency in four-week centred rolling window for the crisis and non-crisis (post-crisis) periods. The volatility correlation among East Asian currencies, as shown in Table 4.2 (Panels A and B), presents interesting results as follows: Firstly, correlation coefficients among most East Asian currencies are always significant and positive in the crisis period, especially for the crisis-affected countries. The correlation between Malaysia and Indonesia is the highest (0.83) while Hong Kong has relative low correlations with both Korea (0.00) and Thailand (0.09). Secondly, the computed correlations appear lower for most currencies in the post-crisis period, indicating the relatively less volatility transmission during the tranquil period. The volatility of Hong Kong dollar, Singapore dollar and Thailand baht are detected to be positively correlated with other currencies while the negative correlations can be found between Korean won and Indonesian rupiah (-0.10), as well as Philippines peso and Malaysian ringgit (-0.03). In particular, the volatility of Hong Kong dollar has been most correlated with Singapore dollar (0.35) and least correlated with Philippines peso (0.13) in the post-crisis period.

In short, it is possible to note that the exchange rates volatility increased during the crisis period, in terms of inspection of volatility charts and volatility correlations discussed above. In fact, it is more likely that volatility will be higher and returns will be lower when asset markets are under stress. It has been shown in the finance literature that in such conditions, correlations between asset markets tend to increase. In particular, these results preliminarily imply the possibility of existence of volatility transmission in the East Asian region. In order to examine the time-varying volatility of currencies and detect any significant impact of the volatility transmission among these currencies, we formally construct a set of GARCH models in the next section.

4.4 Models Descriptions and Implications

4.4.1 GARCH Model

The ARCH/GARCH models have been the standard econometrical tools to analyse the volatility. According to the basic version of the least squares model, the expected value of all error terms, when squared, is assumed to be the same at any given point. This assumption is known as the homoskedasticity. Nevertheless, financial data may suffer from heteroskedasticity, in which the variances of the error terms are not equal and the error terms may reasonably be expected to be larger for some points than for others. In the presence of heteroskedasticity, the standard errors and confidence intervals estimated by conventional least squares procedure will be too narrow and this would produce a false sense of precision (Engel, 2001). Instead, ARCH and GARCH models can treat heteroskedasticity as a variance to be modeled. The application of these models in finance can not only correct the deficiencies of least squares but also compute the prediction of variance of each error term. In addition, the amplitude of the return series has been identified to vary over time and financial analysts usually describe this as "volatility clustering". The ARCH and GARCH models are designed to capture this set of issues. They have become widespread tools for dealing with time series heteroskedastic models and provide a robust volatility measure of the high frequency financial data.

Prior to the introduction of ARCH/GARCH models, there have been no methods available for the variance when using the information to forecast the mean and variance of the return, conditional on the past information. Engel (2001), in particular, point out the traditional descriptive tool such as rolling standard deviation is based on a fixed number of the most recent observations. It assumes that the variance of tomorrow's return is an equally weighted average of the squared residuals from the last periods, and such assumption of equal weights seems unattractive. Nevertheless, as further suggested by Engel (2001), the ARCH/GARCH model is a weighted average of past squared

residuals and it gives parsimonious models that are easy to estimate. Thus, the ARCH/GARCH model allows the data to determine the best weights used in forecasting the variance and this kind of model has been successful in predicting conditional variances.

The descriptive validity of the univariate ARCH and GARCH models in characterising the exchange rate dynamics have been well documented, see, for instance, Engle and Bollerslev (1986), Bollerslev (1987), Diebold and Pauly (1988), Diebold and Nerlove (1989), Baillie and Bollerslev (1989), among many others. The fact that high frequency financial data exhibit volatility clustering is widely recognised by a large body of empirical studies. It has also long been known that exchange rates exhibit volatility clustering so that large changes tend to be followed by large changes of either sign and periods of tranquility alternate with periods of high volatility. One of the most popular models that allows us to model the dynamic process of the conditional volatility is the GARCH model developed by Bollerslev (1986), following the seminal work of Engle (1982). In order to give a general description of exchange rate volatility for a particular country, a GARCH (p, q) model of exchange rates can be written as follows:

$$y_t = c_0 + \sum_{1}^{m} c_m y_{t-m} + \varepsilon_t \tag{4.2}$$

$$\varepsilon_t \mid I_{t-1} \sim N(0, \sigma_t^2) \tag{4.3}$$

$$\sigma_t^2 = \alpha_0 + \sum_{1}^{q} \alpha_q \varepsilon_{t-q}^2 + \sum_{1}^{p} \beta_p \sigma_{t-p}^2 \tag{4.4}$$

and $\sigma > 0, \beta_i \geq 0, \alpha_i \geq 0; \sum_{i=1}^{q} \alpha_i + \sum_{i=1}^{p} \beta_i < 1$

where y_t represents the first differences of the logarithm of daily exchange rates in the selected countries at time *t*, ε_t is the innovation to exchange rate changes, given the information set I_{t-1} at the time *t*-1. We assume market efficiency which implies that

daily exchange rate changes are distributed with mean zero. Thus, ε_t is distributed as a normal with zero mean and time-varying conditional variance σ_t^2. The p is the autoregressive lag and the q is the moving average lag. When $\beta_i = 0, \quad i = 1,2,...p$, the above model reduces to ARCH (q) which is proposed by Engle (1982). The non-negativity conditions on the parameters implied a non-negative variance and the condition on the sum of the β_i's and α_i's required for wide sense stationarity. The volatility shocks are quite persistent if the sum of the ARCH and GARCH coefficients is very close to one. In fact, the persistent volatility is usually observed in high frequency financial data.

The conditional distribution of the error term is assumed to be normal (Gaussian) distribution and the estimation method employed here is Quasi-Maximum Likelihood (QML), computing Bollerslev-Wooldridge (1992) robust standard errors. When the assumption of conditional normality does not hold, the GARCH parameter estimates will still be consistent, provided the mean and variance functions are correctly specified. Therefore, the QML estimators are robust in the sense that they can produce consistent estimates of the parameters of a correctly specified conditional mean, even if the distribution is incorrectly specified.

4.4.2 EGARCH Model

Note that for the above traditional GARCH models, positive and negative past values have a symmetric impact on the conditional variance. In practice, financial data series may have strong asymmetric influence on the conditional variance. The tendency for returns and volatility to be negatively correlated is a well established characteristic of many equity markets. It implies that negative returns are more likely to be associated with greater volatility than positive returns. The early studies such as Black (1976) and Christie (1982) sought to explain this asymmetry in volatility by reference to a "leverage effect". In finance, the leverage effect predicts that an asset's returns may

become more volatile when its price decreases. Our study thereby takes into account the potential existence of asymmetry in exchange rates, and attempts to investigate the possible leverage effect in the exchange rates data. The Exponential GARCH or EGARCH model proposed by Nelson (1991) has been widely used to model and capture the leverage effect. This model allows the conditional variance to be depended on the magnitude as well as the sign of the innovations (that is, error term). This means that the variance of the exchange rate process is an asymmetric function of past error terms. That is, negative and positive innovations can have different impacts on expectational errors. Furthermore, this technique does not require the imposition of non-negativity constraints on coefficients in order to ensure positive variance. The specification of the conditional variance for the EGARCH (p, q) model can be written as follows:

$$\log(\sigma_t^2) = \omega + \sum_{i=1}^{q} \alpha_i g(z_{t-i}) + \sum_{j=1}^{p} \phi_j \log(\sigma_{t-j}^2) \tag{4.5}$$

$$g(z_t) = \theta \cdot z_t + (|z_t| - E|z_t|), \qquad z_t = \frac{v_t}{\sigma_t} \tag{4.6}$$

Different from the basic GARCH model, on the left-hand side of Equation (4.5), it is the log of the conditional variance. This implies that the leverage effect is exponential rather than quadratic, and forecasts of the conditional variance are guaranteed to be non-negative. As mentioned previously, the leverage effect occurs when an asset's return become more volatile as its price decreases. This is the type of behaviour seen in an EGARCH process when $\theta < 0$. Therefore, the presence of leverage effects can be tested by the hypothesis that $\theta < 0$ and the impact is asymmetric if $\theta \neq 0$.

Especially, the specification of the EGARCH (1, 1) conditional variance is described as follows:

$$\log(\sigma_t^2) = \alpha_0 + \alpha_1(|z_{t-1}| - E|z_{t-1}|) + \theta z_{t-1} + \phi \log(\sigma_{t-1}^2) \qquad \text{where } z_t = \frac{v_t}{\sigma_t} \tag{4.7}$$

The component $(|z_{t-1}| - E|z_{t-1}|)$ captures the size effect and indicates how the magnitude of past innovations increases or decreases the current volatility of exchange rates, z_{t-1} captures the sign effect of the lagged residuals. A negative sign implies that negative innovations (expectations of exchange rates' appreciations) increase volatility more than positive innovations (expectations of exchange rates' depreciations). On the other hand, the positive sign implies that negative innovations (exchange rates' appreciations) increase volatility less than positive innovations (exchange rates' depreciations). Finally, the last term is the logarithm of the last period conditional variance. The degree of volatility persistence depends on the size of the coefficient ϕ. For ϕ = 1, the unconditional variance does not exist. Therefore, it is a random walk, implying that the conditional variance is an integrated process of degree 1. For $\phi < 1$, the unconditional variance exists and is a mean reverting process.

The parameters in the Equation (4.7) can be obtained by maximising the log likelihood function. In most empirical studies the normal density is used even though the standardised residuals obtained from ARCH-type models, which assume normality, remain leptokurtic. As suggested by Nelson (1991), the errors can be assumed to follow a Generalised Error Distribution (GED). The advantage of using a more general distribution is that parameter estimates are not excessively influenced by extreme observations that occur with low probability, such as during speculative attacks.

4.5 Interpretation of the Empirical Results

4.5.1 Unit Root Tests

It is well known that the data generating process for most macroeconomic time series are characterised by unit roots, which puts the use of standard econometric methods under question. Therefore, it is important to analyse the time series properties of the data in order to avoid the spurious results due to unit roots in the data. GARCH

techniques require variables to be stationary. Hence, the unit root tests are conducted to test the stationarity of series before conducting the estimation. As mentioned in Section 4.3.1, the daily return of exchange rates (log differenced to convert them into continuously compounded returns) is recommended to use for analysis of this study. This section further demonstrates the validity of this proposition. Table 4.3 reports the results of the Augmented Dickey-Fuller tests for levels and first differences of logarithms of exchange rates in East Asian countries. As one would expect, exchange rates of most countries (expect Hong Kong and post-crisis Malaysia) are not stationary and integrated of order one. These results suggest that it is more convenient to continue the analysis of volatility working with the first differences of the variables, calculating the daily changes in the logarithm of the exchange rate instead of their levels for most countries in sample.

4.5.2 Residual Tests

In the first step of the analysis, we have estimated Equation (4.2) for each East Asian currency by using Ordinary Least Squares (OLS) method in order to check the presence of heteroskedasticity in the residuals. The lag length in the mean equation for each regression is determined by the Schwarz Information Criterion (SIC). The Correlogram-Q-statistics, which display the correlogram (autocorrelations and partial autocorrelations) of the standardised residuals, help test for remaining serial correlation in the mean equation and check the specification of the mean equation. If the mean equation is correctly specified, all Q-statistics should not be significant. Moreover, the ARCH LM test can be carried out to check whether the standardised residuals exhibit additional ARCH. If the variance equation is correctly specified, there should be no ARCH left in the standardised residuals. The statistics presented in Table 4.4 are Ljung-Box Q statistics for the squared residuals and the p-value related to the test for ARCH effects. The former test is based on the null hypothesis that no auto-correlation up to the order *k*, while the Lagrange multiplier (LM) principle is to test the null hypothesis of no ARCH effects versus the alternative that the conditional error variance is given by an ARCH (q) process. This test approach is to generate the squared residuals

on a constant and q lagged values of the squared residuals. According to the results from Table 4.4, the $Q^2(10)$ test statistics suggest that conditional homoskedasticity can be rejected for most currencies except for Hong Kong dollar (HKD) and Thai baht (THB) in the crisis period. The LM tests, as shown in Panel A, further confirm that all currencies exhibit ARCH (1) effects in their error terms at the daily frequency during the crisis period. Regarding the post-crisis period (as shown in Panel B), on the other hand, the results clearly indicate the presence of conditional heteroskedasticity according to the Q squared statistics. In every case, LM test shows that the null hypothesis of absence of ARCH can be rejected at the conventional levels. Overall, the slow decline of the auto-correlation function of the squared residuals, as well as the presence of ARCH effects, suggest that a GARCH (1, 1) process may be suitable for describing the errors for both sub-sample periods.

4.5.3 Results of GARCH and EGARCH Estimations

Table 4.5 provides a summary of exchange rate volatility results, by using both GARCH and EGARCH estimations. First, the GARCH (1, 1) model in general performs rather well for most regressions in both sub-sample periods, with the coefficients of both lagged squared innovations and the lagged variance being always positive and significantly different from zero (Note that the lagged squared innovations are not significant in the cases of Indonesia and Malaysia for the non-crisis period). Higher order GARCH representations did not perform well, when measured by the value of the log likelihood function.

Alternatively, the EGARCH (1, 1) estimation results, provided in the Table 4.5, can interpret the size effect, sign effect and persistence effect on the volatility of exchange rate dynamic. The size effect, captured by α_1, indicates how the magnitude of innovations increases or decreases the current volatility or risk of exchange rate. It is positive and significant at the 1 percent level for all currencies for both sub-sample periods with the exception of Hong Kong for the crisis period. Thus, the magnitude of

the past innovations increases the current volatility or risk of exchange rate. Also, the size effect is obviously larger during the crisis period, but declines during the non-crisis period for most currencies. The sign effect is captured by θ. The negative sign implies that negative innovations (expectations of exchange rate appreciations) increase volatility more than positive innovations (expectations of exchange rate depreciations). On the other hand, the positive sign implies that negative innovations increase volatility less than positive innovations. As for the crisis period, θ is positive but insignificant for most currencies expect the Indonesia Rupiah, which suggests no presence of leverage effects can be identified among these markets. As for the non-crisis period, the leverage effects can be found only in the case of Hong Kong and Singapore, according to the negative sign of coefficient θ. However, θ is still insignificant for most currencies (except Hong Kong), indicating there is little evidence of asymmetric impact of past error terms on the variance of the exchange rate process. The coefficient ϕ, which measures the persistence of innovations on volatility, is positive and significant for all currencies for both crisis and non-crisis periods. In particular, for the non-crisis period, all ϕ values in the sample currencies are close to 1, indicating the volatility shocks are quite persistent.

4.5.4 Volatility Transmission Analysis

The second objective of this paper is to detect the evidence of exchange rates volatility contagion or spillover in the region. Regarding the analysis of volatility contagion over the crisis period, our particular interest is to examine the volatility transmission effect from Korean won to other currencies in the region. Thus, guided by the previous volatility analysis for each of seven currencies, the estimated conditional variance from a GARCH (1, 1) model of Korean exchange rates volatility (KRWVOL) has been used as an exogenous regressor included in the conditional variance of other currencies. As for the analysis of volatility transmission in the non-crisis period, since our interest is to identify the evidence of exchange rate volatility transmission from Hong Kong to other currencies, the estimated conditional variance form GARCH (1, 1) models of Hong

Kong exchange rates volatility (HKDVOL) has been used as an exogenous regressor included in the conditional variance of other currencies. Therefore, the Korea-specific volatility variable (KRWVOL) and Hong Kong-specific volatility variable (HKDVOL) will be included in the estimation of the conditional variance equation for each currency in question.

Specifically, a general specification of the new model can be written as follows:

$$\sigma_t^2 = \alpha_0 + \sum_1^q \alpha_q \varepsilon_{t-q}^2 + \sum_1^p \beta_p \sigma_{t-p}^2 + \gamma VOL_t \tag{4.8}$$

The exogenous regressor VOL_t in the conditional variance equation refers to indicators of external exchange rates volatility during the specific period. The estimation of coefficient γ captures the effect of these external exchange rates volatility on the conditional variance of y_t. The hypothesis of "exchange volatility contagion/spillover effect" will be accepted if the coefficient γ is positive and significantly different from zero.

The estimation of these equations allows us to address a number of issues: First, the estimation of these equations will allow us to compute estimated series of conditional exchange rate volatility for each country. Parameters α and β provide an idea of the nature of volatility of these currencies, including their degrees of persistence. Second, the estimation of Equation (4.8) will provide information on whether during the specific period there has been a presence of volatility transmission effect. If such effect exists, the estimated coefficient of VOL will be positive and significantly different from zero. Third, the comparison of the estimated value of γ for each East Asian country can provide some information on the process of exchange rates volatility in these countries. If, as the authorities expected, capital controls in country A have been effective, then we

would expect a smaller coefficient of γ in this country than others. This is because effective and appropriate capital controls on international capital moments can avoid currencies volatilities from speculative activities.

Crisis Period

Table 4.6 reports a set of GARCH estimations results, with exogenous regressor KRWVOL included conditional variance of daily foreign exchange returns. N is the number of observation, ARCH LM test is Engle's test for the presence of residual conditional heteroskedasticity; and IGARCH is a Wald χ^2 test for the null hypothesis that $\alpha + \beta = 1$. Several findings are summarised as follows:

First, the GARCH (1, 1) model seems to perform rather well for most regressions, with the coefficients of both lagged squared innovations and the lagged variance being always significantly different from zero[19]. Second, according to Engle's LM test, the null hypothesis that no conditional heteroskedasticity remains in the residuals cannot be rejected in most cases (except Indonesia). Note that the GARCH (1, 1) model of Indonesia Rupiah volatility performs unwell due to the negative coefficient in the lagged squared innovations. Third, and more important for the current study, the results show a very different transmission effect of Korean won's volatility on other currencies' conditional variances during the crisis period. On one hand, coefficients of KRWVOL for HKD, MYR and PHP are statistically significant different from zero at the 5 percent level, indicating the presence of volatility contagion effect from Korea exchange rates to Hong Kong, Malaysia and Philippines over the crisis period. On the other hand, in the cases of Singapore and Thailand, while the coefficients of Korea exchange rates volatility are always positive, they are not significant different from zero at the 5 percent level. This might suggests the less evidence of exchange rates volatility spillovers effect from Korea to both two countries during the crisis period.

[19] Higher order GARCH representations did not perform well, when measured by the value of the log likelihood function.

Finally, in several regressions the sum of the GARCH coefficients (α and β) is close to one, implying that volatility shocks are quite persistent. When this sum is equal to one, the GARCH process is defined as Integrated in variance, or IGARCH. The presence of a high degree of persistence in GARCH models is a common feature of many high frequency financial time series. Table 4.6 also reports the tests of the presence of Integrated GARCH process in the estimation. The Wald statistics indicate that the hypothesis that $\alpha + \beta = 1$ can be rejected in most regressions at the 5 percent level with the exception of Hong Kong, suggesting the presence of IGARCH (1, 1) models in Hong Kong. In this case the unconditional variance does not converge to $(\varphi/(1-\alpha-\beta))$, as in the most common case when $\alpha + \beta < 1$.

Tranquil (Non-Crisis) Period

A second set of estimations included the variable that capture Hong Kong exchange rates volatility (HKDVOL) to identify the evidence of exchange rate volatility transmission from Hong Kong to other currencies during the tranquil period. The main findings reported in Table 4.7 can be interpreted as follows:

First, coefficients of the HKDVOL are always positive in most regressions with the exception of Philippines over the non-crisis period. Second, the impact of Hong Kong exchange rate volatility on Korean won; Malaysian ringgit and Singapore dollar are statistically significant, since coefficients are significantly different from zero at the 5 percent level. As for Indonesia, Philippines, and Thailand, the HKDVOL coefficients are not significant over the post-crisis period. These outcomes are broadly consistent with results from the previous correlation analysis, providing evidence of volatility transmission of Hong Kong dollar to currencies of Korea, Malaysia and Singapore during the tranquil period. Third, it is worthwhile noting that the hypothesis that no residual conditional heteroskedasticity remains in the residuals cannot be rejected for all cases. The Wald tests show that the hypothesis of IGARCH presence is rejected in Malaysia, Singapore, Philippines and Thailand, but accepted in Indonesia and Korea.

4.6 Concluding Remarks

Investigating the sources of financial crisis has emerged as an important research focus in the aftermath of the 1997/98 Asian financial crisis. The strong trade linkages and macroeconomic similarities have been proved by several theoretical and empirical researchers as major sources spreading the crisis from one market to the entire or even other regions. The empirical literature also finds the presence of contagion effect in the financial crises and generally suggests currency contagion may have been a cause of the crises. The focus of this paper is to expand the existing research by looking into the nature of exchange rate volatility and the presence of volatility transmission effect in the selected East Asian economies.

Using high frequency data, the volatility of seven foreign exchange markets has been modeled in the frameworks of GARCH and EGARCH for both crisis and tranquil periods. According to the regressions, the GARCH (1, 1) model performs rather well for most currencies in both crisis and non-crisis periods, with the coefficients of both lagged squared innovations and the lagged variance being always positive and significantly different from zero. As an alternative estimation, the EGARCH (1, 1) model is applied to interpret the potential size effect, sign effect and persistence effect on the volatility of exchange rates. However, little evidence of asymmetric impact of past error terms on the variance of the exchange rates process can be found for most exchange rate markets through the EGARCH estimation. Both GARCH and EGARCH estimations confirm the volatility shocks are quite persistent in the foreign exchange markets under the time period of study.

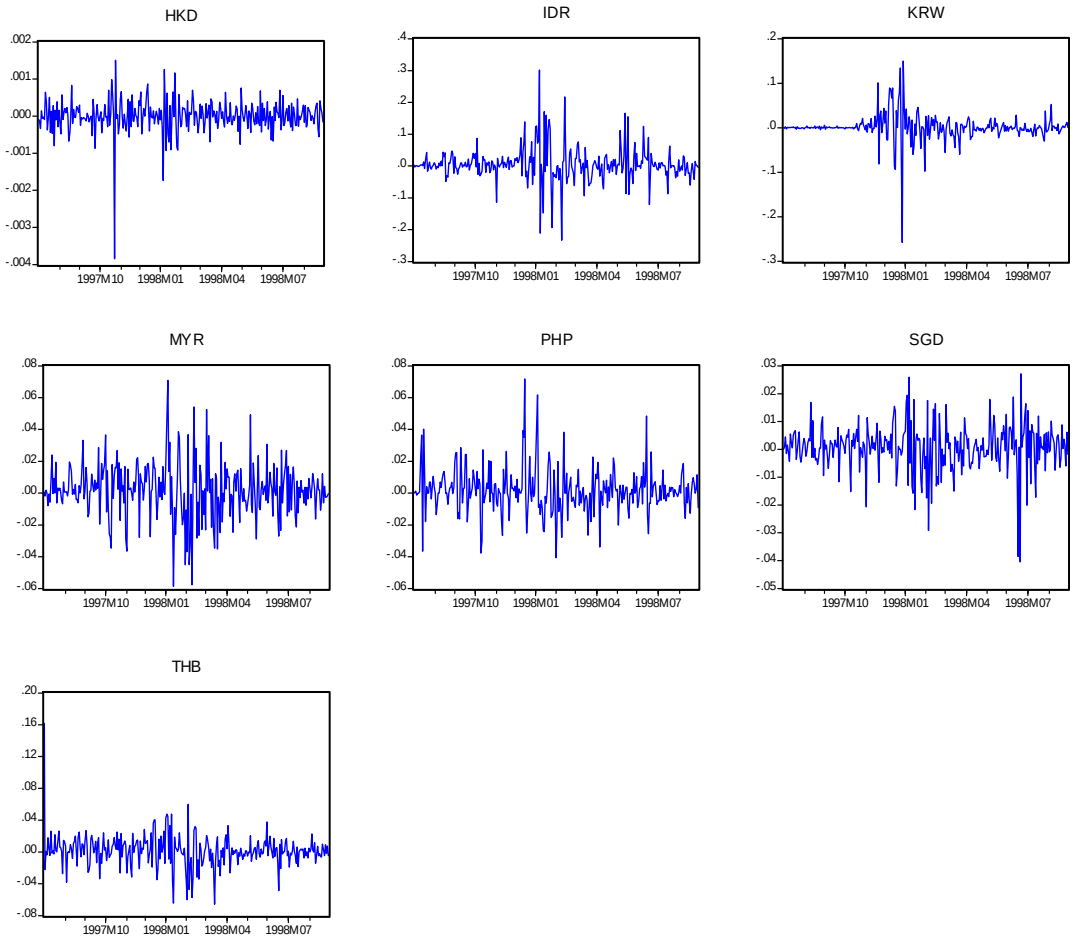
In order to identify the presence of volatility contagion/spillover effect, particular interests of this chapter are to look into the possible exchange rates volatility transmission from Korea to other regional markets in the crisis period; and from Hong Kong to other regional markets in the tranquil period. Thus, guided by previous volatility analysis for each of seven currencies, we construct the GARCH (1, 1)

extension model and find evidence of volatility transmission from Korea won to Hong Kong dollar, Malaysia ringgit, and Philippine peso over the crisis period. We also find the fact that movements of Hong Kong dollar have a significant impact on other regional currencies (Korean won, Malaysian ringgit, and Singapore dollar) during the tranquil period.

Overall, empirical results in general provide the evidence of the volatility transmission among the East Asian foreign exchange markets. The presences of volatility contagion effect during the financial collapse, as well as the volatility spillover effect over the tranquil period, can be found in this study. These results imply a certain degree of interdependence among East Asian exchange rate markets, which may signal tight trade and financial linkages and macroeconomic similarities in East Asian region. Exploring the interdependence and intra-regional transmissions of exchange rate volatility in East Asia region has important policy implication. This is because a thorough understanding of the dynamic properties of cross-market volatility transmission is crucial for evaluating the level of integration between markets. From a broader perspective, closer integration with Korea and Hong Kong would represent closer co-movements of economic fundamentals and may facilitate the transmission of shocks between Korea or Hong Kong and other economies in the region. Our study of volatility contagion/spillovers provides useful insights into how information is transmitted from Korea or Hong Kong foreign exchange market to other Asian exchange markets. The nature of co-movements between Korea or Hong Kong and other Asian foreign exchange rates sheds some light on how, and to what extent, the volatility of Asian currencies are affected by Korea won and Hong Kong dollar. Accordingly, given the empirical findings generated from this study, policy markers or financial managers from other Asian economies might design appropriate exchange rate polices in case an adverse shock is observed in Korea and Hong Kong foreign exchange markets where contagion/spillover effect is empirically evident.

Figures:

Figure 4.1 Daily Frequencies of Spot Exchange Rates Returns against U.S. Dollar in the Crisis Period (02/07/1997-31/08/1998)



Notes:

HKD=Hong Kong Dollar

IDR= Indonesia Rupiah

KRW= Korean Won

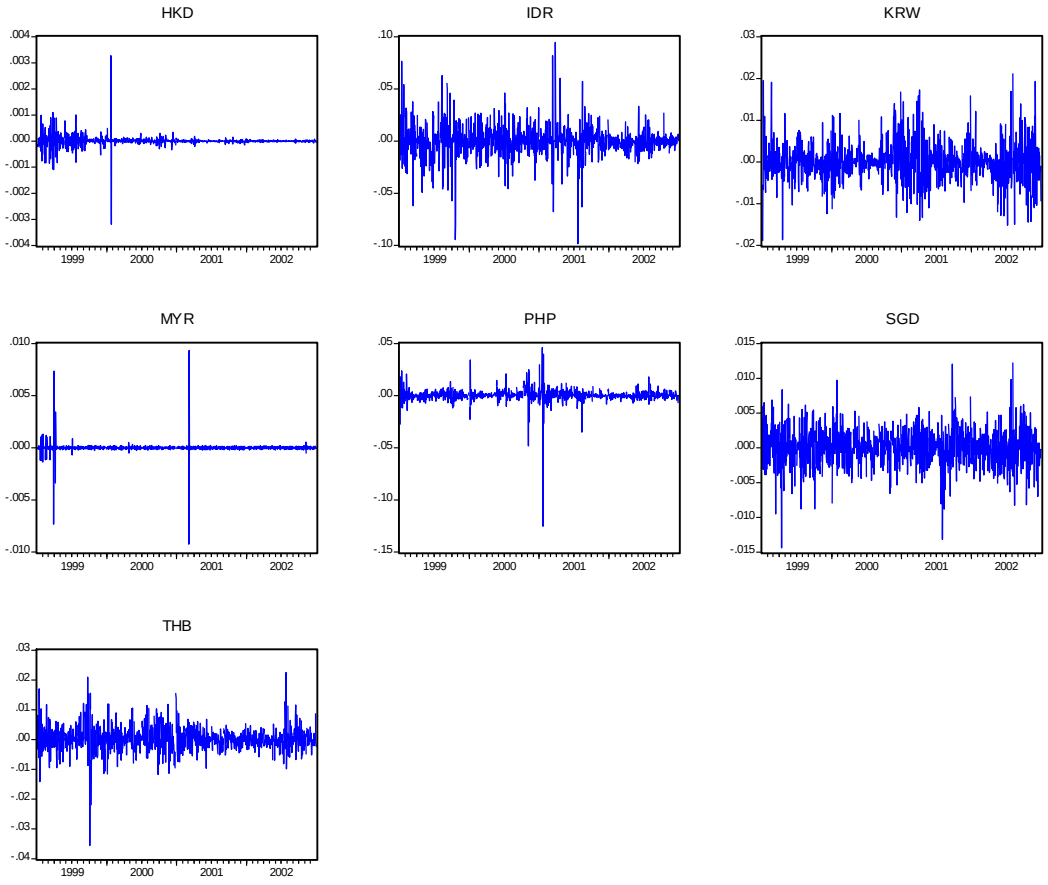
MYR= Malaysia Ringgit

PHP= Philippine peso

SGD= Singapore Dollar

THB= Thai Baht.

Figure 4.2 Daily Frequencies of Spot Exchange Rates Returns against U.S. Dollar in the Post-crisis Period (04/01/1999-31/12/2002)



Notes:

HKD=Hong Kong Dollar

IDR= Indonesia Rupiah

KRW= Korean Won

MYR= Malaysia Ringgit

PHP= Philippine peso

SGD= Singapore Dollar

THB= Thai Baht.

Tables:

Table 4.1 Descriptive Statistics of Exchange Rates (Daily Returns)

Panel A. Crisis period (02/07/1997-31/08/1998)

Currency	Mean	Std.Dev	Skewness	Kurtosis	Jarque-Bera	Observations
HKD	1.23E-06	0.000	-2.325	24.261	5782.629	293
IND	0.0052	0.052	0.576	10.666	733.726	293
KRW	0.0014	0.030	-1.479	26.551	6877.939	293
MYR	0.0017	0.017	-0.022	5.105	54.142	293
PHP	0.0017	0.014	0.826	6.904	219.446	293
SGD	0.0007	0.008	-0.845	7.036	233.657	293
THB	0.0018	0.020	1.365	17.321	2594.931	293

Note: all currencies are in terms of units of U.S. dollar.

Panel B. Post-crisis period (04/01/1999-31/12/2002)

Currency	Mean	Std.Dev	Skewness	Kurtosis	Jarque-Bera	Observations
HKD	6.54E-06	0.0002	0.2311	109.6271	474678.4	1002
IND	0.000134	0.0152	-0.2305	11.4668	3001.758	1002
KRW	0.0000	0.0048	0.3719	5.4438	272.447	1002
MYR	7.88E-08	0.0006	0.1681	187.6907	1424125.	1002
PHP	0.00032	0.0067	-6.4145	134.5386	729246.2	1002
SGD	4.47E-05	0.0027	-0.1638	5.3111	227.4793	1002
THB	0.000175	0.0042	-0.1786	11.0188	2689.91	1002

Note: all currencies are in terms of units of U.S. dollar.

Table 4.2 Correlation Analysis of the Currencies Volatility among East Asian Economies

Panel A. Crisis period

Currency	HKD	IDR	KRW	MYR	PHP	SGD	THB
HKD	1.00						
IDR	0.31	1.00					
KRW	0.00	0.35	1.00				
MYR	0.47	0.83	0.16	1.00			
PHP	0.41	0.47	0.51	0.49	1.00		
SGD	0.14	0.65	0.13	0.64	0.34	1.00	
THB	0.09	0.34	0.16	0.42	0.69	0.28	1.00

Panel B. Post-crisis period

Currency	HKD	IDR	KRW	MYR	PHP	SGD	THB
HKD	1.00						
IDR	0.15	1.00					
KRW	0.18	-0.10	1.00				
MYR	0.29	0.44	0.17	1.00			
PHP	0.13	0.05	0.30	-0.03	1.00		
SGD	0.35	0.21	0.32	0.16	0.02	1.00	
THB	0.25	0.42	0.14	0.06	0.31	0.25	1.00

Note: Volatility is calculated as the standard deviation of the variables in 4-week centred rolling windows.

Table 4.3 Unit Root Tests

Exchange Rates	Period	ADF statistics (Trend and Intercept)	
		Levels	First Differences
Hong Kong (HKD)	Crisis	-3.137**	-22.012***
	Non-crisis	-2.878**	-22.879***
Indonesia (IDR)	Crisis	-1.275	-16.467***
	Non-crisis	-1.938	-31.165***
Korea (KRW)	Crisis	-1.450	-14.249***
	Non-crisis	-1.321	-32.158***
Malaysia (MYR)	Crisis	-1.969	-15.720***
	Non-crisis	-10.306***	-18.290***
Philippines (PHP)	Crisis	-2.100	-14.360***
	Non-crisis	-1.054	-21.735***
Singapore (SGD)	Crisis	-1.638	-19.205***
	Non-crisis	-2.029	-31.892***
Thailand (THB)	Crisis	-1.481	-16.097***
	Non-crisis	-1.729	-31.498***

Notes: ***, **, and * denote rejection of the null of unit root for the ADF test at the 1%, 5%, 10% significance levels, respectively. The chosen lag length is automatically based on SIC.

Table 4.4 Results of Residual Tests

Panel (A) Crisis period

Currency	$Q^2(10)$	$p-value$	LM ARCH(1)	$p-value$
HKD	7.296	0.697	5.693	0.017
IND	99.850	0.000	19.236	0.000
KRW	89.805	0.000	40.720	0.000
MYR	71.258	0.000	14.455	0.000
PHP	33.740	0.000	18.565	0.000
SGD	74.908	0.000	12.192	0.000
THB	2.058	0.996	7.602	0.006

Panel (B) Post-crisis period

Currency	$Q^2(10)$	$p-value$	LM ARCH(1)	$p-value$
CNY	240.92	0.000	239.875	0.000
HKD	240.01	0.000	238.687	0.000
IND	50.911	0.000	16.194	0.000
JPY	32.137	0.000	8.526	0.004
KRW	156.16	0.000	26.322	0.000
MYR	252.98	0.000	247.525	0.000
PHP	31.184	0.001	12.222	0.000
SGD	48.595	0.000	11.293	0.004
THB	254.85	0.000	17.577	0.000

Notes: The Ljung-Box Q statistics for the squared residuals is based on the null hypothesis that no auto-correlation up to the order k, while the Lagrange multiplier (LM) principle is to test the null hypothesis of no ARCH effects versus the alternative that the conditional error variance is given by an ARCH (q) process.

Table 4.5 Estimates of Conditional Variance with GARCH (1, 1) and EGARCH (1, 1)

Panel A. Crisis period (02/07/1997-31/08/1998)

	GARCH (1,1)			EGARCH (1,1)			
Currencies	α_0	α_1	β_1	α_0	α_1	θ	ϕ
HKD	3.26E-08	0.3792	0.5195	-4.1094	0.3862	0.0759	0.7575
	(0.0002)	(0.0010)	(0.0000)	(0.0932)	(0.0503)	(0.4770)	(0.0000)
IDR	3.09E-05	0.1142	0.8852	-0.4760	0.2378	0.1564	0.9526
	(0.0002)	(0.0000)	(0.0000)	(0.0001)	(0.0038)	(0.0045)	(0.0000)
KRW	3.82E-07	0.2620	0.8209	-0.4119	0.4171	0.0862	0.9849
	(0.0036)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.1388)	(0.0000)
MYR	7.27E-06	0.0891	0.8862	-0.3866	0.2003	0.0486	0.9709
	(0.0222)	(0.0000)	(0.0000)	(0.0442)	(0.0107)	(0.2963)	(0.0000)
PHP	5.65E-05	0.3143	0.3943	-2.9596	0.7147	0.1116	0.7125
	(0.0001)	(0.0001)	(0.0007)	(0.0074)	(0.0018)	(0.4140)	(0.0000)
SGD	5.35E-06	0.1696	0.7550	-0.8250	0.2929	0.0863	0.9371
	(0.0150)	(0.0004)	(0.0000)	(0.0590)	(0.0025)	(0.1641)	(0.0000)
THB	7.68E-05	0.3818	0.3840	-1.6799	0.4583	0.0581	0.8388
	(0.0000)	(0.0000)	(0.0000)	(0.0049)	(0.0008)	(0.5056)	(0.0000)

Notes: The estimation method for both is Quasi-Maximum Likelihood. P-values are in parentheses.

(Continued) Table 4.5 Estimates of Conditional Variance with GARCH (1, 1) and EGARCH (1, 1)

Panel B. Non-crisis period (04/01/1999-31/12/2002)

	GARCH (1,1)			EGARCH (1,1)			
Currencies	α_0	α_1	β_1	α_0	α_1	θ	ϕ
HKD	5.93E-09 (0.2679)	0.2349 (0.0082)	0.6753 (0.0000)	-0.5145 (0.0000)	0.2747 (0.0000)	-0.1738 (0.0000)	0.9832 (0.0000)
IDR	3.34E-07 (0.5785)	0.0418 (0.0879)	0.9578 (0.0000)	-0.4882 (0.0002)	0.2776 (0.0000)	0.0117 (0.7284)	0.9647 (0.0000)
KRW	3.83E-07 (0.0226)	0.1559 (0.0000)	0.8442 (0.0000)	-0.7391 (0.0001)	0.3612 (0.0000)	0.0193 (0.5193)	0.9561 (0.0000)
MYR	6.83E-08 (0.4647)	0.1496 (0.3296)	0.5993 (0.0000)	-2.7788 (0.0000)	0.2368 (0.0003)	0.1024 (0.0958)	0.8500 (0.0000)
PHP	7.26E-07 (0.0000)	0.3988 (0.0003)	0.7077 (0.0000)	-1.1687 (0.0000)	0.4555 (0.0000)	0.0497 (0.2170)	0.9219 (0.0000)
SGD	6.02E-07 (0.0180)	0.0786 (0.0031)	0.8392 (0.0000)	-1.1156 (0.0418)	0.1699 (0.0020)	-0.0104 (0.7013)	0.9169 (0.0000)
THB	6.04E-07 (0.0019)	0.1309 (0.0001)	0.8353 (0.0000)	-0.6895 (0.0008)	0.2575 (0.0000)	0.0227 (0.3588)	0.9556 (0.0000)

Notes: The estimation method for both is Quasi-Maximum Likelihood. P-values are in parentheses.

Table 4.6 Estimates of the Regressors KRW in a GARCH (1, 1) Model of Daily Exchange Rates (Returns) in the crisis period

Variable	HKD	IDR	MYR	SGD	PHP	THB
C	1.81E-08	1.99E-05	6.24E-06	4.06E-06	7.31E-05	7.36E-05
	(0.0283)	(0.0000)	(0.0031)	(0.0266)	(0.0000)	(0.0000)
ε_{t-1}^2	0.3009	-0.0432	0.0457	0.1166	0.3276	0.2864
	(0.0037)	(0.0000)	(0.0170)	(0.0007)	(0.0028)	(0.0006)
σ_{t-1}^2	0.6449	1.0129	0.9151	0.8059	0.1208	0.3792
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.4319)	(0.0000)
KRWVOL	**0.0034**	0.0573	**0.0035**	0.0008	**0.0105**	0.0238
	(0.0131)	(0.0000)	**(0.0137)**	(0.2830)	**(0.0071)**	(0.1650)
Wald χ^2 / IGARCH	2.5119	38.1440	9.0928	4.0325	17.0850	14.2432
	(0.1130)	(0.0000)	(0.0026)	(0.0446)	(0.0000)	(0.0002)
LM Test	0.1868	5.1773	0.5765	0.0171	0.0556	0.2700
	(0.6655)	(0.0228)	(0.4477)	(0.8958)	(0.8135)	(0.6034)

Notes: The estimation method is Quasi-Maximum Likelihood, computing Bollerslev-Wooldridge robust standard errors. P-values are in parentheses. Coefficients in bold denote significance at the 5 percent level of positive coefficients of exogenous variable.

Table 4.7 Estimates of the Regressors HKD in a GARCH (1, 1) Model of Daily Exchange Rates (Returns) in the Post/non-crisis Period

Variable	IDR	KRW	MYR	SGD	PHP	THB
C	3.25E-07 (0.0901)	3.08E-07 (0.0006)	6.78E-08 (0.0000)	5.55E-07 (0.0053)	7.98E-07 (0.0000)	5.71E-07 (0.0000)
ε_{t-1}^2	0.0417 (0.0000)	0.1535 (0.0000)	0.1488 (0.0000)	0.0766 (0.0001)	0.3820 (0.0000)	0.1313 (0.0000)
σ_{t-1}^2	0.9577 (0.0000)	0.8409 (0.0000)	0.5978 (0.0000)	0.8313 (0.0000)	0.7129 (0.0000)	0.8328 (0.0000)
HKDVOL	2.0608 (0.6527)	**3.2248** **(0.0025)**	**0.0080** **(0.0197)**	**2.5235** **(0.0078)**	-0.9739 (0.1714)	1.3885 (0.3161)
Wald χ^2 / IGARCH	0.1524 (0.6963)	0.2996 (0.5841)	22.0038 (0.0000)	8.8131 (0.0030)	53.6180 (0.0000)	10.4603 (0.0012)
LM Test	0.0843 (0.7715)	3.9665 (0.0464)	0.19145 (0.6617)	1.1116 (0.2917)	0.0642 (0.7999)	0.1237 (0.7251)

Notes: The estimation method is Quasi-Maximum Likelihood, computing Bollerslev-Wooldridge robust standard errors. P-values are in parentheses. Coefficients in bold denote significance at the 5 percent level of positive coefficients of exogenous variable.

Chapter 5

Exchange Market Pressure and Monetary Policy in the Post-crisis East Asia

5.1 Introduction

It is generally believed that a managed floating exchange rate regime began to predominate for most industrialised economies after the collapse of the Bretton Woods system in the early 1970s. For the countries with a managed floating regime, the monetary authorities allow some exchange rate flexibility but often intervene in the foreign exchange market to influence the path of the exchange rate. Thus, more and more attention from both academic and political worlds has been recently received to the development of the exchange rate and the actions of the monetary authority, leading to a growing concern on the pressure of exchange rate market as well as the degree of foreign exchange intervention or management. Regarding the tensions of foreign exchange market, measuring the speculative pressure of currency is one of the centered issues. One of the possible approaches to this is building an exchange market pressure (EMP) index, whose extreme values on the depreciation side indicate the event of currency crisis. The performance of monetary policy in response to the pressure of emerging foreign exchange markets, on the other hand, has been extensively debated since the financial crisis of 1990s. One of the frequently argued questions is that whether monetary policy was tight or loose over and after the crisis. The traditional view suggests that tighter monetary policy, as implemented through lower domestic credit growth or higher interest rates, should in principle help strengthen a currency whether this is reflected in the exchange rate, in addition to foreign reserves, or both (see, for example, Backus and Driffill, 1985).

However, recent debates have doubted the validity of traditional theory regarding the experience of crisis-affected Asian countries during 1997-1998. It is questioned that

whether tight monetary policy (especially those adopting higher interest rates) could successfully defend exchange rates. While the IMF has argued that the steep rise in interest rates was vital in stabilising Asian exchange rates, the World Bank points out that interest rate hikes destabilised the currencies further by increasing the risk of bankruptcy, which led to a further loss of confidence in these economies (Stiglitz, 1999). Furthermore, a "revisionist" view proposed that raising interest rates could actually exacerbate the currency deprecation and a "Laffer curve" could exist, following which contractionary monetary policy induces a panic among investors and a loss of a currency's value (Corsetti *et al*., 1998; Furman and Stiglitz, 1998; Radelet and Sachs, 1998a, 1998b; Pakko, 2000). In terms of this view, high interest rates can cause actual or expected bankruptcies, or fears of default on debt, which weaken not only the economy but the banking system as well, resulting in a higher risk premium. The expected return on domestic assets declines as the risk premium rises, even though domestic interest rates rise (Gochoco-Bautista and Bautista, 2005). Some studies also put forward a fiscal-based theory in which high interest rates indicate a high burden on the public sector, implying that the currency would not strengthen without a corresponding adjustment of the primary surplus (see Flood and Jeanne, 2000; Lahiri and Vegh, 2000, 2001).

With respect to the dilemma regarding the appropriate monetary policy reaction to the pressures on the domestic currency, drawing out policy lessons from episodes such as the Asian crisis is clearly vital for safeguarding international financial stability in the future. Contributing to this key policy debate, this chapter not only provides an investigation on the measurement of foreign exchange market pressure and currency crisis proneness, but also examines interrelation between exchange market pressure (henceforth, EMP) and monetary policy for a representative group of East Asian countries (Indonesia, Korea, Philippines, Singapore and Thailand). Rather than focusing on exchange rate movements alone as most previous empirical studies did, we gauge the strength of the domestic currency through building and measuring EMP, which not only captures tensions on the foreign exchange market but also sheds light on the degree of exchange rate management by monetary authorities.

Specifically, the following issues will be covered in this study: First, this study measures tensions (pressure) on the exchange rate market and countries susceptibility to currency crisis for a group of East Asian economies. In doing this, we construct and evaluate the model-independent EMP indices for monthly data series covering the period from January 1995 to December 2005 which fully involve the currency collapse of 1997 and 1998. We also conduct the robustness (sensitivity) analysis to check whether the number of crises episodes and incidences are sensitive to the arbitrary choice of EMP construction. Second, we aim to explore the relationship between exchange market situation and monetary policy stance, especially for the post-crisis period that has not mainly taken into account in previous studies. Monthly data series from January 1999 to December 2005 have been employed for these five East Asian countries which experienced a temporary and significant monetary policy tightening during the Asian financial crisis and then moved towards more flexible exchange rate and inflation-targeting regimes in the post-crisis period. On one hand, we are interested in the way monetary policy affect EMP: Does contractionary (expansionary) monetary policy reduce (raise) EMP as the traditional theory suggests in the post-crisis East Asia? On the other hand, what is the reaction of monetary policy to EMP? To address these issues, this study employs vector autoregression (henceforth, VAR) technique and a similar approach as Tanner (2001) to present a framework that examines the relationships between monetary policy and EMP in both directions. Such a framework not only yields the response of EMP to the monetary policy shocks, but also generates a policy reaction function to EMP.

The remainder of the study is organised as follows: Section 5.2 provides a review of literature on the concept and measurement of EMP, and the empirical studies on the relationship between EMP and monetary policy. Section 5.3 constructs a model-independent EMP index and measures countries susceptibility to currency crises. Section 5.4 explores the interaction between EMP and monetary policy in the post-crisis East Asia. Section 5.5 offers concluding remarks.

5.2 A Review of Literature

5.2.1 Literature on the Measure of Exchange Market Pressure

The exchange rate policy can be reflected by movements of the exchange rate, foreign exchange reserves, and the interest rate. A central bank can control exchange rate fluctuations with two policy instruments: foreign exchange reserves and interest rate. It is generally believed that the managed floating exchange rate regime, which allows some exchange rate flexibility but often intervenes in the foreign exchange market to influence the behaviour of exchange rate, has been prevailing in the most industrialised economies after the collapse of the Bretton Woods system in the early 1970s. Recent studies have argued that under a managed floating regime monetary authorities should focus on the pressure on the exchange rate market, rather than changes in exchange rates and foreign exchange reserves alone (Tanner, 2001). Li *et al*. (2006) further point out that measures of currency depreciation only capture crises and "successful"[20] speculative attacks. Nevertheless, there are many cases of unsuccessful speculative attacks which are not addressed by the measures of currency depreciation. For instance, although there were intense and sustained speculative attacks on the currency through sharp interest rate hikes in the 1997/98 financial crisis, Hong Kong still was able to maintain its U.S. dollar-based currency board arrangement. A similar case can also be found in Argentina which defended its currencies in the year of 1995 by allowing a drain in reserves. Thus, in order to capture such "unsuccessful" currency attacks and incidences, there have been a growing number of studies focusing on the measures of EMP.

Model-dependent Measurement

The notion of EMP is firstly put forward by Girton and Roper (1977, G-R thereafter) from the insight that excess demand or supply on the foreign exchange market can

[20] Successful speculative attacks are those that lead the monetary authority to give up the pegged exchange rate with consequent depreciation of the currency.

result in a change in the price of foreign exchange as well as in a change in the level of foreign reserves. The G-R model is based on the monetary approach to the balance of payments posited by Johnson (1972). The EMP is measured as the sum of exchange rate depreciation and reserve outflows, scaled by base money. According to this idea, changes in exchange rates or balance of payments can be regarded as adjustments reflecting some monetary disequilibrium, and any disequilibrium of the foreign exchange market must be resolved either by an exchange rate adjustment, or an official intervention, or both of them simultaneously. According to Girton and Roper (1977), such construction of the EMP index is applicable to all exchange rate regimes and to different degrees of exchange rate management. If the authorities keep the exchange rate fixed, they must neutralise exchange market pressure by foreign exchange interventions. On the other hand, in case of a free float the possibility of exchange rate defense is by definition excluded and the whole speculative pressure is reflected by exchange rate changes. In all intermediate exchange rate systems, some mixture of adjustments in official reserves and the exchange rate resolves the disequilibrium. Thus the concept of EMP can be used to identify and examine the exchange rate regimes: in a fixed exchange rate regime, the change of exchange rate will be zero, while in a flexible exchange rate regime, the change of international reserves will be zero, and in a managed float, EMP is absorbed by either currency depreciation, or reserve losses, or a combination of them.

A number of studies have developed monetary models similar to the G-R (see, for example, Connolly and Dantas Da Silverira, 1979; Kim, 1985; Mah *et al*., 1998; Bahmani-Oskooee and Shiva, 1998; Pentecost *et al*., 2001). Based on a small open-economy monetary model, Weymark (1995, 1997, and 1998) introduces a more general framework to provide a measure of exchange market pressure and the degree of intervention. Spolander (1999), as a further extension, incorporates into the model a monetary policy reaction function and sterilised foreign exchange intervention. This group of studies on EMP measure, together with previous literature such as Girton and Roper (1977), Roper and Turnovsky (1980) are the well known attempts to analytically construct an operational model-dependent statistic of exchange market pressure.

Model-independent Measurement

On the other hand, many researchers have criticised the most undesirable aspect of the EMP measure that largely depends on a particular model. For example, Eichengreen *et al*. (1996, p. 278) argue that "model-dependence is not a desirable characteristic of an operational index because empirical models linking macroeconomic variables to the exchange rate have little explanatory power at short and intermediate horizons". Rather than concentrating on a specific model for the EMP variables, an EMP index that was originally introduced by Eichengreen *et al*. (1996) is a simple measure and fully model-independent. According to Eichengreen *et al*. (1996), this EMP index is a weighted sum of exchange rate changes, foreign reserve changes and interest rate changes. Rather than estimating any model, the weights are usually calculated from sample variances of those three components. This simplicity made the model-independent EMP measure widely used by several empirical studies in the context of currency crises literature (Eichengreen *et al*., 1996; Kaminsky *et al*., 1998; Kaminsky and Reinhart, 1999; Glick and Hutchison, 2001; Pentecost *et al*., 2001, Edison, 2003; and others). The currency attacks have often been identified as an unusually large EMP. Hence, EMP acted as a crisis indicator can generally measure tensions on the foreign exchange market and countries susceptibility to crisis.

However, some recent studies point out the limitations of the model-independent based approach to constructing EMP. In particular, the conventional method of defining currency crisis has been argued statistically to be flawed or inaccurate in capturing the "true" dispersion of any given EMP series. For example, Pontines and Siregar (2004) point out it may be inappropriate to use the standard deviation as the parametric measure of volatility. This is because any standard deviation measure is a form of averaging and is only as appropriate with the underlying conformity of the data to a conventional parametric assumption of normal distribution needed to employ such a method. In fact, speculative price series such as the exchanges rate and the interest rates have already been widely recognised as the non-normality distribution. The weighting of EMP components is becoming one of disputed issues. Bertoli *et al*. (2005) argue that

financial time series are characterised by volatility clustering and constant weights do not allow researchers to adequately smooth volatility when they are time-varying or undergo structural break. Some studies also point out such model-independent measures of EMP have little clear economic interpretation since they result from a combination of market generated volatilities and policy reaction functions (see Nitithanprapas and Willett, 2000; Willett *et al*., 2005). Basically, the observed combination of exchange rate changes, reserve changes and interest rate changes described the policy response function of the monetary authority. Thus all three components are considered policy variables and their volatilities partially reflect the preference of authority's policy strategies. Since monetary authority can heavily intervene in the foreign exchange market through buying or selling foreign reserves, we may expect a higher volatility or a greater variance of reserves, which, does not necessarily imply the large volatility of reserves itself but reflect the monetary authority's policy.

In summary, despite two alternative (model-dependent and model-independent) measurements of EMP index, various combinations of EMP indices depend on at least two of the three variables: exchange rates, international reserves and interest rates. Although both approaches of EMP construction have been assessed in the literature, it is not always possible to rank which measure is superior to others since different choices can be defended on different empirical and theoretical grounds.

5.2.2 Existing Literature on the Relationship between Monetary Policy and Exchange Rate/EMP

The recent financial crises with episodes of capital flight and currency depreciation have created policy difficulty for the countries affected by the crises. The standard prescription of policy contains fiscal restraint and the maintenance of high interest rates to prevent capital outflows. Nevertheless, the contractionary effects of these policy prescriptions have been argued to exacerbate problem associated with currency depreciation as well as capital outflows. Regarding the relationship between monetary policy and the exchange rate, the traditional view, on which the IMF position is based,

is that a tight monetary policy strengthens the exchange rate by sending a signal that the authorities are committed to maintaining a fixed rate, thereby increasing capital inflows (Backus and Driffill, 1985). Some recent studies such as Nadal-De-Simone and Razzak (1999) and Goldfajn and Gupta (1999) also find support for traditional theory. However, in the case of the Asian financial crisis, a number of economists have argued against the signaling value of tighter monetary policy by pointing to the effects of higher interest rates on the probability of bankruptcy of highly leveraged borrowers (see, for example, Radelet and Sachs, 1998a, 1998b; Feldstein, 1998; Stiglitz, 1999). These studies suggest a larger country risk premium, a lower expected return to investors and capital flight, generating downward pressure on the exchange rate. This situation is termed as a perverse effect of a tight monetary in the literature (see also Gertler *et al*., 2000; and Aghion *et al*., 2001). Thus, there is a "foreign exchange-interest rate Laffer curve" predicted by the "revisionist" view: higher interest rates are counterproductive for defending the exchange rate after some point. That is, an increase in domestic interest rates fails to reverse capital outflows and support a country's exchange rate. In particular, Pakko (2000) evaluates the conditions when a "Laffer curve" type of effect occurs. He finds the possibility of unorthodox effect of high domestic interest rates on capital flows can enter through the risk premium. If raising interest rates increases the probability associated with a default on outstanding debt, the result can be a worsening of the country's capital account position. Nevertheless, Krugman (1998) argues that for countries with a large external debt dominated in foreign currency, even very high interest rates might be preferable to a free fall in the exchange rate in these countries.

The existing empirical evidence on the relationship between exchange rate and monetary policy is mixed. For instance, Furman and Stiglitz (1998) examine nine emerging markets with episodes of temporarily high interest rates and find that both the magnitude and duration of such interest rate hikes are associated with exchange rate depreciation. Using a model for the behaviour exchange rates in the long run, Nadal-De-Simone and Razzak (1999) find that an increase in the nominal interest rate differential leads to appreciation of the domestic currency. Using monthly data from 80 countries covering the period of 1980-98, Goldfajn and Gupta (1999) also find that

higher interest rates are associated with real currency appreciation through changes in the nominal exchange rates. They further point out tight monetary policy facilitates the reversal of currency undervaluation through nominal appreciation. When the economy is experiencing a banking crisis, the results are not robust and depend on the specification. Using monthly observations, Kraay (2000) finds that a tight monetary policy does not increase the likelihood of a successful defense of currency depreication in a sample of 75 developed and developing countries.

The evidence of a perverse effect of tight monetary policy on the exchange rate has been found by Baig and Goldfajn (1998), using the VAR estimation and impulse response analysis of daily data for five East Asian countries. Using weekly data, Gould and Kamin (1999) apply Granger causality tests on interest rates and exchange rates for Indonesia, Korea, Malaysia, Philippines, Thailand and Mexico. They find that exchange rates are not significantly affected in any of the countries examined by changes in interest rates during the financial crises. A similar finding is reported by Ohno *et al*. (1999), who focus on daily observations of interest rates and exchange rates in Thailand, Korea, Indonesia, Philippines, Malaysia, Taiwan and Singapore. Based on monthly data for Indonesia, Korea and Thailand, Basurto and Gosh (2000) find little evidence that higher real interest rates result in a higher risk premium, whilst they appear to be associated with an appreciation of the currency.

Tanner (2001), in particular, develops a VAR framework to investigate the interrelations between exchange market pressure (EMP) and monetary policy for the cases of Brazil, Chile, Mexico, Indonesia, Korea and Thailand in 1990-98. He finds that a reduction in domestic credit growth helps reduce EMP either by increasing the value of a country's currency and/or its stock of foreign reserves. He also finds that the response of EMP to interest rate shocks is weaker than its response to changes in domestic credit growth. A very similar study of EMP with VAR can be found in Kamaly and Erbil (2000), who examine the cases in Turkey, Egypt, and Tunisia but get somewhat more mixed results than findings from Tanner (2001). Gochoco-Bautista and Bautista (2005) investigate the relationships between monetary policy and EMP in

Philippines for the period 1990-2000. They conclude that the responses of monetary policy to EMP are more contractionary in the crisis period; also, that the impact of interest rates on EMP is negative in the tranquil period, but positive in the crisis period. Garcia and Malet (2005) include the effect of economic growth on the exchange market pressure to investigate the interactions between EMP and monetary policy by focusing on the case of Argentina for the period 1993-2004. They find evidence of a positive and double-direction relationship between EMP and domestic credit, but output growth also plays a role in the determination of EMP, even more than domestic credit or the interest rate.

5.3 EMP and Currency Crisis: A Model-independent Approach

5.3.1 A Model-independent Measure of EMP

As mentioned earlier, as a good measure of crisis proneness, EMP can capture currency attacks that have been successfully resisted by the monetary authorities. In this section, we firstly focus on EMP as a general measure of tensions on the foreign exchange market and countries susceptibility to crisis. Following Kaminsky *et al*. (1998), we construct a model-independent EMP index as follows:

$$EMP_{i,t}^{KRL} = \frac{\Delta e_{i.t}}{e_{i,t}} - \frac{\sigma_e}{\sigma_r}\frac{\Delta r_{i,t}}{r_{i,t}} + \frac{\sigma_e}{\sigma_{\text{int}}}\Delta \text{int}_{i,t} \qquad (5.1)$$

where $EMP_{i,t}^{KRL}$ is the exchange market pressure index proposed by Kaminsky *et al*. (1998) for country *i* in period *t*; $e_{i,t}$ is the units of country *i*'s currency per U.S. dollar in period *t*; σ_e is the standard deviation of the rate of change in the exchange rate ($\frac{\Delta e_{i.t}}{e_{i,t}}$); $r_{i,t}$ is the gross foreign reserves of country *i* in period *t*; and σ_r is the

standard deviation of the rate of change in reserves ($\frac{\Delta r_{i,t}}{r_{i,t}}$); $\text{int}_{i,t}$ is the nominal interest rate for country *i* in period *t*, and σ_{int} is the standard deviation of the change in the nominal interest rate $\Delta \text{int}_{i,t}$. From Equation (5.1), one can observe the different weights given to these three key components of exchange market pressures. In particular, the weights for the reserve and interest rate fluctuations depend on the relative size of their standard deviations (σ_r and σ_{int}, respectively) against that of the exchange rate σ_e. By construction, an EMP index increases with a depreciation of the domestic currency, a loss of international reserve, and a rise in the domestic interest rate. The main advantage of this approach is the greater emphasis put on the interest rate, which has often been identified as an important factor of exchange rate determination in theory. Eichengreen *et al*. (1996) point out the interest rate hikes are the central banks' response to speculative attacks as well and should be included in the computation of the EMP index.

Data Description and Properties

Given that our aim is to measure tensions on the foreign exchange market and countries susceptibility to currency crisis, monthly data series over the period from January 1995 to December 2005 are used in this section in order to fully cover the currency collapse of 1997 and 1998. The exchange rate is expressed in local currency per U.S. dollar. The 3-month money market rates are used as the measure of domestic interest rates. Line 11 of the IFS database (foreign assets of the monetary authorities) is used as the measure of foreign exchange reserves.

Figure 5.1 depicts the movements of model-independent EMP indices based on Equation (5.1) for five East Asian countries from 1995 to 2005. Along with the exchange market pressure line, the lines representing 1.5 multiple of standard deviation above and below the mean value are portrayed. Different exchange rate arrangements

adopted by the sample countries during the analysed period are distinguished by shaded areas as indicated in Figure 5.1. The descriptive statistics of the model-independent EMP indices are displayed in Table 5.1. We find that EMP indices are skewed to the right in Korea, Philippines and Thailand, while are skewed to the left in Indonesia and Singapore. All of EMP series exhibit excess kurtosis which reflects fat-tailedness. In addition, the Jarque-Bera statistics are highly significant for all sample countries which further imply the non-normality distribution of the all EMP series.

We observed the following from Figure 5.1: As for the pre-crisis period, Singapore has experienced considerably volatile development of the exchange market pressure among the sample countries. This is evident for the higher values of standard deviation as well as the higher magnitudes of EMP indices in the Singapore than those in other countries. In the crisis years of 1997/1998, most East Asian countries experienced the severe currency pressure and witnessed a significant increase in EMP indices. In the post-crisis period, the values of EMP indices began to decrease for most countries but still maintained a higher level than those in the pre-crisis period for most countries, which revealed a stronger selling pressure on the domestic currency for these countries. In addition, a greater volatility of EMP indices identified for most sample countries in the post-crisis period reflected the frequent changes in the exchange rates, foreign reserves and interest rates in these countries.

5.3.2 EMP as A Measure of Currency Crisis Proneness

To our knowledge, Eichengreen *et al*. (1996) are the first to employ the EMP as a basis for the analysis of currency crisis. If the speculative attack (currency pressure) is successful, there is a sharp depreciation of the domestic currency. However, the monetary authorities may instead accommodate the pressure by running down their foreign reserves or deter the attack by raising the interest rates. By constructing a weighted average of exchange rate changes, reserve changes and interest rate changes, the exchange rate is said to be under stress (there is selling pressure) if there is a significant increase in the exchange market pressure index.

Especially, Eichengreen *et al*. (1996) define the crises as extreme values of EMP index in the following way:

$$\text{Crisis}_{i,t}=1 \text{ if } \text{EMP}_{i,t} > 1.5\sigma_{EMP} + \mu_{EMP} \quad (5.2)$$

$$=0 \text{ otherwise,}$$

where μ_{EMP} and σ_{EMP} are the sample mean and standard deviation of EMP respectively. This approach is widely used as a conventional method of selecting an arbitrary threshold in the crisis literature. It is important to highlight that a currency crisis in the context of exchange market pressure is not only defined as capturing instances of successful attacks (i.e., when a depreciation of the currency occurs), but also instances of unsuccessful attacks (pressure rebuffed by loss in reserves and/or rise in interest rates) (Kaminsky, *et al*., 1998; Goldstein *et al*., 2000).

Following the definition of crisis as Eichengreen *et al*. (1996) specify, we compute the number and proportion of currency crises to which countries have been subjected during the analysed period, as reported in Table 5.2. A crisis quarter is defined as one in which the EMP-measure exceeds the mean value by 1.5 standard deviation. The choice of three-month window is adopted in order to examine the sensitivity of the results and to avoid counting the same crisis more than once, due to the fact that crisis may often last for over a month and more crises occur in successive months. According to the incidences of crises (or number of crises episodes) reported in Table 5.2, Indonesia is the one most severely afflicted by the crises among the sample countries, with 5.3% crises incidences. Philippines and Thailand witness 3.8% incidences of crises for the period under study. There are 4 crises episodes identified in the case of Singapore. Korea is the least severely crisis-affected country among the sample countries, with merely 2 crises episodes according to the EMP measure. Once the crisis incidence episodes have been computed, the dates of the currency pressure (crisis) can be captured accordingly. As shown in the last column of Table 5.2, it is evident that dates of crises episodes for five sample countries mainly cover the years of 1997 and 1998, confirming

the evidence of severe currency depreciation around the currency collapse of 1997 and 1998 for five East Asian countries.

5.3.3 Sensitivity Analysis

In order to check whether the number of crises episodes and incidences are sensitive to the arbitrary choice of EMP construction, another form of EMP index developed by Eichengreen *et al*. (1996) is constructed as well. Different from Equation (5.2), reserves and interest rates of reference country (U.S.) have been taken into account in the construction of EMP:

$$EMP_{i,t}^{ERW} = \frac{1}{\sigma_e}\frac{\Delta e_{i,t}}{e_{i,t}} - \frac{1}{\sigma_r}\left(\frac{\Delta rm_{i,t}}{rm_{i,t}} - \frac{\Delta rm_{US,t}}{rm_{US,t}}\right) + \frac{1}{\sigma_i}\left(\Delta(i_{i,t} - i_{US,t})\right) \qquad (5.3)$$

where $EMP_{i,t}^{ERW}$ is the exchange market pressure index proposed by Eichengreen *et al*. (1996) for country *i* in period *t*; $e_{i,t}$ is the units of country *i*'s currency per U.S. dollars in period *t*; σ_e is the standard deviation of the relative change in the exchange rate $\frac{\Delta e_{i,t}}{e_{i,t}}$; $rm_{i,t}$ is the ratio of gross foreign reserves to money stock or monetary base for country *i* in period *t*; σ_r is the standard deviation of the difference between the relative changes in the ratio of foreign reserves and money base in country *i* and the reference country (U.S.) $\left(\frac{\Delta rm_{i,t}}{rm_{i,t}} - \frac{\Delta rm_{US,t}}{rm_{US,t}}\right)$; $i_{i,t}$ is the nominal interest rate for country *i* in period *t*; $i_{US,t}$ is the nominal interest rate for the reference country (U.S.) in period *t*; σ_i is the standard deviation of the nominal interest rate differential $\Delta(i_{i,t} - i_{US,t})$. The EMP index can take values on the real line, with high positive values associated to a pressure on the domestic currency, as a combination of a nominal depreciation, a widening of the interest rate spread or a loss of foreign reserves.

Table 5.3 shows the number and proportion of currency crises to which countries have been subjected, using the $EMP_{i,t}^{ERW}$ index. Similarly, a crisis quarter is defined as one in which the $EMP_{i,t}^{ERW}$ measure exceeds the mean value by 1.5 standard deviation. However, as indicated in Table 5.3, the $EMP_{i,t}^{ERW}$ index suggests different number and proportion of crises episodes for each country. For example, 5 crises episodes have been identified in Thailand using the $EMP_{i,t}^{KRL}$ index while 11 crises episodes have been identified in this country using the $EMP_{i,t}^{ERW}$ index. Obviously, a comparison of the two types of EMP indices indicates that the number and incidence of crises episodes are sensitive to the arbitrary choice of EMP construction. Our analysis thereby implies that EMP turns out to be notably sensitive to minor choices on the index construction.

5.4 EMP and Monetary Policy: An Empirical Analysis

In this section, we restrict our attention to the interactions between EMP and monetary policy in the post-crisis East Asia. Most existing studies heavily focus on the crisis event in East Asia and mainly examine the links of currency attack and monetary policy effectiveness prior to or during the crisis. To fill in the gap of little study on the post-crisis or recent East Asia, monthly data series covering the period January 1999-December 2005 (yielding 84 monthly observations for sample countries) are employed in this section to revisit the interactions between EMP and monetary policy recently. The data are extracted from the IMF International Financial Statistics (See Appendix 5.1 for a full description of the data series). Since the East Asian financial debacle of 1997-98, a handful of countries in the region—Indonesia, Korea, Philippines and Thailand—explicitly or implicitly changed their exchange rate policies from more "rigid" to more flexible arrangements after the Asian financial crisis (Calvo and Reinhart, 2002). Note that the Asian financial crisis prompted these countries to alter their monetary policy regimes in addition to exchange rate policy regimes. Korea, Indonesia, Philippines, and Thailand have instituted monetary policy arrangements

fashioned around an inflation objective, that is, inflation-targeting regimes[21]. It is, then, necessary for policymakers and researchers to examine whether and by how much, monetary policy responds to the exchange market pressure under more flexible exchange rate and inflation-targeting regimes adopted by these countries after the crisis.

In answering this question, the issue that needs to be addressed firstly is how to measure the stance of monetary policy. Regarding this, the earlier literature emphasised monetary aggregates as the monetary policy indicator. For instance, in the traditional monetary approach to the balance of payments, the domestic credit component of the monetary base was considered to be the variable controlled by policy makers. On the other hand, recent studies began to emphasise the role of interest rates (see, for example, Bernanke and Blinder, 1992). Nevertheless, the nominal interest rate, which is usually viewed as the *de facto* instrument of monetary policy tightening, is argued to be inadequate as the only factor that measure the stance of monetary policy (Gould and Kamin, 1999). This is because not all changes in interest rates are the result of deliberate policy actions. Expectations of future depreciation or default on debt may not only cause a domestic currency to depreciate but also cause interest rates to rise. Furthermore, Gochoco-Bautista and Bautista (2005) point out in the case of sterilised intervention and exchange rate targeting, foreign reserve losses will be offset by increase in domestic credit. Monetary policy is loose even though interest rates have not fallen. Considering these, as a compromise, the monetary policy variables we choose in this study are both changes in domestic credit as a proportion of the monetary base, and the differential between domestic and U.S. interest rates. Thus, the effectiveness of both domestic credit growth and interest rate differential as monetary policy variables are examined in this study. We present a theoretical framework that captures the above factors in the next section.

[21] Korea was the first Asian country to implement the new regime in 1998, followed by Indonesia in 1999, Thailand in 2000, and the Philippines in 2002. Singapore operates a quasi inflation target in that its monetary policy rule is the trade-weighted exchange rate rather than the interest rate.

5.4.1 The Components of a Model-based EMP

As a common model-dependent measure of exchange market pressure, the version of Girton and Roper (1977) model has been utilised and modified by a growing literature to investigate the relationship between monetary policy and EMP. Among them, a simple monetary model by Tanner (2001) is outlined as follows:

Consider the usual stylised depiction of the asset side of the central bank balance sheet, on the demand side, the growth of real base money (m_t) is:

$$m_t = \Delta M_t / M_{t-1} - \pi_t \tag{5.4}$$

where M_t is nominal (base) money at time *t* and π_t is the inflation rate ($\Delta P_t / P_{t-1}$, P_t is the price level).

The inflation rate is linked to world inflation π_t^* through the rate of growth of the nominal exchange rate e_t (units of the country's currency per U.S. dollar):

$$e_t = \pi_t - \pi_t^* + z_t \tag{5.5}$$

where z_t is the deviation from purchasing power parity.

On the supply side, the two components of nominal base money are international reserves R_t and net domestic assets D_t . Thus, the stock of money is given as follows:

$$\Delta M_t / M_{t-1} = (\Delta R_t + \Delta D_t) / M_{t-1} = r_t + \delta_t \tag{5.6}$$

where $r_t = \Delta R_t / M_{t-1}$ and $\delta_t = \Delta D_t / M_{t-1}$.

Assuming that purchasing power parity holds and world inflation equals zero ($z_t = \pi_t^* = 0$), we substitute Equations (5.5) and (5.6) into (5.4) and rearrange them to get an expression for *EMP*:

$$EMP_t \equiv e_t - r_t = \delta_t - m_t \tag{5.7}$$

Equation (5.7) implies that EMP is measured as the sum of exchange rate depreciation and reserve loss/outflows (scaled by base money). It should equal the difference between the growth rates of the domestic component of the monetary base (δ_t) and money demand (m_t). If the real money demand is assumed constant, that is, $m_t = 0$, we will get the following: the changes of EMP equal the changes of δ_t. This indicates that EMP and δ_t should move together with each other in this case.

5.4.2 The Theoretical Implications of EMP and Monetary Policy

As reviewed in the survey, traditional theory suggests that tight monetary policy, as implemented through lower domestic credit growth or higher interest rates, should in principle help strengthen a currency. Thus, monetary contraction should theoretically reduce the exchange market pressure. Nevertheless, some researchers also point out indirect effects and possible interactions between variables, which were hidden in the simple monetary framework (for example, Kamaly and Erbil, 2000; Garcia and Malet, 2005). When the monetary transmission mechanism is taken into account, the relationship between domestic credit and EMP becomes ambiguous. On one hand, the monetary model indicates that a restrictive credit policy will decrease market pressure against the domestic currency. On the other hand, if a decline in domestic credit growth brings about a slowdown of output growth, this may in turn provoke an increase in EMP.

This is because lower output growth may feed devaluation expectations and thereby bring about pressures on the domestic currency.

Interest rate, acted as a policy tool by central banks to control the growth of domestic credit δ_t. EMP shocks and the interest rate differential, as Tanner (2001) suggests, should be positively correlated. This is because higher exchange depreciation and/or lower reserves signals more risk for investors. As suggested by Garcia and Malet (2005), an increase in the interest rate in the country would lead to a rise in the EMP, both directly as indicated in the monetary model (related in the model to lower demand for money) and indirectly via a decrease in output, as described in the monetary transmission mechanism.

However, the relationship between EMP and interest rate deserves more discussion. Such relation has been frequently argued as negative, precisely opposite to that implied in the monetary model (Kamaly and Erbil, 2000). In this case, an interest rate defense exacerbates financial fragilities or the quasi-fiscal deficit (Flood and Jeanne, 2000; Lahiri and Vegh, 2001; and others). A standard IMF prescription to affected East Asian countries in the financial crisis was to use contractionary monetary policy to counter depreciation pressures and also suggested a belief in a negative relationship between interest rate and EMP (Boorman, *et al*., 2000). Such consideration is based on the rationale that, under capital mobility, the contractionary monetary policy will raise the differential between domestic and world (U.S.) interest rates (ϕ). A higher (lower) interest rate differential attracts (expels) foreign investment and capital inflows, which, in turn, shrinks (widens) the gap between domestic currency demand and supply, implying a decrease (increase) of EMP. Nevertheless, as suggested by many studies, ϕ may be a noisy indicator of monetary policy since it contains market elements as well, including expected exchange depreciation and a risk premium. Sometimes higher interest rates are not due to the tight monetary policy but due to the overall economic situation and the risk prevalent in the market.

Moreover, the relationship regarding EMP and monetary policy is also reflected in the currency crises models. The first generation models stress the effect of domestic credit on EMP and consider that an expansionary monetary policy with a fixed exchange rate (via an increase in domestic credit not matched by an increase in money demand) will end up with the loss of international reserves (see, for example, Krugman, 1979; Flood and Garber, 1984). Therefore, if an empirical result suggests that domestic credit indeed increase EMP - maybe due to scarce monetary transmission to economic activity - the idea in Krugman (1979) can be supported accordingly. The second generation models predict a direct relationship between domestic interest rates and EMP. These models state the devaluation expectations, interest rate differentials, and any fundamentals-related problem that makes the maintenance of the nominal peg costly (see, for example, Obstfeld, 1986). Regarding the policy reaction, on the other hand, it is generally believed that authorities usually tighten monetary policy in response to increases in EMP. Nevertheless, several recent papers point out when there are large capital outflows, monetary authorities are likely to expand domestic credit to sterilise EMP increases (Flood *et al*., 1996; Calvo and Mendoza, 1996).

In summary, the relationships between EMP and variables of monetary policy relay on the specific monetary framework. For the purpose of this study, our theoretical framework focuses on the interactions among EMP, domestic credit growth, and the differential between domestic and foreign interest rates. Although a scale variable for money demand should also be included in a monetary framework. Most frequently, this variable is gross domestic product (GDP). However, our study uses monthly data, for which GDP is not available.

5.4.3 Empirical Framework: A Vector Autoregression (VAR) Approach

As observable in many theoretical links between the variables under study, an analysis of the determinants of EMP using traditional Ordinary Least Square (OLS) technique would suffer from endogeneity problems. To overcome this problem, we follow previous studies and utilise a VAR technique. In particular, a similar strategy as Tanner

(2001) is used for the estimation presented in this study. We construct the VAR framework which includes the following variables: EMP, domestic credit growth, and the differential between domestic and foreign interest rates. This framework can be described as follows (Tanner, 2001):

$$X_t = a_0 + a_1 X_{t-1} + a_2 X_{t-2} + \ldots + v_t \tag{5.8}$$

where $X_t = (\delta, \text{EMP}, \phi)$ is a vector of variables, the a_is is a vector of coefficients, and $v_t = (v_\delta, v_{EMP}, v_\phi)$ is a vector of error terms. δ is the scaled domestic credit growth, EMP is exchange market pressure, and ϕ is the differential between domestic interest rate and U.S. interest rate. This system can help test for effects of past values of X on current values. According to Tanner (2001), the error vector includes the "own" error terms $w_t = (w_\delta, w_{EMP,} w_\phi)$ and the contemporaneous correlations with other errors. Thus, we get the following equation:

$$v_t = Bw_t \tag{5.9}$$

where *B* is a 3x3 matrix whose diagonal elements indicating the "own" correlations equal one, and whose non-zero off-diagonal elements reflect contemporaneous correlations among the error terms. Specifically:

$$v_\delta = w_\delta + b_{\delta EMP} w_{EMP} + b_{\delta\phi} w_\phi \tag{5.10}$$

$$v_{EMP} = b_{EMP\delta} w_\delta + w_{EMP} + b_{EMP\phi} w_\phi \tag{5.11}$$

$$v_\phi = b_{\phi\delta} w_\delta + b_{\phi EMP} w_{EMP} + w_\phi \tag{5.12}$$

Therefore, contemporaneous relationships among variables in X are reflected in both the expected signs of and *priori* (exogeneity) restrictions on the b coefficients. As suggested by Tanner (2001), the ordering of the variables in a VAR is justified by

imposing certain restrictions or assumptions on the matrix *B*. This permits a simple Cholesky decomposition to be used. Similar to Kamaly and Erbil (2000), Tanner (2001), and Gochoco-Bautista and Bautista (2005), we consider that domestic credit growth δ is more "exogenous" than EMP or the interest rate differential ϕ. Hence, as the exogenous policy variable, innovations to domestic credit growth δ only reflect the preferences of the policymakers.

To implement the impulse response function, the Cholesky decomposition approach as Tanner (2001) is employed, assuming the following relationships between the individual components of v_t:

$$v_{\delta_t} = w_{\delta_t} \tag{5.13}$$

This equation indicates the shocks to domestic credit growth v_{δ_t} are from its own error terms w_{δ_t}.

Second, shocks to exchange market pressure v_{EMP_t} has two parts: one is its "own" shock w_{EMP_t} which can be thought of as a shock to demand for a country's currency, the other one is the portion of shocks to EMP that is contemporaneous correlated with the domestic credit (i.e. $b_{EMP\delta} w_{\delta_t}$):

$$v_{EMP_t} = w_{EMP_t} + b_{EMP\delta} w_{\delta_t} \tag{5.14}$$

Third, shocks to change in the interest rate differential v_{ϕ_t} has three parts: one is its "own" shocks w_{ϕ_t} which potentially contains policy and market determined elements, the other two elements are the portions of shocks to the interest rate differentials that are contemporaneous correlated with domestic credit (i.e. $b_{\phi\delta} w_{\delta_t}$) and EMP (i.e.

$b_{\phi EMP} w_{EMP_t}$), respectively:

$$v_{\phi_t} = w_{\phi_t} + b_{\phi\delta} w_{\delta_t} + b_{\phi EMP} w_{EMP_t} \quad (5.15)$$

The interest rate differential should respond to changes in EMP: if EMP shocks and the interest rate differential are positively correlated, this implies that higher exchange deprecation and/or lower reserves signals more risk for investors. Such effects are captured in the term $b_{\phi EMP} w_{EMP_t}$. The innovations to domestic credit w_{δ_t} affect the interest rate differential through either standard liquidity or Fisher channels. Therefore, such an ambiguity about sign of $b_{\phi\delta}$ reflects whether liquidity effects dominate Fisher effects. Thus, the above restrictions imply a Cholesky ordering of δ, EMP, ϕ. As Tanner (2001) suggests, this ordering permits a role for both monetary aggregate δ and an interest rate variable ϕ as the central bank's instrument. This is because the central banks' preference regarding δ and ϕ in the current period are assumed to be contained in the shock terms w_{δ_t} and w_{ϕ_t}. In addition to the contemporaneous relationships shown in Equations (5.13) through (5.15), The effect of past innovations (i.e., lagged elements of w_t) to current values of X can be described by the impulse response functions (henceforth, IRFs).

5.4.4 Interpretation of Estimation Results

Table 5.4 shows the results of Augmented Dickey-Fuller tests of the time series properties of the main variables, namely, EMP, δ, and ϕ. It is evident that these variables are stationary in levels for most countries. For Korea and Thailand, since ϕ_t is nonstationary in levels but stationary in first differences, we used the first differenced series of interest rate differential ($\Delta\phi$) for these two countries accordingly. Table 5.5 presents the bivariate Granger-causality tests using 4 lags. The IRFs generated by the

Cholesky decomposition are presented in Figure 5.2, with the ordering: δ, EMP, ϕ[22]. The empirical findings are summarised as follows:

Effects of domestic credit growth on EMP

Regarding the domestic credit growth δ as policy variable, if monetary policy works in the expected direction, the coefficient $b_{Emp\delta}$ (i.e., shocks to EMP that is contemporaneously correlated with domestic credit growth) should be positive and significant, indicating a restrictive credit policy decreases market pressure against the domestic currency. However, we may also expect the negative impact of δ on EMP since a decline in domestic credit growth might bring about a slowdown of growth, which might in turn provoke an increase in EMP. Allowing for the 10 percent level of significance, the F-statistics (Granger causality) find lagged δ does not help explain EMP in most countries with the exception of Thailand, indicating little evidence that lagged δ precedes EMP for the other four countries over the sample period. The results of IRFs show that the direction of the response is diversified. For Philippines, the IRFs show that an innovation in δ has a significant and positive impact on EMP in one period, as expected in the traditional theory. For Singapore, according to IRF, there are significant positive and negative impacts of an innovation in δ on EMP. In contrast, the negative and significant effects of δ on EMP are found in Indonesia, Korea, and Thailand for one period. Hence, our findings suggest the ambiguous relationship between δ and EMP for the sample countries.

Effects of interest rate differential on EMP

Regarding the interest rate differential ϕ, lagged effects are captured by corresponding IRFs and F-statistics (Granger causality) of ϕ on EMP in system. Results from the

[22] To see whether the results are sensitive with respect to other orderings, an alternative ordering of the variables in the VAR is also considered, placing δ after EMP rather than before. However, results were largely insensitive to alternative ordering.

Granger causality test show that lagged ϕ precedes EMP only in Philippines and Singapore at the 10 percent significance level. As for the other three countries, we find no causality from lagged ϕ to EMP. The negative effects of ϕ on EMP can be found only in Singapore with an initial negative response, suggesting that positive innovations in the domestic interest rate help reduce EMP. As for Thailand, the effect of a shock to ϕ on EMP is initially positive but turns to negative in two periods. This may be because a higher interest rate differential signals greater currency depreciation and risk or both. Also note that for Indonesia, Korea and Philippines, the effect of a shock to ϕ on EMP is found to be even weaker and insignificant within two periods. These mixed results suggest that, working through the whole system, a rise in interest rate differential does not always reduce the EMP as the traditional theory predicts. Nevertheless, somewhat weak response of EMP to interest rate shocks should not cast doubt on the effectiveness of monetary policy for affecting EMP. The inconclusive results highlight the fact that interest rates have market-determined and policy-determined elements, as many previous studies suggest (for example, Tanner, 2001; Gochoco-Bautista and Bautista, 2005).

Effects of EMP on the domestic credit growth

As with the policy reaction, we also investigate the response of the monetary authorities to the impact of EMP. Regarding the domestic credit growth δ, the reaction function is summarised by IRFs and F-statistics (Granger causality) of lagged EMP on δ. Does the pressure on the currency lead the monetary authorities to increase domestic credit – that is, to sterilise the loss of reserves in order to preserve enough liquidity in the economic system? The Granger-causality tests show that lagged EMP can cause δ in Indonesia, Korea and Philippines at the 10 percent significance level over the sample period. The IRFs show a lagged positive effect of EMP on δ for most countries (expect Singapore), implying that the authorities of these countries in general respond to increased EMP by providing additional liquidity to the banking system rather than

contracting the money supply. Thus, lagged sterilisation has taken place for these countries. For Singapore, there is a negative impact of EMP δ on at least for three periods, which may be related to the alternation of attempts to sterilise with a restrictive (hence, defensive) stance. However, the evidence stemming from the Granger-causality tests is weak.

Effects of EMP on interest rate differential

We may investigate whether the exchange market pressure has a positive or negative impact on the interest rates. If it is predicted as second generation models of currency crises, we may expect a positive effect of EMP on interest rates. If governments respond exchange market pressure by reducing interest rates to compensate for scarce external liquidity, we may expect a negative effect of EMP on interest rates. Regarding the interest rate differential ϕ, the reaction function is summarised by lagged IRFs and F-statistics (Granger causality) of EMP on ϕ. The Granger causality test results show that lagged EMP does not Granger cause ϕ in most countries with the exception of Indonesia over the whole period. According to the IRFs, shocks to EMP in general affect ϕ positively for all sample countries. This is not surprising, since an increase in EMP is generally associated with an increase in either expected exchange depreciation, risk or both. This positive impact tends to reflect the fact that interest rates have both market-determined and policy-determined effects. When EMP goes up, the authorities attempt to raise the interest rate differential in order to reduce EMP or stem the depreciation of the domestic currency, or that the interest rate differential widens when EMP increases because of fears of currency depreciation and a higher risk premium. Note that the effect of a shock to EMP on ϕ is found to be slightly negative in Singapore after two periods, this may imply that the government of Singapore wants to compensate for scarce external liquidity and lowering interest rates in face to an increase in EMP.

Effects of domestic credit growth on interest rate differential

The effect of money supply on the nominal interest rates is typically discussed from two perspectives: the liquidity effect and the Fisher effect. In theory, the term liquidity effect refers to a fall in nominal interest rates following an exogenous persistent increase in money supply. According to the classical Fisher effect, however, an exogenous persistent increase in money is predicted to increase expected inflation and so increase nominal interest rates. As Friedman (1968) argues, both forces operate in practice: a persistent increase in the money supply both reduces nominal interest rates and increases expected inflation so that the real interest rate (nominal minus expected inflation) also falls. Thus, regarding the effects of expansions in domestic credit on the interest rate differential, theory presents an ambiguous nature of the link: the liquidity effect implies that domestic credit shocks affect interest rate differential negatively while the Fisher effect implies that the positive impact of domestic credit shocks on interest rate differential. In this study, the positive responses of the interest rate differential to domestic credit growth can be generally found in Indonesia, Korea and Philippines, while the negative responses can be witnessed in Singapore within three periods. Note also that for Thailand, the effect of a shock to δ on ϕ is found to be even weaker and insignificant. Hence, the liquidity effect appears to prevail in Singapore while the Fisher effect appears to dominate in Indonesia, Korea and Philippines. Nevertheless, the Granger causality tests show little evidence of lagged δ proceeds ϕ for most sample countries (expect Indonesia), suggesting the weak role of δ in explaining ϕ for most countries.

Effects of interest rate differential on domestic credit growth

The Granger test shows that changes in interest rate differential ϕ do not precede domestic credit growth δ in the system. But the IRFs present mixed results in relation to the sign of such relationship: the negative impact of an innovation to ϕ on δ can

be found in Thailand in three periods while shocks to ϕ affect δ positively in the case of Singapore. For other three cases (Indonesia, Korea, and Philippines), the responses of δ to ϕ according to IRFs are found to be insignificant. These diversified results have portray different reactions of δ to ϕ: in face of changing interest rates, monetary authorities can either compensate for the lack (excess) of liquidity induced by a rise (decline) in interest rates, or reinforce the monetary contraction (expansion).

5.5 Concluding Remarks

This chapter provides an investigation on the measurement of foreign exchange market pressure and currency crisis proneness, as well as examines interrelations between exchange market pressure and monetary policy for a representative group of East Asian countries (Indonesia, Korea, Philippines, Singapore and Thailand) over the period 1999-2005.

Our findings confirm the presence of the severe currency pressure from a significant increase in the EMP indices during the 1997/98 financial crisis period. A stronger selling pressure on the domestic currency for sample countries has been identified. Our findings also imply the frequent changes in the exchange rates, foreign reserves and interest rates for sample countries after the crisis. With the model-independent measure of EMP index, we capture the crises episodes as well as the dates of the speculative attack on currency, and find evidence of severe currency depreciation around the currency collapse of 1997/1998 for five East Asian countries. Nevertheless, the sensitivity analysis on the basis of another EMP index indicates that the number and incidence of crises episodes are sensitive to the arbitrary choice of EMP construction. The methodological choices do matter and would affect the analysis of currency crises determinants. Given this, it is important for crisis researchers to investigate the sensitivity of their empirical results to alternative sets of EMP construction.

This study also attempts to investigate the monetary authorities' response to pressures on currency for these five countries which adopt more flexible exchange rate and inflation-targeting regimes after the 1997/98 financial crisis. Using both changes in domestic credit and interest rate differential to measure the stance of monetary policy, this study applies the VAR techniques to investigate the interaction among three variables: EMP, domestic credit growth and interest rate differential. Our results can be summarised in the following manner. First, as for the effect of monetary policy on EMP, shocks to domestic credit have either positive or negative effect on EMP, depending on the country under study. The positive response supports the view that contractionary monetary policy helps defend the exchange rate, while the negative response possibly implies the occurrence of monetary transmission. The reaction of EMP to interest rate differential shocks is also inconclusive for studied countries. The initial negative response can be found only in Singapore with an initial negative response, suggesting that a higher interest rate help reduce EMP. The initial positive response can be found in Thailand, providing the evidence that higher interest rate differential can signal greater currency depreciation and risk or both in this case.

Second, as for the policy reaction, we find positive impacts of EMP on δ for most countries with the exception of Singapore, indicating that monetary authorities of most countries sterilised the changes in foreign reserves, probably in order to preserve the liquidity of the economic system. We also find shocks to EMP in general affect ϕ positively for five sample countries. This is not surprising, since an increase in EMP is generally associated with an increase in either expected exchange depreciation, risk or both. This positive impact tends to reflect the fact that interest rates have both market-determined and policy-determined effects. Moreover, our study confirms the ambiguous nature of the link between the domestic credit growth and interest rate differential. The liquidity effect appears to prevail in Singapore while the Fisher effect appears to dominate in Indonesia, Korea and Philippines.

Overall, there is considerable cross-country variety in the IRFs patterns. The empirical findings of this study provide further evidence on the post-crisis EMP responses and policy reactions for five East Asia countries. The mixed findings generated from this study, however, are broadly consistent with existing literature with inconclusive results regarding the mutual reactions between EMP and domestic credit growth, and between EMP and interest rate differential. In general, our study suggests that measuring exchange market pressure should jointly consider the exchange rate movements and foreign reserves rather than only focusing on either of them. This is in particular appropriate for economies which are neither perfectly fixed nor freely floating.

Figures:

Figure 5.1 Model-independent Measure of EMP per Country

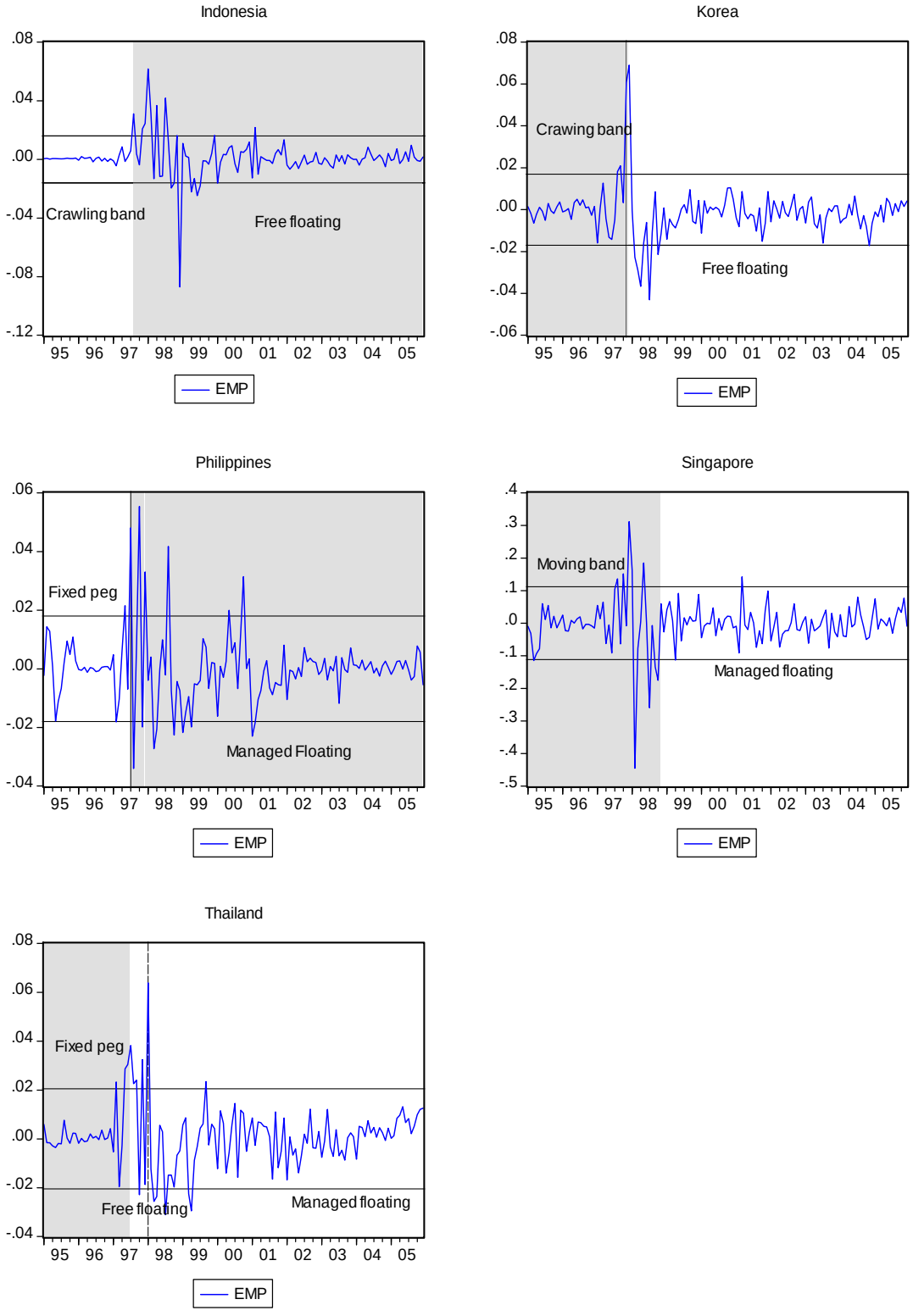
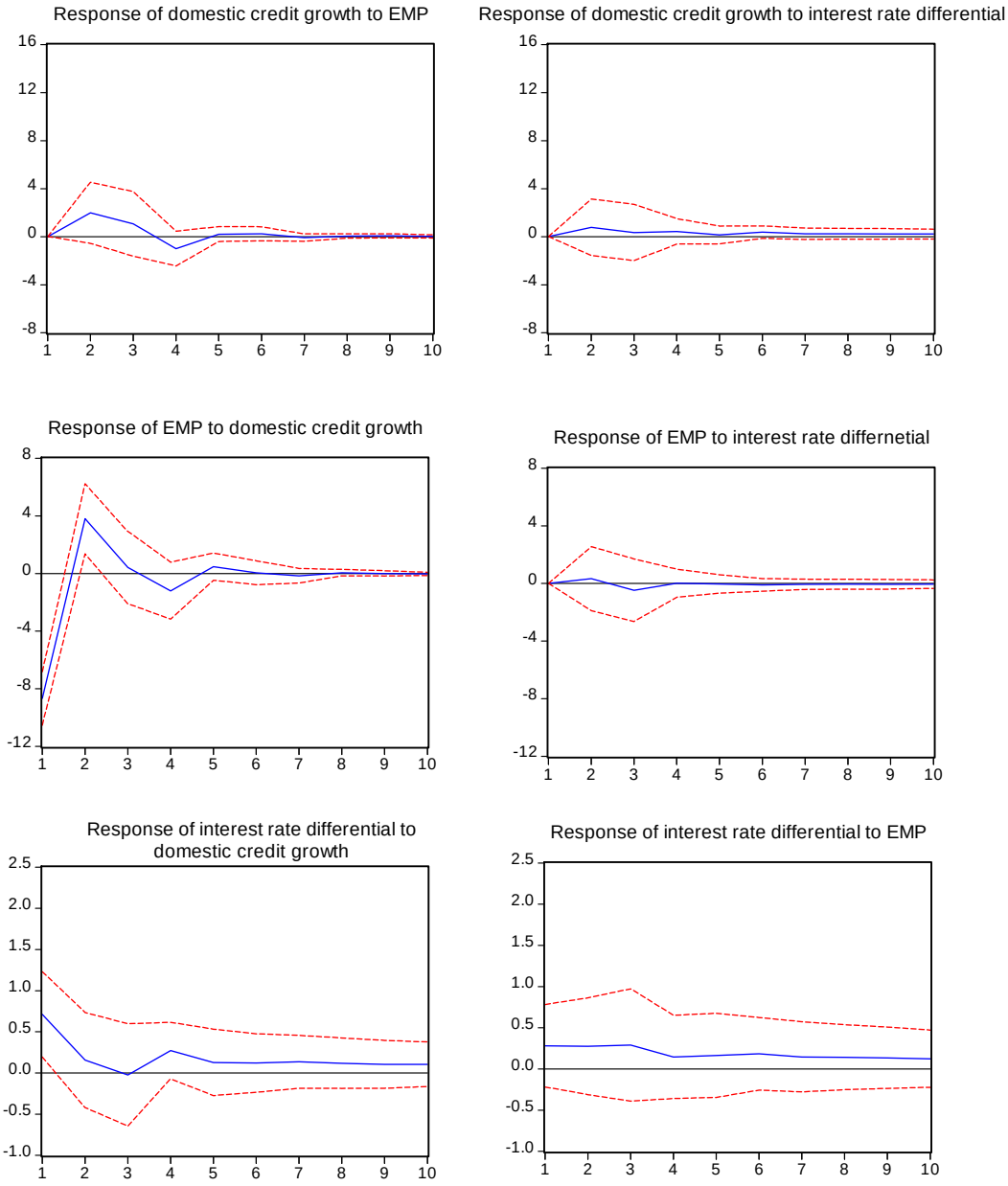


Figure 5.2 Impulse Response Functions (IRFs):
Response to Cholesky One S.D. Innovations ± 2 S.E.

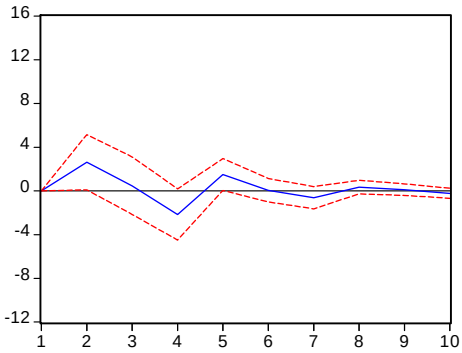
Indonesia



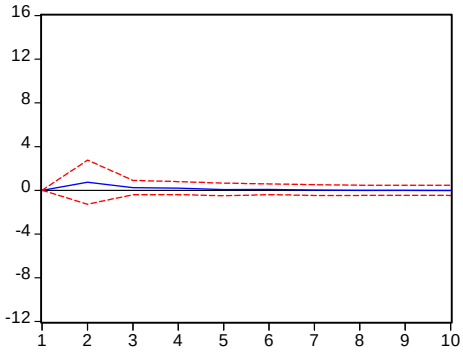
(Continued) Figure 5.2 Impulse Response Functions (IRFs): Response to Cholesky One S.D. Innovations ± 2 S.E.

Korea

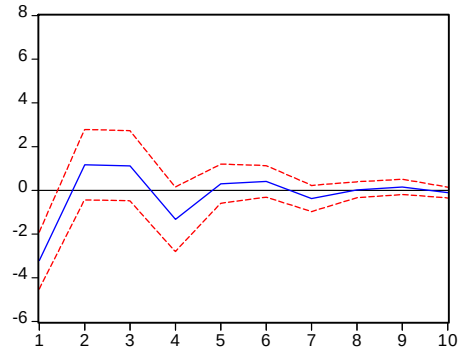
Response of domestic credit growth to EMP



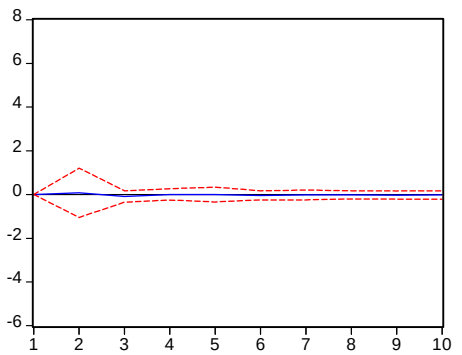
Response of domestic credit growth to interest rate differential



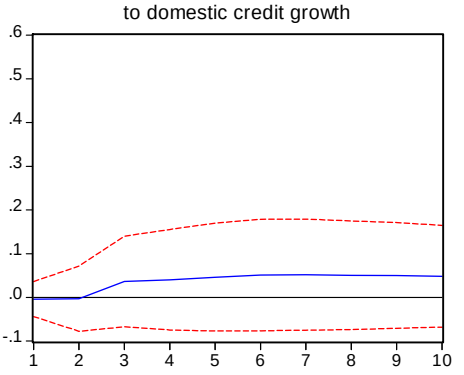
Response of EMP to domestic credit growth



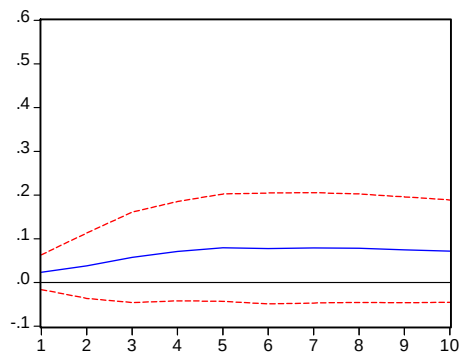
Response of EMP to interest rate differential



Response of interest rate differential to domestic credit growth

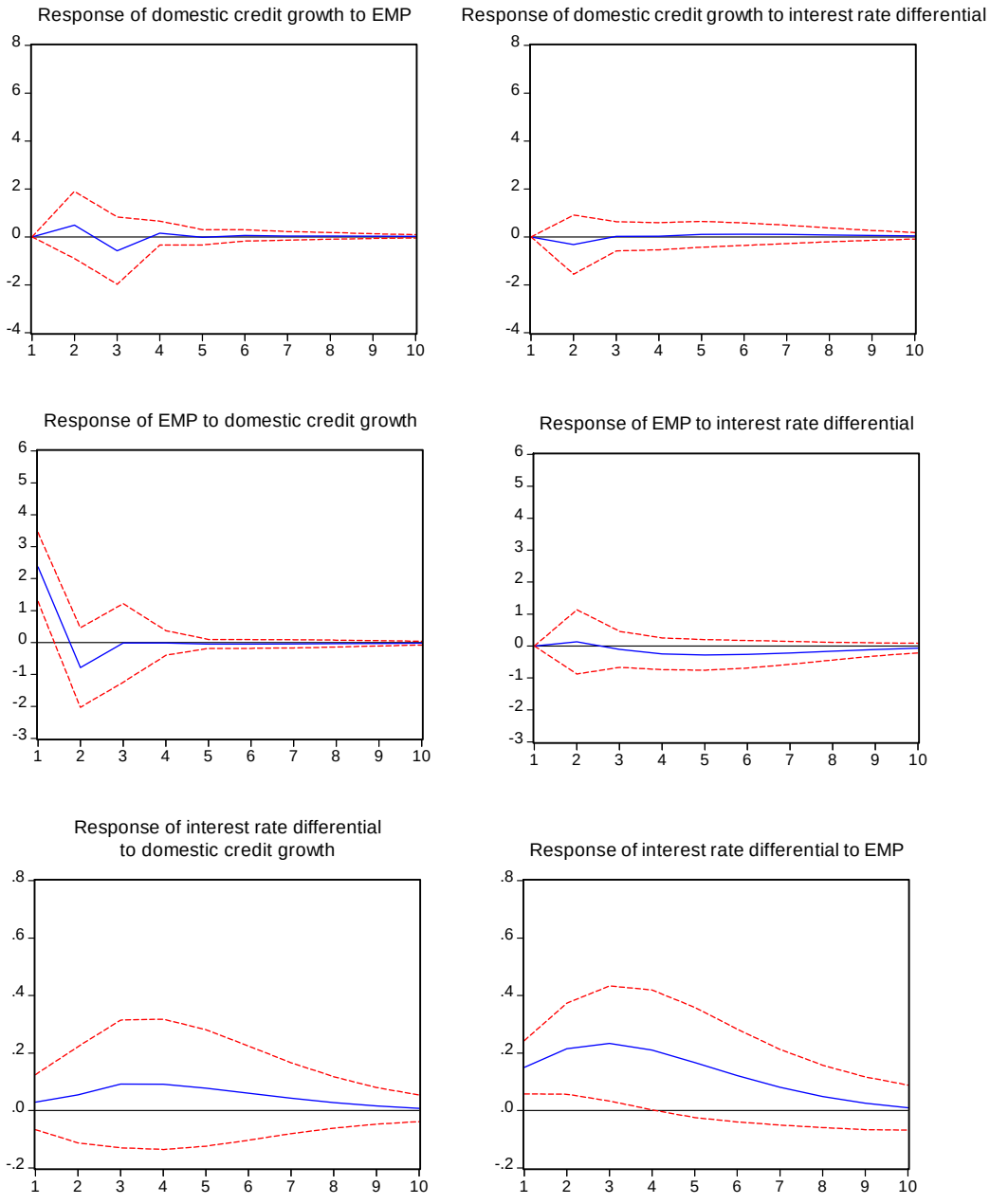


Response of interest rate differential to EMP



(Continued) Figure 5.2 Impulse Response Functions (IRFs): Response to Cholesky One S.D. Innovations ± 2 S.E.

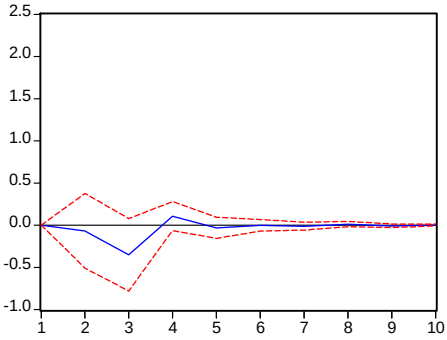
Philippines



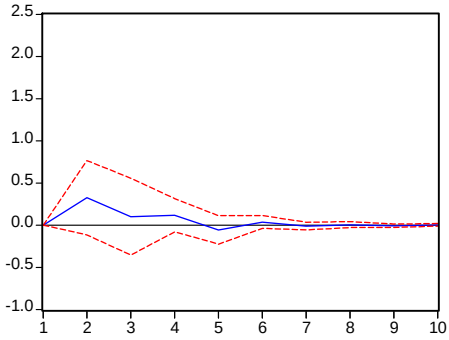
(Continued) Figure 5.2 Impulse Response Functions (IRFs): Response to Cholesky One S.D. Innovations ± 2 S.E.

Singapore

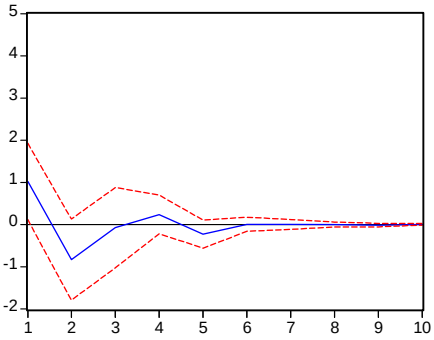
Response of domestic credit growth to EMP



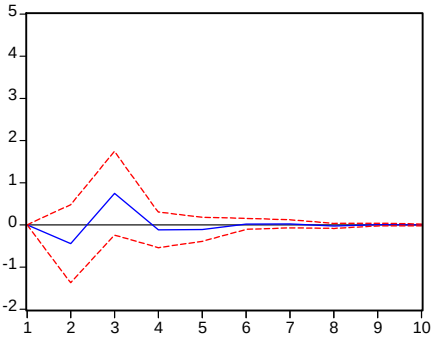
Response of domestic credit growth to interest rate differential



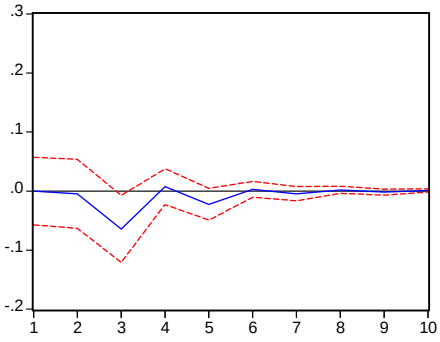
Response of EMP to domestic credit growth



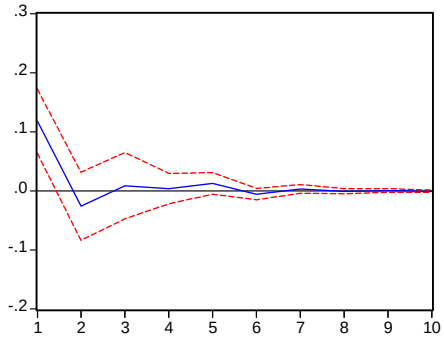
Response of EMP to interest rate differential



Response of interest rate differential to domestic credit growth



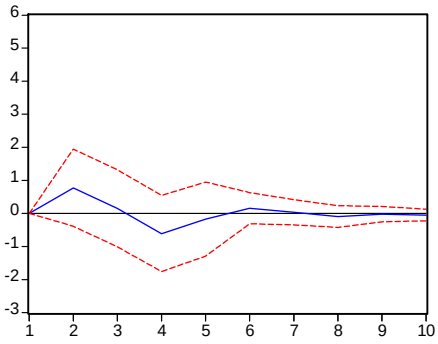
Response of interest rate differential to EMP



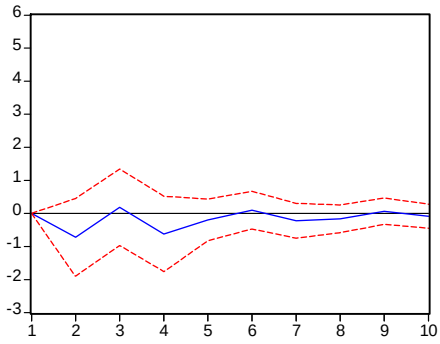
(Continued) Figure 5.2 Impulse Response Functions (IRFs): Response to Cholesky One S.D. Innovations ± 2 S.E.

Thailand

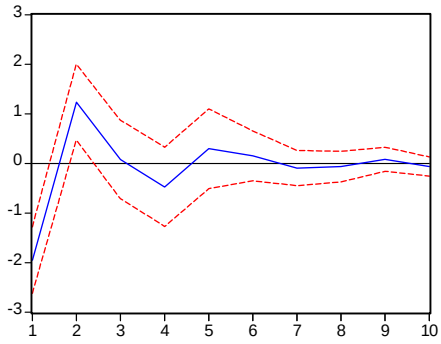
Response of domestic credit growth to EMP



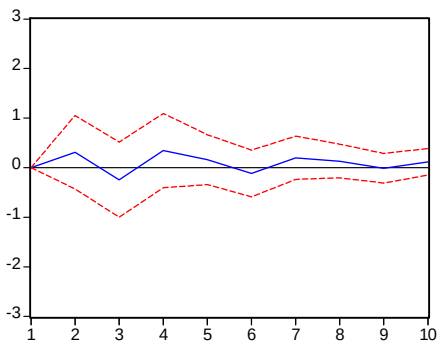
Response of domestic credit growth to interest rate differential



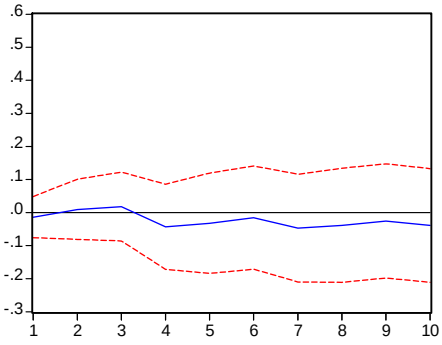
Response of EMP to domestic credit growth



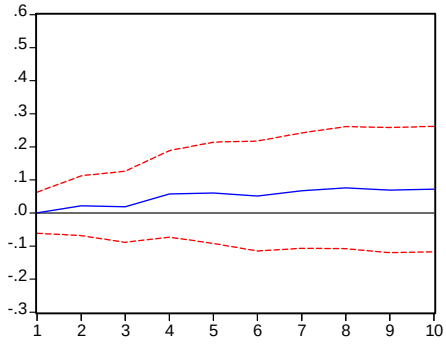
Response of EMP to interest rate differential



Response of interest rate differential to domestic credit growth



Response of interest rate differential to EMP



Tables:

Table 5.1 Descriptive Statistics of EMP Indices of Sample Countries

	Indonesia	Korea	Singapore	Thailand	Philippines
Mean	0.001	-0.001	-0.002	0.001	0.000
Median	0.001	-0.001	-0.003	0.001	0.000
Maximum	0.062	0.069	0.311	0.064	0.055
Minimum	-0.087	-0.043	-0.445	-0.031	-0.034
Std. Dev.	0.013	0.012	0.076	0.013	0.012
Skewness	-1.018	1.975	-1.068	0.917	1.287
Kurtosis	19.721	17.310	13.264	7.435	8.561
Jarque-Bera	1560.539*	1212.033*	604.523*	126.661*	206.531*
Probability	0.000	0.000	0.000	0.000	0.000
Observations	132	132	132	132	132

Note: *denotes the null hypothesis of a normally distributed EMP measure is rejected.

Table 5.2 Number and Proportion of Crisis Episodes ($EMP_{i,t}^{KRL}$ Measure)

(Sample period: 1995:01- 2005:12)

Country	No. of Observations	No. of Crisis Episodes	Incidence	Date of Crisis Episodes
Indonesia	132	7	5.3%	Aug 1997 Nov1997 April 1998 July 1998 Nov 1998 Dec1999 Feb 2001
Korea	132	2	1.5%	Aug 1997 Nov1997
Philippines	132	5	3.8%	May 1997 Oct 1997 Aug 1998 May 2000 Oct 2000
Singapore	132	4	3 %	Aug 1997 Dec 1997 May 1998 Mar 2001
Thailand	132	5	3.8%	Feb 1997 May 1997 Aug 1997 Nov 1997 Sept 1999

Note: Incidence = No. of Crisis Episodes/ No. of Observations *100%.

Table 5.3 Number and Proportion of Crisis Episodes ($EMP_{i,t}^{ERW}$ Measure)

(Sample period: 1995:01- 2005:12)

Country	No. of Observations	No. of Crisis Episodes	Incidence	Date of Crisis Episodes
Indonesia	132	5	3.8%	Jan 1995 April 1995 July 1995 Oct 1995 Aug 2005
Korea	132	4	3.0%	Nov1997 Sept 1999 Dec 2000 Sept 2001
Philippines	132	7	5.3%	Feb 1995 July 1997 Oct 1997 Aug 1998 Oct 2000 July 2002 June 2003
Singapore	132	9	6.8%	Jan 1996 Aug 1997 Dec 1997 Jan 1998 Jan 1999 Mar 2001 Sept 2001 Sept 2002 July 2004
Thailand	132	11	8.3%	Jan 1995 Aug 1995 Sept 1996 Jan 1998 Sept 1999 Sept 2000 Jan 2001 April 2001 Sept 2001 Sept 2002 Mar 2003

Note: Incidence = No. of Crisis Episodes/ No. of Observations *100%.

Table 5.4 Augmented Dickey-Fuller Tests

Countries	EMP		δ		ϕ	
	Levels	First Differences	Levels	First Differences	Levels	First Differences
Indonesia	-12.350***	/	-11.819***	/	-3.578***	/
Korea	-12.346***	/	-13.581***	/	-2.054	-4.620***
Philippines	-8.986***	/	-10.270***	/	-3.823***	/
Singapore	-11.249***	/	-9.604***	/	-10.023***	/
Thailand	-8.202***	/	-9.208***	/	-0.759	-6.170***

Notes: *** denotes rejection of the null of unit root for the ADF test (with trend and intercept) at the 1% significance level. The critical values are -3.511, -2.897, -2.586 at 1%, 5%, 10% level, respectively. The chosen of lag length is automatically based on SIC.

Table 5.5 Pairwise Granger Causality Tests

(Sample period: 1999:01- 2005:12 Lags: 4)

Indonesia

Null Hypothesis:	F-Statistic	Probability
δ does not Granger Cause EMP	0.10194	0.98146
EMP does not Granger Cause δ	2.79791*	0.06807
ϕ does not Granger Cause EMP	0.49658	0.73826
EMP does not Granger Cause ϕ	2.13554*	0.08528
ϕ does not Granger Cause δ	0.62309	0.64754
δ does not Granger Cause ϕ	3.48687**	0.01173

Note: Level of significance indicated by asterisks, ** 5 percent and * 10 percent.

Korea

Null Hypothesis:	F-Statistic	Probability
δ does not Granger Cause EMP	1.03628	0.39467
EMP does not Granger Cause δ	3.77952**	0.02707
$\Delta\phi$ does not Granger Cause EMP	1.86864	0.12543
EMP does not Granger Cause $\Delta\phi$	0.24746	0.91029
$\Delta\phi$ does not Granger Cause δ	0.94202	0.44484
δ does not Granger Cause $\Delta\phi$	1.14430	0.34285

Notes: Level of significance indicated by asterisks, ** 5 percent and * 10 percent.

The interest differential is entered as a first difference $\Delta\phi$.

(Continued) Table 5.5 Pairwise Granger Causality Tests

(Sample period: 1999:01- 2005:12 Lags: 4)

Philippines

Null Hypothesis:	F-Statistic	Probability
δ does not Granger Cause EMP	0.23042	0.92043
EMP does not Granger Cause δ	2.98455**	0.02454
ϕ does not Granger Cause EMP	2.80763**	0.03184
EMP does not Granger Cause ϕ	1.06643	0.37960
ϕ does not Granger Cause δ	1.28322	0.28477
δ does not Granger Cause ϕ	0.16923	0.95339

Note: Level of significance indicated by asterisks, ** 5 percent and * 10 percent.

Singapore

Null Hypothesis:	F-Statistic	Probability
δ does not Granger Cause EMP	1.74629	0.14942
EMP does not Granger Cause δ	0.49916	0.73639
ϕ does not Granger Cause δ	0.71290	0.58584
δ does not Granger Cause ϕ	1.64086	0.17352
ϕ does not Granger Cause EMP	2.18339*	0.07954
EMP does not Granger Cause ϕ	0.62234	0.64807

Note: Level of significance indicated by asterisks, ** 5 percent and * 10 percent.

(Continued) Table 5.5 Pairwise Granger Causality Tests

(Sample period: 1999:01- 2005:12 Lags: 4)

Thailand

Null Hypothesis:	F-Statistic	Probability
EMP does not Granger Cause δ	1.86033	0.12694
δ does not Granger Cause EMP	2.28251*	0.06883
$\Delta\phi$ does not Granger Cause δ	0.91593	0.45956
δ does not Granger Cause $\Delta\phi$	1.00161	0.41258
$\Delta\phi$ does not Granger Cause EMP	1.50439	0.21014
EMP does not Granger Cause $\Delta\phi$	1.38904	0.24651

Notes: Level of significance indicated by asterisks, ** 5 percent and * 10 percent.

The interest differential is entered as a first difference $\Delta\phi$.

Appendix 5.1 Data Description

The variables e_t and r_t, which compose EMP, are calculated as follows:

e_t is the change of nominal bilateral exchange rate of domestic currency against U.S. dollar. It is obtained from IFS line AE, logged values.

r_t is the change in international reserves divided by lagged monetary base. International reserves were obtained from IFS line 11.D; and monetary base is from IFS line 14, respectively.

ϕ is the interest rate differential between domestic 3-month money market rate (obtained from IFS line 60B) and the 3-month U.S. Treasury bill rate (obtained from IFS line 60CS.ZF).

δ_t is the change in the domestic credit provided by monetary authorities divided by lagged monetary base.

For Indonesia, Philippines, and Thailand, domestic credit is defined as the sum of central bank credit to the government and to the financial system (obtained from the sum of lines 12 A, 12E, and 12F from the IFS). For Korea and Singapore, domestic credit is defined as the difference between the monetary base and net foreign assets (IFS line 14 minus line 12 plus line 16). Monetary base was, again, line 14 from the IFS.

Chapter 6

The Relationship between Stock Prices and Exchange Rates: Evidence from Hong Kong

6.1 Introduction

Following the generalised floating of the major currencies in the early 1973, the importance of exchange rates in influencing domestic prices, including stock prices, has been heightened. The dramatic increases in world trade and capital movements have made the currency value one of the main determinants of business profitability and equity prices. Therefore, developments of increased integration in the financial markets and the recent emergence of new capital markets have received considerable attention of researchers and policymakers in studying the exchange rates-stock prices linkage. The research of this area has mainly focused on the determination of causality between stock prices and exchange rates in both developed and developing countries. The 1997/98 financial crisis, in particular, leads to the turmoil in both currency and stock markets for a group of Asian countries. A particular feature of the East Asian crisis is the almost simultaneous decline in asset prices and currencies, as international investors moved their capital out of the respective domestic markets. This resulted in a subsequent depreciation of the exchange rate as the domestic currency was sold. The crisis has motivated several researchers to dwell on the relationship between stock market and exchange rate or currency market (e.g., Granger *et al*., 2000; Ramasamy and Yeung, 2002, and among others). When investigating the possible relationship between stock markets and the exchange rate, the main concern is usually over the direction of causality between these two variables. However, there is no theoretical consensus on this relationship, specifically, on the direction or a particular sign of the relationship.

The "flow oriented" models (the traditional approach) and "stock oriented" models (the portfolio approach) are two classical theories on the exchange rate determination.

Specifically, “flow oriented” models put forward that exchange rates lead stock prices with arbitrary correlation. This is because currency appreciation may affect product international competitiveness and trade balance position. The contraction of output can affect the firms’ profit and in turn affect the stock prices. In contrast, the proponents of the portfolio approach suggest that equity may affect exchange rate changes via demand for money because equity can be acted as part of wealth. Higher stock prices, for instance, may lead to a higher demand for money with ensuring higher interest rates. With relatively higher interest rates, foreign capital inflows will result in an appreciation of domestic currency. Therefore, stock prices lead exchange rates with negative correlation.

As theoretical economists and empirical researchers are far from reaching any consensus related to the interactions between stock market and foreign exchange market, it is advisable to carry out further investigation on this kind of issue. Establishing the relationship between stock prices and exchange rates has important policy implications and might affect both monetary and fiscal policy. For instance, a booming stock market usually has a positive effect on aggregate demand. Gavin (1989) suggests if such positive effect is large enough, expansionary monetary or contractionary fiscal policy that targets the interest rate, and the real exchange rate, will be neutralised. Policy-markers also advocate less expensive currency in order to boost the export sector. It would be of great interest for them to be aware of whether such a policy would depress the stock market or not. Exploring the link between the two markets may also be used for predicting the path of each other. If the stock prices and exchange rates are closely related, investors can then predict the behaviour of one market using the information from the other. The multinational corporations can also take advantage of such information in managing their exposure to foreign contracts and exchange rate risk and/or do the currency hedging. Moreover, knowledge of the relationship between stock prices and exchange rates can be helpful to predict a crisis. If there is a causality relationship, for instance, running from exchange rates to stock prices, then we may prevent the crisis in the stock markets by adjusting the exchange rates. Khalid and Kawai (2003) as well as Ito and Hashimoto (2004) among others, claim that the link

between the stock and currency markets help propagate the Asian financial crisis in 1997/98. The depreciation of the Thai baht not only has triggered the depreciation of other regional currencies, but also has led to the collapse of the stock markets. Awareness of such a relationship between the two markets would help take effective preventive action before the spread of a crisis.

To address the above issues, this chapter provides further evidence on the relationship between stock prices and exchange rates, in the case of Hong Kong, to realise what kind of causality prevailed over the period 1995-2001. Hong Kong is selected to be investigated in this study for three reasons: First, being the second largest stock market in Asian, exceeded only by Japan, Hong Kong plays a significant role as a major international financial center and is characterised by its high degree of internationalisation, free trade and flow, and financial information network. Second, Hong Kong adopts a unique exchange rate regime: with currency board arrangement (CBA), Hong Kong fixes its nominal exchange rate against the U.S. dollar at a specific level. Third, during the 1997/98 financial crisis, the Hong Kong dollar has remained remarkably stable under the anchor of the linked exchange rate, while many other currencies in the Asian region have all suffered sharp depreciation. Hence, we can infer that the case of Hong Kong differs from that of most crisis-affected Asian economies, which provides a particularly interesting opportunity to investigate the long-run and short-run causal relationship between stock prices and exchange rates.

Compared to previous work, this study provides a full investigation on how far both stock and exchange rate markets can be interrelated by employing a set of empirical methodologies. We firstly address the stationarity of the data series by conducting a group of unit root tests to draw robust conclusion on the data properties. We not only employ the conventional unit roots tests as previous studies did, but also take the possibility of a structural break into account. This is because the conventional tests may not be reliable when the sample period includes some major events. Failure to consider these events could lead to erroneous conclusions. Then we employ both Engle-Granger two-step methods and the Johansen cointegration procedure to investigate the long-run

relationship between stock prices and exchange rates. The Granger noncausality tests in the setting of the vector autoregressive (VAR) (or vector error correction (VEC) model), together with the impulse response (IR) function are adopted to examine the short-run causal relationship between two variables. Moreover, this chapter further explores the relative importance of each variable in forecasting the other, by estimating and comparing the adjusted R square from a set of regressions using the Ordinary Least Square (OLS) method. In addition, most of previous studies have been conducted under periods where the stock markets are operating under normal conditions. This study provides a full examination of the relationship between exchange rates and stock prices during normal and stressful conditions. It would be important and interesting to take into account the situation where asset markets are under stress. In fact, exchange rates are often the easy target for policy intervention during an economic crisis. Hence, it would be crucial to know how exchange rates affect other asset markets.

The chapter is organised as follows: Section 6.2 briefly reviews the theoretical literature and highlights the main empirical findings in developed and emerging economies. Section 6.3 discusses the methodological issues in detail. Section 6.4 introduces the data used in this study and provides some preliminary statistics of data series. Section 6.5 presents an interpretation of the empirical results. Finally, Section 6.6 offers concluding remarks.

6.2 A Review of Literature

6.2.1 Main Theories on the Stock Prices- Exchange Rates Linkage

The economic theories suggest a relationship between stock market performance and exchange rate behaviour. The literature in general also provides some evidence of joint determination between both markets. Nevertheless, there is no theoretical consensus on the direction of causality relationship: does a stock price change cause an exchange rate change or does an exchange rate change lead a stock price change? In this section, we

mainly outline three major competing theories that attempt to interpret this causal relationship between stock prices and exchange rates.

Traditional Approach

The traditional approach, represented as the "flow oriented" models, suggests that exchange rates should lead stock prices. This approach postulates that changes in the exchange rate or exchange rate fluctuations will affect the competitiveness of a firm, which in turn will influence the firm's earnings and net worth and stock prices in general (Dornbusch and Fischer, 1980). To be specific, the "flow oriented" models assume that the exchange rate is determined largely by a country's current account or trade balance of performance. Stock prices, on the other hand, are usually defined as the present value of future cash flows of firms. According to these models, changes in exchange rates or currency movements affect international competitiveness and the balance of trade position, and consequently influence the real economic variables such as income and output of the country. Firms get involved in international trade activities and could be exposed to foreign exchange risk. Bodnar and Gentry (1993), in particular, suggests the exchange rate fluctuations can affect firm's prices and assets denominated in foreign currencies.

Other studies which refer to the exchange rate exposure models also get the similar conclusion. For example, Hekman (1985) proposes a present value based financial valuation model for multinational firms, in which the exchange rate is a leading indicator of the stock prices. By exploring the impact of exchange rate volatility on the market value of firms, Sercu and Vanhulle (1992) conclude that an increase in exchange rate volatility has a positive effect on the market value of firms. Furthermore, Granger *et al*. (2000) argue that a change in exchange rates would change the market value of all firms that trade internationally. Granger *et al*. (2000) further imply the impact of exchange rates on firm's stock prices would depend on firm's status in terms of net importers or exporters: the currency devaluation would have a beneficial effect on firms' profitability and thereby their stock market values if firms are net exporters.

In short, the traditional approach proposes that changes in exchange rates can Granger cause changes in stock prices. Nevertheless, firm can be either an exporter or an importer, and the net effect of the aggregation or stock market values cannot be explicitly determined. The sign of the correlation between exchange rates and stock prices is thereby arbitrary to some extent. The depreciation of the domestic currency will make local firms who are exporters more competitive and in turn raise their stock prices. Under this circumstance, we may expect a positive causal relationship running from exchange rates to stock prices.

Portfolio Approach

Alternatively, the portfolio approach which is typically represented by "stock oriented" models, highlight the role of exchange rates to the demand for and the supply of domestic as well as foreign assets from the viewpoint of internationally diversified portfolios. According to this approach, individuals hold domestic and foreign assets including currencies in their portfolio. If we define exchange rate as the price of one unit of foreign currency in local currency terms, then a decrease in exchange rate imply currency appreciation. When domestic stock prices increase, individuals will demand more domestic assets and sell foreign assets, leading to an appreciation of local currency. Hence, a negative relationship between stock prices and exchange rates is deduced according to this approach. Moreover, a traditional money demand equation proposes that changes in domestic economic activities (proxied by stock returns) lead to changes in demand for real currency balances and, consequently to changes in exchange rates (Ajayi *et al*., 1998).

The portfolio adjustments (inflows/outflows of foreign capital) can be deemed as another channel through which changes in stock prices influence the movements of exchange rates. An increase in stock prices would lead to an increase in the wealth of domestic investors. This will result in a rise in the demand for money and thereby a rise in interest rates. Therefore, inflows of foreign capital would rise, leading to a currency appreciation. Again, the financial asset price or stock prices movements affect exchange

rate dynamics with a negative correlation. Earlier studies based on the portfolio-balance models can be traced back to the work by Branson (1983), Frankel (1983) and Gavin (1989). These studies have indicated that rising (falling) stock prices influence capital flows from foreign investors who substitute local (foreign) currency for foreign (local) currency. Bahmani-Oskooee and Sohrabian (1992) argue that changes in stock prices may affect exchange rates through firms' portfolio adjustments. Yu (1995) also provides a similar argument that capital outflows affect exchange rates if changes in stock prices are sufficiently persistent to generate or destroy the confidence of stock market investors. As a whole, the portfolio approach states that stock prices Granger cause exchange rates with a negative relationship: a rise in stock prices will lead to an appreciation of domestic currency due to an increase in the demand for domestic currency. Similarly, a fall in stock prices will lead to a deprecation of the exchange rate due to an increase in the supply of foreign currency.

Asset Approach

In addition to the former two different explanations of interactions between stock prices and exchange rates, the asset market approach implies that there is a weak or no association between both variables[23]. The exchange rate under this scenario is viewed as the price of an asset or price of one unit of foreign currency. Like prices of other assets from which the expected future value can determine the current value, the current exchange rate can be affected by any news or factors that affect future values. As developments of stock prices and exchange rates may be driven by different factors, it may imply no link between the said variables. Muhammad and Rasheed (2002) also explain the case of having no such association as follows: The domestic currency depreciation would raise the price of those firms that export goods to other countries. However, when these firms import most of its inputs from abroad, domestic currency depreciation would lead an increase in the cost of production and a decline in firm's profit. Then these firms become less competitive and their stock price may not rise.

[23] More details about basic asset market models are given in Frenkel (1976), Dornbusch (1976), and Frankel (1979). For a comprehensive review of asset market models, see, for instance, MacDonald and Taylor (1992).

Nevertheless, we could still expect an association between these two financial variables if there are some common factors (for example, interest rates) that affect both stock prices and exchange rates. In fact, the theoretical models mostly consider the economic fundamentals like money supply, interest rate, price level in the determination of exchange rate movements. This implicitly implies an important link between stock prices and exchange rates.

6.2.2 Empirical Studies on the Relationship between Stock Prices and Exchange Rates

The relationship between stock prices and exchange rates has been empirically examined by extensive studies involving both developed and developing countries. For instance, studies on developed countries or advanced markets can be found in Bahmani-Oskooee and Sohrabian (1992); Ajayi and Mougoue (1996); Nieh and Lee (2001). Studies on Central and Eastern European countries can be found in Bahmani-Oskooee and Domac (1997); Grambovas (2003). Studies on South Asian countries can be found in Smyth and Nandha (2003); Mishra (2004); Narayan and Smyth (2005); Venkateshwarlu and Tiwari (2005). Studies on countries in North and East Asia can be found in Yu (1995); Abdalla and Murinde (1997); Ajayi *et al*. (1998); Granger *et al*. (2000); Ibrahim (2000); Wu (2000); Hatemi-J and Roca (2005); Ramasamy and Yeung (2005). In Table 6.1, a brief description of selected empirical findings is given. Close examination of the studies reported in Table 6.1 reveals the existence of numerous mixed findings regarding the statistical relationship between stock prices and exchange rates. In general, there has been no theoretical or empirical consensus on the direction of causation if stock prices and exchange rates are related. The disparity of results might be attributed to the different countries analysed and subjected to the different degrees of the capital mobility, trade volume and economic links among them. As for the same country investigated across the empirical studies, the existence of contradictions and inconclusive findings might also result from different methodology, time periods, and variables used in each study.

Obviously, in nearly all empirical studies mentioned in Table 6.1, Granger causality test has been extensively used. Regarding the varied results, ranging from bi-causality to no causality, however, it is suggested to take great caution when interpreting Granger causality results. Ramasamy and Yeung (2005), for example, point out that causality studies need to consider shorter periods for analysis if the results are to contribute towards any policy adjustments. Employing the standard Granger causality methodology to a research setting similar to that of Granger *et al*. (2000), they find the direction of causality can vary according to the length of period chosen.

This chapter attempts to contribute to the literature by providing further empirical evidence for the case of Hong Kong on the relationship between stock prices and exchange rates. As mentioned in Section 6.1, Hong Kong is a typical example which offers a particularly interesting opportunity to investigate the relationship between stock prices and exchange rates due to its high degree of internationalisation, free capital mobility and unique exchange rate arrangement.

6.3 Methodology Issues

In this section, the methodology issues that apply to carry out the empirical investigation are described in details.

6.3.1 Unit Root Tests

Since this chapter deals with the time series financial data, the issue of unit roots needs to be taken into account in the presence of non-stationary variables. Many studies have previously shown that majority of time series variables are non-stationary or integrated of order 1. Thus, a unit root test should precede any empirical estimation to avoid the problem of spurious regressions. As a first step, the unit root tests are implemented to investigate whether the time series of exchange rate and stock price are stationary or not.

Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests

The commonly used methods to test for the presence of unit roots are Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979 and 1981) and Phillip-Perron (PP) test (Phillips and Perron, 1988) in the empirical literature. In both tests, the null hypothesis is that a unit root exists in the autoregressive representation of the time series.

In general, an ADF (p) model can be written as follow (Dickey and Fuller, 1979, 1981):

$$\Delta x_t = \alpha + (1-\phi)x_{t-1} + \gamma t + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + \varepsilon_t \qquad (6.1)$$

where $\Delta x_t = x_t - x_{t-1}$, x_t is a macroeconomic variable such as exchange rate or stock price, t is a trend variable, ε_t is a white noise term. Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) are often used to determine the optimal lag length or p. The null hypothesis is $H_0 : \phi = 1$ and x_t is said to possess the unit root property if one fails to reject H_0; whereas the rejection of the null indicates the time series is stationary. On the other hand, PP test is an alternative (nonparametric) method of controlling for serial correlation when testing for a unit root. Moreover, Perron (1989) suggests that failure to allow for an existing break leads to a bias that reduces the ability to reject a false unit root null hypothesis. The PP test can overcome this problem by allowing for a known or exogenous structural break in the ADF tests.

KPSS test

However, the above tests have been criticised for having lower power and tend to accept the null hypothesis too frequently against a stationary alternative (Schwert, 1987; DeJong *et al*., 1992). Our study also utilises mean stationary test proposed by Kwiatkowski *et al*. (1992) (hereafter, KPSS) to complement the ADF and PP tests. The KPSS test is based on the following statistics (Kwiatkowski *et al*., 1992):

$$\eta(u) = (1/T^2)\sum_{t=1}^{T} S_t^2 / \sigma_k^2 \text{ , and } \; S_t = \sum_{i=1}^{t} V_t, t = 1,....T. \qquad (6.2)$$

where V_t is the residual term from a regression of y_t on an intercept, and σ_t^2 is a consistent long-run estimate of y_t, and *T* represents the sample size. If the computed value of $\eta(u)$ is larger than the critical value, then the null hypothesis of stationarity is rejected.

Zivot and Andrews (1992) test

A problem common with the conventional unit root tests —such as the ADF, PP tests, is that they do not allow for the possibility of a structural break. It is well established that standard tests for integration order have low power if the effect of structural breaks that have occurred during the period of study is not explicitly taken into account. For example, as suggested by Granger *et al*. (2000), the ADF test is unreliable when the sample period includes some major events (for example, great depression, oil shocks). Failure to consider it properly could lead to erroneous conclusions in the case when the null is not rejected. Assuming the time of the break as an exogenous phenomenon, Perron (1989) shows that the power to reject a unit root decreases when the stationary alternative is true and a structural break is ignored. Zivot and Andrews (1992) propose a variation of Perron's original test in which they assume that the exact time of the break-point is unknown. Since the sample of this study includes the turbulent period, the exchange rate and stock index may contain structural breaks. We thereby could consider the case of a unit root test that allows for an endogenous break. Zivot and Andrews (1992) unit root test is based on the following model[24]:

$$\Delta y_t = \alpha + (1-\phi) y_{t-1} + \gamma t + \kappa D_t(\kappa) + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad (6.3)$$

[24] There are three different models provided by Zivot and Andrew (1992). We adopt the unit-root model as shown in Equation (6.3) due to the existence of a trend in the time series. Similar results are obtained using the other two models proposed by Zivot and Andrew (1992).

where $D_t(\kappa) = 1$ for $t > \kappa T$ and zero otherwise; $\kappa = T_B / T$ represents the location of the structural break. T is sample size; and T_B is the date when the structural break occurred. Zivot and Andrews (1992) choose the breakpoint that gives the least favorable result for the null of a unit root, that is, κ is chosen to minimize the t-statistic for the null of $\phi = 1$. Thus, the null hypothesis of Zivot and Andrews (1992) test is a unit root process without any endogenous structural breaks, and the relevant alternative hypothesis is a trend-stationary process with possible structural change occurring at an unknown point in time.

6.3.2 Cointegration Analysis

In general, in order to avoid spurious inferences, stationarity is strictly required in regression analysis. Nevertheless, by differencing the variables some information regarding a possible linear combination between the levels of the variables may be lost. The use of cointegration technique overcomes the problem of nonstationarity and allows for an investigation of both the levels and differences of exchange rates and stock prices (Phylaktis and Ravazzolo, 2005).

In this study, the long-run relationship between the stock prices and exchange rates can be examined by implementing the cointegration analysis to see whether the combination of the variables is cointegrated or not. To test the existence of cointegrating relationship between the said variables, two classical approaches are carried out: the Engle and Granger (1987) two-step method, and the Johansen cointegration procedure (Johansen, 1988; Johansen and Juselius, 1990).

Engle and Granger (1987) cointegration test

We firstly apply the Engle-Granger (1987) two-step method. In the first step the stock prices are regressed on the exchange rates. The reverse-order regression is also taken into account. As a second step we test the presence of cointegrating relationship

between the two variables by applying ADF test of unit roots on the residual obtained from the cointegrating equation.

The Engle-Granger two-step method consists of two equations as follows:

$$LS_t = \alpha + \beta LEX_t + \varepsilon_t \quad \text{or} \quad LEX_t = \alpha + \beta LS_t + \varepsilon_t \tag{6.4}$$

$$\Delta\varepsilon_t = \rho\varepsilon_{t-1} + \beta_1\Delta\varepsilon_{t-1} + \beta_2\Delta\varepsilon_{t-2} + ... + \beta_p\Delta\varepsilon_{t-p} + \mu_t \tag{6.5}$$

where LS_t is the logarithm of stock price index, LEX_t is the logarithm of exchange rate, ε_t is residual from cointegrating equation and μ_t is residual from the equation of ADF unit root test which is assumed to be white noise. If the residual series are stationary, then these two variables have cointegration relations among the related variable pairs.

Johansen cointegration procedure

We can also adopt the Johansen (1988) and Johansen and Juselius (1990) cointegration test to check the robustness of the results generated from the previous Engle-Granger two-step method. Applied the maximum likelihood procedure to determine the presence of cointegrating vectors in non-stationary time series, the Johansen's cointegration test is conducted on the basis of the following vector autoregression (VAR) equation (Johansen, 1988):

$$\Delta Z_t = C + \sum_{i=1}^{K} \Gamma_i \Delta Z_{t-1} + \Pi Z_{t-1} + \eta_t \tag{6.6}$$

where Z_t is a vector of non-stationary (in log levels) variables and C is the constant term. The information on the coefficient matrix between the levels of the Π is decomposed as $\Pi = \alpha\beta'$ where α matrix contains the adjustment coefficients and the β matrix contains the cointegrating vectors.

Especially, two kinds of statistics known as the trace statistic and the maximum eigenvalue statistic are used to make inferences about the number of cointegrating relations. The trace statistic for the null hypothesis of r cointegrating relations against the alternative of n cointegrating relations is computed as follows (Johansen, 1988):

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \log(1 - \hat{\lambda}_i) \qquad r = 0,1,2,...,n-1 \tag{6.7}$$

where T is the number of observations and $\hat{\lambda}_i$ is the i-th largest eigenvalue.

The maximum eigenvalue statistic tests the null hypothesis of r cointegrating relations against the alternative of $r+1$ cointegrating relations. This test statistic is determined using the following formula (Johansen, 1988):

$$\lambda_{\max} = -T \log(1 - \hat{\lambda}_{r+1}) \qquad r = 0,1,2,...,n-2,n-1 \tag{6.8}$$

In order to make inferences regarding the number of cointegrating relationships, we can compute the trace and maximum eigenvalue statistics and compare them with the corresponding critical values which are tabulated in Osterwald-Lenum (1992).

6.3.3 Granger Causality Analysis

To examine the issue of causation between stock prices and exchange rates, the standard Granger causality tests in a bivariate VAR model or Granger causality tests in a vector error correction (VEC) model can be employed, depending upon whether there is a long-run relationship between stock prices and exchange rates.

Standard Granger causality test in a bivariate VAR model

If there is no any cointegrating relationship between the considered variables, standard Granger causality tests would be applied. Thus, the following bivariate VAR model can

be employed to test for the linear causality:

$$\Delta S_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta S_{t-i} + \sum_{i=1}^{p} \alpha_{2i} \Delta ER_{t-i} + v_{1t} \quad (6.9)$$

$$\Delta ER_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta S_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta ER_{t-i} + v_{2t} \quad (6.10)$$

where S_t and ER_t represent stock prices and exchange rates, respectively. The disturbances v_{1t} and v_{2t} are assumed to be uncorrelated, and t denotes the time period. Granger causality test requires that all data series involved are stationary. Otherwise the inference from the F-statistics might be spurious because the test statistics will have nonstandard distributions. Accordingly, the first differences of all log-level series are employed and the first difference operator is marked by Δ.

Equation (6.9) postulates that current S is related to past values of S as well as of past *ER*. Similarly, Equation (6.10) postulates that *ER* is related to past values of *ER* as well as of past S. We may expect four possible conclusions regarding the causality relationship between stock prices and exchange rates as follows: (i) unidirectional causality from S to *ER*; (ii) unidirectional causality from *ER* to S; (iii) bilateral causality, i.e., S and *ER* Granger cause each other and (iv) S and *ER* are independent to each other. Therefore, not to reject $H_0 : \alpha_{21} = \alpha_{22} = ... = \alpha_{2p} = 0$ implies that exchange rates do not Granger cause stock prices. Likewise, not to reject $H_0 : \beta_{11} = \beta_{12} = ... = \beta_{1p} = 0$ implies that stock prices do not Granger cause exchange rates.

Granger causality test in the vector error correction (VEC) model

If the variables are non-stationary and are cointegrated, the adequate method to examine the issue of causation is the Vector Error Correction (VEC) model, which is equivalent to the VAR in first differences with the addition of a vector of cointegrating residuals. Thus, the VEC system is represented as follows:

$$\Delta S_t = \alpha_0 + \delta_1 (S_{t-1} - \gamma ER_{t-1}) + \sum_{i=1}^{p} \alpha_{1i} \Delta S_{t-i} + \sum_{i=1}^{p} \alpha_{2i} \Delta ER_{t-i} + \nu_{1t} \quad (6.11)$$

$$\Delta ER_t = \beta_0 + \delta_2 (S_{t-1} - \gamma ER_{t-1}) + \sum_{i=1}^{p} \beta_{1i} \Delta S_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta ER_{t-i} + \nu_{2t} \quad (6.12)$$

where $S_{t-1} - \gamma ER_{t-1}$ is the error correction term obtained from the cointegrating equation (6.4). Δ is the first difference operator. δ_1 and δ_2 are the error coefficients which capture the adjustments of ΔS_t and ΔER_t towards long-run equilibrium. The coefficients on ΔS_t and ΔER_t, that is, α_{1i}, α_{2i}, β_{1i}, and β_{2i} are expected to capture the short-term dynamics of the model. Therefore, inferences regarding the causality between the said variables can be made as follows: *ER* causes S if either δ_1 is statistically significant (the long-run causality) or the α_{2i}'s are jointly significant (short-term causality).

Similarly, S causes *ER* if δ_2 is statistically significant (the long-run causality) or the β_{1i}'s are jointly significant (short-term causality). For $\delta_1 = \delta_2 = 0$ which implies no long-run equilibrium relationship between S and *ER*, the above causality test in the framework of VEC model then reduces to the standard Granger causality test in the framework of VAR model as shown in Equations (6.9) and (6.10). In particular, Granger and Weiss (1983) suggest that even if the coefficients on lagged changes in stock prices are not jointly significant, the error correction approach allows for the finding that stock prices causes exchange rates due to the presence of the long-run causality. This is because the VEC model incorporates lagged residuals from the cointegrating regression and Granger causality thereby may emerge and equilibrium could be established *via* this additional channel.

6.4 Data and Descriptive Statistics

Weekly (Friday) closing prices in the Hang Seng Stock Price Index and foreign exchange rate (units of Hong Kong dollar per U.S. dollar) are employed and obtained from Datastream. The whole sample runs from 2 January, 1995 to 31 December, 2001. This particular sample is chosen to include financial crisis events. The use of weekly data in this study is justified by the fact that higher frequency data such as daily or intraday data contains too much noise while the lower frequency data such as the monthly or quarterly data may not be adequate to fully capture the information of changes in stock prices and exchange rates. Hence, the use of weekly data can compensate the weakness of both high and low frequency data properties.

In order to better understand the particular relationship between the said variables during the turbulent time, we define the period 7 July, 1997- 4 May, 1998 as the crisis sub-sample. We can therefore compare the results obtained from both whole and crisis periods. This helps us to examine possible changes in either intensity or direction of mutual relationships between said variables over different time periods. In particular, for the crisis period when volatilities in the stock and exchange rate markets are high, it would be appropriate to consider short-term movements instead of long-term ones. Ajayi *et al*. (1998, p. 243) argue that "attempts at revealing long-term causalities may prove to be futile because the implications of the causality study can hold practical implications for regulators who are interested in the proper functioning of financial markets, and for financial institutions, multinational corporations, or individual investors who are interested in internationally diversified portfolios and management of foreign exchange risks". Therefore, it is more reasonable to interpret and analyse the interactions between stock prices and exchange rates in each sub-sample period.

We transform all variables into natural logarithmic form and thus the first differences correspond to growth rates which are computed as follows:

$$R_{i,t} = \ln(P_{i,t} / P_{i,t-1}) = \ln(P_{i,t}) - \ln(P_{i,t-1}) \quad (6.13)$$

where $P_{i,t}$ is the price level of market i ($i = 1$ for the stock market and $i = 2$ for the exchange rate market) at time t.

Figure 6.1 and Figure 6.2 plot the data series of Hong Kong stock prices and exchange rates over the period 1995-2001, respectively. As shown in Figure 6.1, the Hong Kong stock market dropped suddenly during the crisis period but turned out to be booming after the crisis. On the other hand, while the nominal exchange rate of the Hong Kong dollar against the US dollar has remained around the 7.80 level (as shown in Figure 6.2), the market rate still deviates from the official rate. Nevertheless, the currency fluctuations, although small in magnitude, provide some justification for the conducting analysis, in the same vein as Granger *et al*. (2000) have done. Table 6.2 provides a summary of descriptive statistics for each series (logarithmic differenced changes). As for the average value of the series, the sample means for stock price series and exchange rate series are not statistically different from zero. As shown in Table 6.2, the measures for skewness and excess kurtosis show that both return series are positively skewed and leptokurtic with respect to the normal distribution. Each series generally appears to follow a non-normal distribution as the Jarque-Bera statistics reject the null hypothesis of a normal distribution at the 1 percent level of significance. The Ljung-Box statistics (up to 10 lags) calculated for the return series, indicate the presence of significant linear dependencies possibly due to some forms of market inefficiency or market structure.

6.5 Interpretation of Empirical Results

6.5.1 Tests for Stationarity

We implement the ADF and PP tests with and without the trend as recommended by Engle and Granger (1987) and back up their results by the KPSS test again with and without the trend. The optimal number of lags is selected according to Schwartz

Information Criterion (SIC) and the bandwidth is based on Newey-West using the Bartlett kernel spectral estimation method. The results of the ADF and PP unit root tests and KPSS stationarity tests are reported in Table 6.3. The results indicate that each of the series in levels is generally non-stationary. Although exchange rate changes in levels are found to be stationary according to the ADF test with constant and trend, both PP and KPSS tests indicates the nonstationary properties of exchange rate changes in levels. These tests in general reveal that the data series are non-stationary and integrated to the first order. Furthermore, considering the possible structural breaks that the Hong Kong economy encountered during the whole sample, the unit root test with an endogenous break has also been carried out in this study. The results of Zviot and Andrews test are presented in Table 6.4. However, we cannot reject the null hypothesis for both two variables at the 1 percent and 5 percent significance levels, that is, all data series follow a unit-root process without any endogenous structural breaks. This confirms the validity of results using the conventional unit root tests (ADF and PP tests) which do not allow for the possibility of a structural break. All of these tests for stationarity imply that it is adequate to use the first differenced data series for the regression analysis.

6.5.2 Cointegration Tests

In this section, both Engle-Granger two-step method and Johansen cointegration tests are carried out to examine whether any combinations of the said variables are cointegrated. Table 6.5 presents the results of Engle-Granger cointegration test. The upper part of this table lists the statistics when y_{1t} (stock price) is regressed on y_{2t} (exchange rate) whereas the statistics of the reverse-order regression is reported in the lower part of this table. The results indicate that there is unit root in the residual series for both the whole and the crisis periods. This implies that the two series are not cointegrated for the periods under analysis.

Using a 5 percent significance level, Table 6.6 and Table 6.7 report the results of Johansen cointegration test for the whole sample period and the crisis period,

respectively. This approach uses a maximum likelihood procedure that tests for the number of cointegration relationships and estimates the parameters of those cointegration relationships. The lag length is selected according to SIC on the undifferenced VAR[25]. Again, the outcome shows that the null hypothesis of zero cointegration vectors cannot be rejected for both data sets sampled from the whole period and the crisis period, according to both trace statistics and maximum-eigenvalue statistics.

In summary, the findings from both Engle-Granger two-step method and Johansen cointegration procedure suggest no evidence of cointegrating (long-run) relationship between exchange rates and stock prices for both the whole sample covering the period 1995-2001, and for the crisis sample covering the period 1997-1998. This is not surprising as it could be explained by the particular exchange rate policy (currency board arrangement) adopted in Hong Kong. The nominal exchange rate of Hong Kong is officially pegged to U.S. dollar. The market rate is allowed to fluctuate only within a very tightly band. Thus, mutual relations between stock prices and exchange rates could not emerge completely in the long-run. This finding is similar to the previous study such as Granger *et al*. (2000) and Nieh and Lee (2001) which state that there is no long-run significant relationship between stock prices and exchange rates. Since stock prices and exchange rates are not cointegrated, the following Granger causality test is based on the bivariate VAR without error correction terms.

6.5.3 Bivariate VAR and Pairwise Granger Causality Test

As the above analysis indicates no cointegrating (long-run) relationship between stock prices and exchange rates, this section continues to seek for any possible short-run causal relationship between both two variables. We attempt to answer the following question: Do changes in exchange rates cause stock prices or do changes in stock prices cause exchange rates in short-run? The standard Granger causality tests, as outlined in Equations (6.9) and (6.10), are employed to examine such linear causality. Tables 6.8

[25] Reimers (1992) finds that the SIC does well in selecting the lag length.

and 6.9 report the F statistics and probability values constructed under the null hypothesis of non-causality for the whole sample period and the crisis period, respectively. Number of lags is chosen on the basis of SIC, whilst two lags are identified as an optimal lag length in the estimation[26]. The results for the whole sample period (as shown in Table 6.8) suggest that the null of Granger non-causality from exchange rates to stock prices can be rejected at the 5 percent level of significance. In contrast, the null of Granger non-causality from stock prices to exchange rates cannot be rejected at the 5 percent level of significance. Hence, a one-way causality running from exchange rates to stock prices for the whole sample period is identified through the tests, in line with the traditional approach which states that changes in exchange rates can affect changes in stock prices. This finding could imply that the transmission of information between the two asset markets is inefficient. It provides the hedge opportunity for investors in this case. Given the significant causality relation from exchange rates to stock prices, stocks could be used as a hedge for foreign exchange investment.

On the other hand, the results for the crisis sample period, as reported in Table 6.9, indicate that there is no causality evidence between stock prices and exchange rates. The values of the F-statistics suggest that no trace of short-run dynamics can be found in the crisis period: exchange rates do not affect the stock prices; stock prices do not cause the exchange rates, either. This finding implies the independent relationship of both considered variables over the crisis period. Thus, this may indicate that the foreign exchange and stock markets become more efficient or that they cease to be integrated during the crisis period. Similar to the finding by Ajayi *et al*. (1998) who show insignificant causality between these markets, it is not possible to hedge the currency and stock risks by investing in both markets over the crisis period. In this case, one market cannot also serve as a base for policy intervention for stabilising the other market. That is, the foreign exchange market cannot serve as venue for intervention for the purpose of stabilising the stock market and vice versa.

[26] In order to check for the robustness with respect to the different lags, Table 5 and 6 report the results with lags 1 to 4.

As suggested by Kasman (2003), the inadequate lag selection could result in the omission of important information and hence lead to the spurious rejection of causal relationship. Considering that the results derived from the Granger causality test might be sensitive to the selection of the lag length, other lag length (lag = 1, 3, 4) is also selected to re-examine the causal relationship of both variables. However, as presented in Table 6.8 and Table 6.9, the conclusion in general is irrelevant with the different lags used in the estimation. Note that the empirical findings in this area unveil the fact that the results are dependent on the time period of the study. This is has been confirmed by Ramasamy and Yeung (2005), who point out that the causality between stock prices and exchange rates may vary depending on the state of the business cycle and the uncertainties surrounding the different markets for the period under study. They also argue that the results of causality are switched according to the length of period chosen. In terms of this, our study thereby provides further evidence on the causality between the said variables using weekly data and specific sample period we have chosen.

6.5.4 Impulse Response Analysis

The previous Granger causality tests have shown that the changes in exchange rates lead those in stock prices in the full sample. However, such definitive pattern obtained by the Grange causality test does not provide signs of such relation. In order to get further insight into the short run dynamic relations over the full sample and the crisis sample, this section takes advantage of the impulse response (IR) functions in the framework of Bivariate VAR and calculates standard deviation for each forecasting period. The IR analysis can provide further evidence on the short-run relations that not addressed by the Granger causality test.

As revealed in Table 6.10, the results from the IR (10 periods) analysis are in conformity with that of the Granger causality test. That is, if the Granger causality test indicates change in exchange rates leads that in stock prices, the responses of exchange rates from one-unit shock of stock prices are insignificant. Such is the case for Hong Kong as shown in upper part of Table 6.10 (Panel A). One-unit shocks from the

exchange rates have very discernible negative response on the corresponding stock prices (as shown in Table 6.10, Panel B). As for the whole period, it takes Hong Kong stocks to respond negatively within the first two weeks. As for the crisis period, the significant positive response can be found in the first week after the one-unit shock in exchange rates. Thus the IR analysis confirms the validity of the traditional approach. According to the traditional approach, exchange rate leads stock prices, but the correlation can be positive or negative depending on whether the individual firm is an exporter (output) or an importer (raw material).

6.5.5 Predictable Portion Analysis

In this section, we check the robustness of the results obtained in the previous sections by analysing the predictable portion of stock prices and exchange rate changes. If changes in exchange rate lead the changes in stock prices, then we expect to use the variations in exchange rates to predict or forecast stock prices. Harvey (1995), in particular, employs adjusted R-square (commonly denoted as $\overline{R}^2$) to investigate the predictability of stock prices for both emerging and developed markets[27]. Following Harvey's method, we examine whether past information on exchange rate variations may be useful in predicting stock price changes in Hong Kong. In general, R-squared (R^2) statistic measures the success of the regression in predicting the values of the dependent variable within the sample. This statistic will equal one if the regression fits perfectly, and zero if it fits no better than the sample mean of the dependent variable. However, one problem with using R^2 as a measure of goodness-of-fit is that R^2 will never decrease as adding more regressors. Adjusted R-square ($\overline{R}^2$), on the other hand, penalises the R^2 for the addition of regressors which do not contribute to the explanatory power of the model. For this reason, adjusted R-square is generally considered to be a more accurate goodness-of-fit measure than R-square.

[27] See Granger *et al*. (2000) for the similar methodology in carrying out the predictable portion analysis.

Table 6.11 presents a comparison of predictable portion of stock price changes. We compare the adjusted R-squares generated from the following two regressions: 1) the regression in which change of current stock price is the dependent variable and its lagged variables[28] are independent variables ($\overline{R}_1^2$), and 2) the regression in which current stock price change is the dependent variable and lagged variables of exchange rate change and stock price change are independent variables ($\overline{R}_2^2$). The estimated method employed is Ordinary Least Squares (OLS). Similarly, in order to check the forecasting ability of stock price change on the exchange rate, Table 6.12 reports a comparison of predictable portion of exchange rate changes. Therefore, in Table 6.12, current exchange rate acts as the dependent variable, instead.

The results in both of the two tables (Table 6.11 and Table 6.12) can help visualise the relative importance of each variable in forecasting the other. $\overline{R}_2^2$ Vs. $\overline{R}_1^2$ is the percentage increases in $\overline{R}^2$ by comparing the two regressions, it is calculated as follows:

$$\overline{R}_2^2 \text{ Vs. } \overline{R}_1^2 = (\overline{R}_2^2 - \overline{R}_1^2)/\overline{R}_1^2 \tag{6.14}$$

The results in Table 6.11 show that exchange rates possess forecasting power for stock prices as we find $\overline{R}_2^2 > \overline{R}_1^2$ for both whole sample period and the crisis period. In particular, the crisis period reveals more prediction power than the whole sample period (34.64% vs. 5.72%). According to the results shown in Table 6.12 where exchange rate is estimated as the dependent variable, the past information on stock prices variations is found to be not useful in forecasting exchange rate changes for the whole sample period. This is because the percentage increase in the adjusted R-square for the whole sample period is negative ($\overline{R}_2^2$ vs. $\overline{R}_1^2$ = -3.61%). This finding confirms the findings from previous Granger-causality analysis which suggests that changes in stock prices changes

[28] 2 lags have been used in this study.

do not lead changes in exchange rates. Note that stock prices possess some degree of prediction power for exchange rates in the crisis period ($\overline{R}_2^2 > \overline{R}_1^2$ and $\overline{R}_2^2$ vs. $\overline{R}_1^2$ = 28.21%). This may provide some possibility of contagion impact or spillover effect from the stock market to currency market over the crisis period.

6.6 Concluding Remarks

The traditional approach and portfolio approach represent competing hypotheses concerning the relationship between stock prices and exchange rates. This chapter provides a further investigation on the interaction between these two variables from the evidence of Hong Kong, using weekly data for the period January 1995-December 2001. After performing thorough analysis and tests of long-run and short-run dynamics between stock prices and exchange rates in Hong Kong, we have the following concluding remarks:

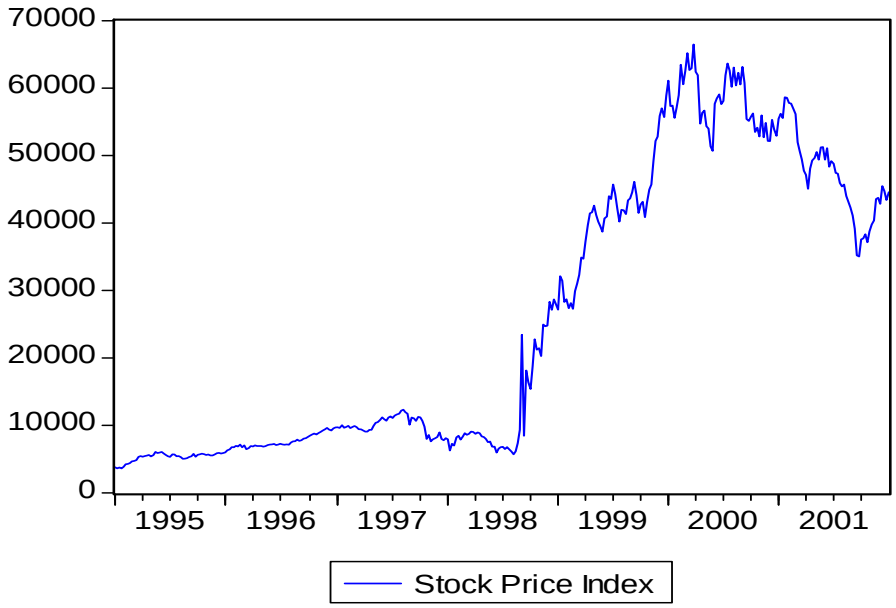
First, we find no evidence on the long-run relationship between the considered variables. A possible explanation is the particular exchange rates policy is currency board arrangement adopted by Hong Kong. The nominal exchange rate is officially pegged to U.S. dollar. The market rate is allowed to fluctuate only within very tightly band. Thus, mutual relations between stock prices and exchange rates could not emerge completely in the long-run. Second, analysis of short-run mutual interactions suggests a one-way causality running from exchange rates to stock prices for the whole sample period, which is in line with the traditional approach. The IR results confirm the Granger causality tests and provide additional information regarding the short-term dynamics of the lead-lag relationship between both said variables. This finding could imply that the transmission of information between the two asset markets is inefficient over the full sample period. Thus, during this period, stocks could be used as a hedge for foreign exchange investment. Note that the independent relationship of both considered variables has been found over the crisis period. This may indicate that the foreign exchange and stock markets became more efficient during the crisis period, and one

market cannot also serve as a base for policy intervention for stabilising the other market during this period. Third, the predictable portion analysis implies that exchange rates possess forecasting power for stock prices for both the full sample and the crisis sample. However, it is interesting to find out that stock prices have certain forecasting power for exchange rates in the crisis period. This might be due to the possible contagion or spillover effect from the stock market to exchange rate market over the turbulent period.

In general, our study finds no evidence of a long-run equilibrium relationship but indicates an only uni-directional, from exchange rate to stock prices, causal relationship between two considered variables in the short-run. A certain degree of "predictive ability" of these variables to each other has also been identified. Our findings are generally consistent with the previous studies such as Granger *et al*. (2000), Nieh and Lee (2001), and Hatemi-J and Roca (2005). Our study in general supports the traditional approach, suggesting that changes in exchange rates lead changes of stock price in Hong Kong. The empirical evidence of this study also supports the view of Morley and Pentecost (2000), who claim that stock price index and exchange rate levels show a common cycle which is fundamentally short-run in nature.

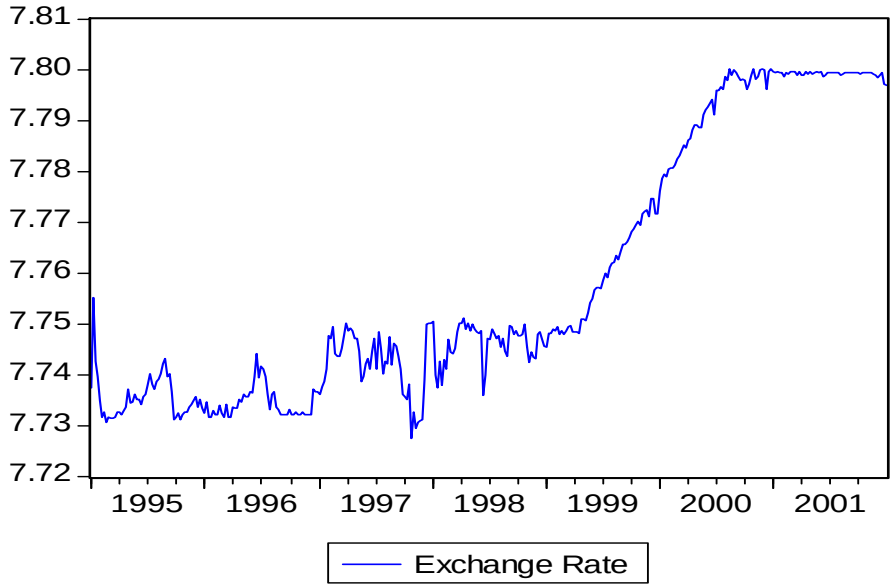
Figures:

Figure 6.1 Time Series of Hong Kong Stock Price Index (Hang Seng Index) over the Period 1995-2001



Source: Datastream

Figure 6.2 Time Series of Hong Kong Exchange Rate (Hong Kong $/US $) over the Period 1995-2001



Source: Datastream

Tables:

Table 6.1 Review of Selected Empirical Studies

Author(s)	Country(s)/ Period (s) of study	Hypothesis Tested	Methodology	Results
Aggarwal (1981)	United States 1974-1978	Investigates the relationship between U.S. stock market indexes and a trade-weighted value of the dollar	Correlation analysis	Stock prices and exchange rates are positively correlated
Soenen and Hennigar (1988)	United States 1980-1986	Analyse the relationship between exchange rates and stock prices: from the US experience between 1980 and 1986	Correlation analysis	There is a significantly negative relationship between stock prices and exchange rates.
Roll (1992)	24 countries 1988-1991	Examines the industrial and the comparative behaviour of international stock market indices	Cross-countries regression model	US dollar is positively related to stock market returns
Abdalla and Murinde (1997)	India, Korea, Pakistan and the Philippines 1985-1994	Establish the causal linkages between leading prices in the foreign exchange market and the stock market	Granger causality tests	Unidirectional causality from exchange rates to stock prices in all sample countries except the Philippines.

(Continued) Table 6.1 Review of Selected Empirical Studies

Author(s)	Country(s)/Period(s) of study	Hypothesis Tested	Methodology	Results
Chow *et al*. (1997)	United States 1977-1989	Examine exchange-rate risk exposure of U.S. stock and bonds	VAR	No relationship for stock returns and real exchange rate returns. However, when the regression was carried out with longer horizons, a positive relationship between a strong dollar and stock returns can be found.
Ajayi *et al*. (1998)	Seven advanced markets from 1985-1991 and eight Asian emerging markets from 1987 to 1991	Examine the causal relationship between stock returns and changes in exchange rates	Pairwise Granger causality tests	Unidirectional causality between the stock and currency markets in all the advanced economies. No consistent causal relations are observed in the emerging economies
Granger *et al*. (2000)	Hong Kong, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Thailand and Taiwan 1983-1997	Determine the appropriate Granger relations between stock prices and exchange rates	Granger causality test in the bivariate VAR model	Data from South Korea were consistent with the traditional approach. Data for the Philippines were consistent with portfolio approach. Data form Hong Kong, Malaysia, Singapore, Thailand and Taiwan indicated strong feedback relations. Indonesia and Japan: No causal relationship.

(Continued) Table 6.1 Review of Selected Empirical Studies

Author(s)	Country(s)/Period(s) of study	Hypothesis Tested	Methodology	Results
Ibrahim (2000)	Malaysia 1979-1996	Explores the interactions between stock prices and exchange rates	Bivariate and multivariate cointegration and Granger causality tests	No long-run or cointegrating relationship between said variables in the bivariate models. There was cointegration between measures of exchange rate and stock prices when money supply (M2) and reserves were included.
Wu (2000)	Singapore In the 1990s	Explores the asymmetric effects of four different exchange rates on Singapore stock prices	Error correction modeling	Singapore currency appreciation against the US dollar and Malaysian ringgit and depreciation against Japanese yen and Indonesian rupiah lead to a long-run increase in stock prices in most of the selected periods in the 1990s. The influence of exchange rates on stock prices increased in a chronological order in the 1990s.
Nieh and Lee (2001)	Canada, France, Germany, Italy, Japan, UK and the US 1993-1996	Identify the dynamic relationship between stock prices and exchange rates	Engle-Granger Johansen's Cointegration tests Vector error correction model	No significant long-run relationship between said variables, ambiguous and significant short-run relationships can be found for these countries.

(Continued) Table 6.1 Review of Selected Empirical Studies

Author(s)	Country(s)/Period(s) of study	Hypothesis Tested	Methodology	Results
Muhammad and Rasheed (2002)	Pakistan, India, Bangladesh, and Sri- Lanka 1994-2000	Examine the long-run and short-run associations between stock prices and exchange rates	Cointegration, Vector error correction modeling technique and Granger causality tests	No short-run association between the said variables for all four countries. No long-run relationship between stock prices and exchange rates for Pakistan and India as well. However, for Bangladesh and Sri-Lanka there appear to be a bi-directional causality between said variables
Broome and Morley (2003)	Thailand, Malaysia, Korea, Indonesia and the Philippines 1996-1999	Assess the effectiveness of stock prices as a leading indicator of the East Asian currency crisis	Granger causality tests in a currency crisis model	Domestic stock price, Hong Kong stock price and particularly U.S. prices are significant leading indicators of the crisis. Causality tests suggest evidence of bi-causality between the stock markets and foreign exchange markets.
Kim (2003)	United States 1974-1998	Investigates the long-run relationships among stock price, industrial production, real exchange rate, interest rate and inflation	Error-correction models Variance decomposition analysis	S&P 500 index is positively related to the industrial production but negatively to the real exchange rate, interest rate and inflation.

(Continued) Table 6.1 Review of Selected Empirical Studies

Author(s)	Country(s)/Period(s) of study	Hypothesis Tested	Methodology	Results
Stavárek (2005)	EU and USA 1969-2003	Tests long-run and short-run dynamics between stock prices and exchange rates	Granger causality test	Neither the intensity nor direction of causal relations are the same in the developed economies and the new EU-member countries It is not possible to register any long-run or short-run relation between stock prices and exchange rates
Mishra (2004)	India 1992-2002	Examines whether stock market and foreign exchange markets are related to each other or not	Granger's Causality test and Vector Auto Regression technique	No Granger's causality between the exchange rate return and stock return
Hatemi-J and Roca (2005)	Malaysia, Indonesia, Philippines and Thailand Jan 1997-Dec 1997	Identify the causal relationship between exchange rates and equity market prices	Bootstrap causality tests with leveraged adjustments	Exchange rates granger caused stock prices in Indonesia and Thailand prior to the crisis, while the reverse was true in Malaysia No significant link between the variables during the crisis

(Continued) Table 6.1 Review of Selected Empirical Studies

Author(s)	Country(s)/Period(s) of study	Hypothesis Tested	Methodology	Results
Phylaktis and Ravazzolo (2005)	Pacific Basin countries 1980-1998	Establish the long-run and short-run dynamics between stock prices and exchange rates	Cointegration and multivariate Granger causality tests	Stock and foreign exchange markets are positively related and that the US stock market acts as a conduit for these links
Yau and Nieh (2006)	Taiwan and Japan 1991-2005	Explore the short-term and long-term interrelationships among the stock prices of Taiwan and Japan and the NTD/Yen exchange rate	Cointegration test and Granger causality test	The portfolio approach is supported for the short-term and the traditional approach is more plausible for the long-term in the Taiwanese financial market, whereas the portfolio approach is not suitable for the Japanese stock market. There is no long-term relation between NTD/Yen exchange rate and the stock prices of Taiwan and Japan.
Tabak (2006)	Brazil 1994-2002	Examines the dynamic relationship between stock prices and exchange rates	Unit root and cointegration tests that allow endogeneous breaks, linear and nonlinear causality tests	No long-run relationship but linear Granger causality from stock prices to exchange rates, in line with the portfolio approach Nonlinear Granger causality from exchange rates to stock prices, in line with the traditional approach

Table 6.2 Descriptive Statistics of Weekly Changes of Stock Price Index and Exchange Rate

Descriptive Statistics	Stock price index	Exchange rate (Hong Kong dollar/US dollar)
Mean	0.006	2.10E-05
Median	0.006	0.000
Maximum	0.920	0.002
Minimum	-1.019	-0.001
Std. Dev.	0.097	0.000
Skewness	0.367	0.142
Kurtosis	65.367	13.658
Jarque-Bera	59164.5***	1728.9***
Probability	0.000	0.000
LB (10)	19.43***	103.04***

Note: *** indicates rejection of null hypothesis at the 1% significance level.

Table 6.3 Results of Unit Root Tests without Structural Break

Panel A. Unit root tests at Level

Variables	ADF		PP		KPSS	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
EX	0.001	-3.301**	-0.067	-2.287	2.086***	0.467***
SR	-1.354	-1.447	-1.389	-1.664	2.138***	0.189**

Panel B. Unit root tests at First difference

Variables	ADF		PP		KPSS	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
EX	-24.652***	-24.728***	-24.656***	-24.889***	0.209	0.100
SR	-10.357***	-10.387***	-29.813***	-29.869***	0.138	0.101

Notes: EX denotes the exchange rate while SR denotes the stock returns. ***, **, and * indicate rejection of null hypothesis at the 1%, 5% and 10% level, respectively. For ADF test, the lag length is based on SIC. For PP and KPSS tests, the bandwidth is determined by Newey-West using Bartlett kernel.

Table 6.4 Results of Unit Roots with Endogenous Break

Variables	t Statistic	Structural break date
SR	-4.43	Aug 24th, 1998
EX	-4.68	Jan 3rd, 2000

Notes: EX denotes the exchange rate while SR denotes the stock returns. Critical values for Zivot and Andrews test are -5.57 and -5.08 at the 1 percent and 5 percent levels of significance, respectively.

Table 6.5 Results of Engle-Granger Cointegration Tests

	ADF Statistics	
y_{1t} is regressed on y_{2t}	Constant	Constant and Trend
Whole period	-2.802 (-2.869)	-2.421 (-3.422)
Crisis period	-1.622 (-2.931)	-2.134 (-3.518)
	ADF Statistics	
y_{2t} is regressed on y_{1t}	Constant	Constant and Trend
Whole period	-2.266 (-2.869)	-2.777 (-3.422)
Crisis period	-2.116 (-2.931)	-2.425 (-3.518)

Notes: y_{1t} denotes the stock price while y_{2t} denotes the exchange rate. The value in parentheses shows the 5 % critical value due to MacKinnon critical value.

Table 6.6 Results of Johansen Cointegration Test in the Whole Sample Period

Panel A. Trace test

Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	0.05 Critical value	Prob.**
None	0.026	10.697	15.495	0.231
At most 1	0.003	1.206	3.841	0.272

Notes:

1. Trace test indicates no cointegration at the 0.05 level.
2. **MacKinnon-Haug-Michelis (1999) p-values.

Panel B. Maximum Eigenvalue test

Hypothesized No. of CE(s)	Eigenvalue	Maximum Eigenvalue statistic	0.05 Critical value	Prob.**
None	0.026	9.490	14.265	0.248
At most 1	0.003	1.206	3.841	0.272

Notes:

1. Maximum-eigenvalue test indicates no cointegration at the 0.05 level.
2. **MacKinnon-Haug-Michelis (1999) p-values.

Table 6.7 Results of Johansen Cointegration Test in the Crisis Period

Panel A. Trace test

Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	0.05 Critical value	Prob.**
None	0.217	14.035	15.495	0.082
At most 1	0.071	3.256	3.841	0.071

Notes:

1. Trace test indicates no cointegration at the 0.05 level.
2. **MacKinnon-Haug-Michelis (1999) p-values.

Panel B. Maximum Eigenvalue test

Hypothesized No. of CE(s)	Eigenvalue	Maximum Eigenvalue statistic	0.05 Critical value	Prob.**
None	0.217	10.779	14.265	0.166
At most 1	0.071	3.256	3.841	0.071

Notes:

1. Maximum-eigenvalue test indicates no cointegration at the 0.05 level.
2. **MacKinnon-Haug-Michelis (1999) p-values.

Table 6.8 Pairwise Granger Causality Tests between Stock Price and Exchange Rate (Whole Sample Period)

Null hypothesis:	F-Statistic	Probability	Lags
E does not Granger Cause S	3.74	0.05	1
S does not Granger Cause E	2.77	0.09	
E does not Granger Cause S	**3.89**	**0.02**	**2**
S does not Granger Cause E	**0.96**	**0.38**	
E does not Granger Cause S	3.18	0.02	3
S does not Granger Cause E	0.91	0.44	
E does not Granger Cause S	2.73	0.02	4
S does not Granger Cause E	0.57	0.68	

Notes: E denotes the exchange rate while S denotes the stock returns. The results in bold indicate the optimal lag length (2 lags) selected by SIC.

Table 6.9 Pairwise Granger Causality Tests between Stock Price and Exchange Rate (Crisis Period)

Null hypothesis:	F-Statistic	Probability	Lags
E does not Granger Cause S	1.14	0.29	1
S does not Granger Cause E	1.97	0.17	
E does not Granger Cause S	**0.59**	**0.55**	**2**
S does not Granger Cause E	**1.12**	**0.34**	
E does not Granger Cause S	0.41	0.75	3
S does not Granger Cause E	1.37	0.27	
E does not Granger Cause S	0.40	0.81	4
S does not Granger Cause E	0.99	0.42	

Notes: E denotes the exchange rate while S denotes the stock returns. The results in bold indicate the optimal lag length (2 lags) selected by SIC.

Table 6.10 Estimation Results of Impulse Response Function

Panel A: response of exchange rates from one-unit shock in stock price changes		
Period (weeks)	Full sample	Crisis sample
1	0.0000	0.0001
2	0.0000	0.0001
3	0.0000	0.0001
4	0.0000	0.0000
5	0.0000	0.0000
6	0.0000	0.0000
7	0.0000	0.0000
8	0.0000	0.0000
9	0.0000	0.0000
10	0.0000	0.0000

Panel B: response of stock prices from one-unit shock in exchange rate changes		
Period (weeks)	Full sample	Crisis sample
1	-0.0123***	0.0192*
2	-0.0166***	-0.0180
3	0.0007	0.0059
4	0.0006	-0.0035
5	-0.0038	0.0014
6	0.0018	-0.0006
7	-0.0010	0.0002
8	-0.0001	-0.0001
9	0.0003	0.0000
10	-0.0003	0.0000

Notes: ***=1% significance level; **=5% significance level; *=10% significance level.

Table 6.11 Comparison of Predictable Portion of Stock Price Changes with and without Exchange Rate Variable

Adjust R-Squares	Whole Sample Period	Crisis Period
$\overline{R}_1^2$	0.2169	0.0384
$\overline{R}_2^2$	0.2293	0.0517
$\overline{R}_2^2$ vs. $\overline{R}_1^2$	5.72%	34.64%

Notes:

1. The estimated equations are:

$\Delta S_t = C_t + \Delta S_{t-1} + \Delta S_{t-2} + v_{1t}$ (a) *Vs.*

$\Delta S_t = C_t + \Delta S_{t-1} + \Delta S_{t-2} + \Delta E_{t-1} + \Delta E_{t-2} + v_{2t}$ (b)

$\overline{R}_1^2$ is obtained from the regression (a) while $\overline{R}_2^2$ is obtained from the regression (b)

2. Estimated method: Ordinary Least Squares (OLS)

Table 6.12 Comparison of Predictable Portion of Exchange Rate Changes with and without Stock Price Variable

Adjust R-Squares	Whole Sample Period	Crisis Period
$\overline{R}_1^2$	0.0083	0.0195
$\overline{R}_2^2$	0.0080	0.0250
$\overline{R}_2^2$ vs. $\overline{R}_1^2$	-3.61%	28.21%

Notes:

1. The Estimated Equations are:

$\Delta E_t = C_t + \Delta E_{t-1} + \Delta E_{t-2} + v_{1t}$ (c) *Vs.*

$\Delta E_t = C_t + \Delta E_{t-1} + \Delta E_{t-2} + \Delta S_{t-1} + \Delta S_{t-2} + v_{2t}$ (d)

$\overline{R}_1^2$ is obtained from the regression (c) while $\overline{R}_2^2$ is obtained from the regression (d)

2. Estimated Method: Ordinary Least Squares (OLS)

Chapter 7

General Conclusions and Future Work

7.1 Contributions

This thesis provides a better understanding of the exchange rate regime and exchange rate performance in East Asia over the last few years. It conducts a comprehensive and thorough study from different angles and aspects regarding the exchange rate regime, exchange rate behaviour and related monetary policy in East Asia. Contributing to the existing literature and current debates, this thesis enriches the current literature from the following three perspectives:

First, considerable interests and fresh theoretical arguments have been embedded within this thesis in the following aspects: i) we have clarified the nature and characteristics of exchange rate regime before and after the 1997/98 financial crisis; ii) we have investigated the progress of regional exchange rate coordination; iii) we have explored the effect of regime choice on the independence of monetary policy; iv) we have examined the possible exchange rate volatility transmission from a designated economy to the other regional markets in both crisis and tranquil periods; v) we have attempted to measure foreign exchange market pressure and countries susceptibility to currency crisis; vi) we have assessed the reaction of monetary policy to exchange market pressure under more flexible exchange rate and inflation-targeting regime in the post-crisis period; and vii) we have analysed the short-run and long-run relationships between stock prices and exchange rates in the case of Hong Kong market where a free flow of trade and capital and currency board arrangement have been prevailed.

The second contribution concerns the new patterns of the exchange rate regime and performance, which differ from those in the 1980s and 1990s. These patterns have been identified by a more recent sample period concerned in this thesis. The whole sample period involved in this study spans from 1990 to recent years (up to 2005), which fully

captures the transition of exchange rate regimes in the context of 1997/98 financial crisis as well as the most recent trend and developments of exchange rate markets in East Asia. Also, the choice of the sample period depends on the availability of data and on the possibility of contrasting alternative exchange rate regimes. Hence, the performance of exchange rate regime and exchange rate behaviour in the pre-crisis and post-crisis periods can be comprehensively compared and assessed, and our findings on recent trend of exchange rate behaviour and management, in particular, provide comparisons to the existing related studies.

Third, guided by established theories, various forms of evidence and empirical techniques have been extensively applied and fully evaluated in this research, including the Ordinary Least Square (OLS), Generalised Method of Movements (GMM), Generalised Autoregressive Conditional Heteroskedasticity (GARCH), Exponential GARCH (EGARCH), Vector Autoregressions (VAR) and their Impulse Response Functions (IRF), Unit Root Tests, Cointegration, and Granger Causality Tests. Our study using the above listed techniques comprehensively covers the different angles viewing the economic phenomenon before, during, and after the 1997/98 East Asian financial crises. Hence, the analysis provided in this thesis can assist us to have a complete understanding in what could be learned from the crisis, and how to evaluate the exchange rate policies, behaviours, and performances. Although this thesis is dedicated to an analysis of East Asian countries, the methodologies covered in this research could be easily extended to other emerging countries. The main findings and key ideas drawn from this research have important policy implications detailed in the next section.

7.2 Main Findings, Key Ideas and Policy Implications

This section gives a brief summary of the main findings, key ideas, and the important policy implications drawn from this research.

Chapter 2 investigates the performance and characteristics of exchange rate regimes in East Asia, before and after the 1997/98 financial crisis from three perspectives: First, it answers the question that how much influence the international anchor currencies, such as U.S. dollar, Japanese yen and Euro/Deutsche mark, had on the local East Asian currencies before and after the crisis. Our findings confirm the important role played by exchange rate regime in influencing the movement of exchange rate. The dominant role of the U.S. dollar played in emerging East Asian currencies until the 1997/98 currency crisis, has been confirmed. However, the increased weights of Japanese yen and Euro have been identified in some East Asian currencies after the crisis. Second, Chapter 2 answers the question that whether the flexibility of exchange rate regime increased after the crisis, compared to the pre-crisis period. Our findings imply that the flexibility of exchange rate regime has indeed increased in most East Asian countries/regions which officially adopted the floating regime in the post-crisis period. This is consistent with the existing literature, while our study involves markedly more recent data for analysis. Third, Chapter 2 addresses the question: has the regional coordination of exchange rate management strengthened after the crisis? Our results show little evidence on the strengthened regional coordination of the exchange rate management in the post-crisis period.

In general, our study suggests that exchange rate policy plays an important role in influencing the movements of exchange rates. Despite more flexibility can be observed after experiencing transitional regime, the managed floating regimes rather than the free floating ones have been dominated for many emerging East Asian economies. These economies recently move within a given band with their centre targeted at a basket of currencies, including the U.S. dollar, the Japanese yen and the Euro, given the diversified trade and foreign direct investment relationships with the Unite States, Japan and the European Union. Our study further supports the argument of less possibility of an optimal currency area (OCA) for East Asian region. This is in line with previous studies, which assess the criteria of OCA, while our study measures the regional coordination of exchange rate management. The financial crisis promoted economists and policy makers to realise the importance of regional financial cooperation in East

Asia. There is a growing perception that stronger and more effective regional financial coordination could help prevent and manage the crises. Since the emerging East Asian economies heavily depend on trade and investment, exchange rate stability, in particular, is desirable for the promotion of trade and investment and economic development. The intra-regional exchange rate stability could also beneficial for East Asian economies that have increasingly integrated with one another. Nevertheless, little progress has been made in the area of exchange rate coordination or stabilisation after the crisis and regional financial cooperation in East Asian is still in its infancy. One of the reasons for the lack of progress might be due to the fact that there is no international rule or best practice with regard to exchange rate regimes. The prevailing "two-corner solution" view highlights exclusively on the crisis prevention. However, countries can appropriately pursue objectives such as growth, trade, investment promotion through exchange rate policy. Therefore, given the desirability of stable exchange rates in East Asia, a framework for exchange rate and monetary policy coordination will have to be developed. East Asian countries should make strong efforts to promote regional monetary and financial cooperation. The firm political commitment to exchange rate decisions, at the same time, would be crucial to ensuring the form of a regional monetary and exchange rate arrangement.

Chapter 3 considers the implications of exchange rate regimes on the independence of monetary policy. From the perspective of monetary independence, this chapter conducts an assessment of the competing claims on the relative merits of alternative exchange rate arrangements. First, this chapter answers the question that whether the adoption of new exchange regime in the post-crisis period affected monetary autonomy. It also addresses the question that how the local interest rates reacted to international interest rates (U.S. interest rates) in the pre- and post-crisis periods. Our findings show that the sensitivity of local interest rates to U.S. interest rates has declined in many East Asian countries, which adopted floating exchange rate regimes in the post-crisis period. In addition, a higher long-run adjustment was observed under a pegged regime, while lower interest rates adjustment was witnessed under a floating regime. Therefore, these findings confirm that countries with more floating exchange rate regimes have a higher

degree of independence in monetary policy than those with an intermediate regime, and far more than those with a pegged regime. Our work also highlights that the choice of the exchange rate regime is a critical factor of the autonomy of monetary policy: the floating exchange rate regime offers East Asian countries a relatively high degree of monetary independence, compared to the intermediate and pegged regimes.

Our findings confirm the effectiveness of the traditional doctrine of impossible trinity or trilemma. With the development of globalisation, broad-ranging capital controls will gradually disappear and East Asian countries will eventually continue to move towards full financial integration. This will leave East Asian with two options: that is, either to achieve both exchange rate stability and financial integration sacrificing monetary independence or aim for monetary independence and financial integration. Therefore, the choice of the exchange rate regime in the process of capital account liberalisation can be framed in terms of trade-off between credibility and flexibility, as well as the trade-off between monetary independence and exchange rate stability.

Chapter 4 examines exchange rate volatility and its contagion/spillover effect from the evidence of East Asia. It tackles the following question: did volatility of one exchange rate market transmit to others in some way? If so, to what extent this volatility contagion/spillover effect worked during the crisis or tranquil period? Our findings imply that the volatility shocks are persistent in the foreign exchange markets under the time period involved in this study. It is also in general consistent with earlier research in the area of financial market contagion. The empirical finding confirms the evidence of volatility contagion from Korea won to other regional currencies during the financial collapse. Hong Kong dollar also generates volatility spillover effect to other regional currencies over the tranquil period. The results imply a certain degree of interdependence among East Asian exchange rate markets, which may signal tight trade and financial linkages and macroeconomic similarities in East Asian economies.

A thorough understanding of the dynamic properties of cross-market volatility transmission is crucial for evaluating the level of integration between markets. From a

broader perspective, closer integration with Korea and Hong Kong would represent closer co-movements of economic fundamentals and may facilitate the transmission of shocks between Korea or Hong Kong and other economies in the region. Our study of volatility contagion/spillovers provides useful insights into how information is transmitted from Korea or Hong Kong foreign exchange market to other Asian exchange markets. These findings are helpful for policy makers to design appropriate polices in case an adverse shock is observed in Korea and Hong Kong foreign exchange markets where contagion/spillover effect is empirically evident.

Chapter 5 studies the exchange rate and monetary policy of five East Asian countries from the perspective of exchange market pressure (EMP). First, it addresses the question that how to measure the tensions (pressure) on the foreign exchange market, and how to estimate countries susceptibility to crisis in East Asia. By constructing a model-independent measurement of EMP index, our study not only confirms the severe currency depreciation during the crisis period, but also fully captures the crisis incidence episodes as well as the dates of the speculative attack on currencies. Nevertheless, the sensitivity analysis on the basis of another EMP index reveals that the number and incidences of crises episodes are sensitive to the arbitrary choice of EMP construction. Second, this chapter addresses the following questions: What is the relationship between EMP and monetary policy, especially for the post-crisis East Asia? How did monetary policy affect EMP? What was the reaction of monetary policy to EMP? Our study yields several findings: As for the effect of monetary policy on EMP, shocks to domestic credit have either positive or negative effect on EMP, depending on the country under study. The positive response supports evidence by Goldfajn and Gupta (1999) that contractionary monetary policy helps support the exchange rate, while the negative response possibly implies the occurrence of monetary transmission. The response of EMP to the monetary policy shocks also varies across different sample countries. As a policy reaction function, in most cases, EMP shocks affect domestic credit growth positively. This implies that the authorities of the sample countries respond, in general, to increase in EMP by providing additional liquidity to the banking system rather than contracting the money supply. We also find shocks to EMP in

general affect interest rate differential positively for these countries. This positive impact reflects the fact that interest rates have both market-determined and policy-determined effects. Moreover, our study confirms the ambiguous nature of the link between the domestic credit growth and interest rate differential. The innovations to domestic credit affect the interest rate differential through either standard liquidity or Fisher channels.

The mixed findings generated from this study, however, are broadly consistent with existing literature with inconclusive results regarding the mutual reactions between EMP and monetary policy. Our study in general reveals that measuring exchange market pressure should jointly consider the exchange rate movements and reserves rather than only focusing on either of them. This is in particular appropriate for economies which are neither perfectly fixed nor freely floating.

Chapter 6 provides a particularly interesting investigation in the relationship between stock prices and exchange rates from the representative case of Hong Kong during 1995-2001. It not only explores the dynamic long-run and short-run relationships between stock prices and exchange rates, but also examines the direction of causality between these two variables. In general, the empirical findings show no evidence of a long-run equilibrium relationship between these two financial variables in Hong Kong. Instead, a uni-directional, from exchange rate to stock prices, causal relationship between the two considered variables has been identified in short-run. This finding could imply that the transmission of information between the two asset markets is inefficient over the full sample period. Hence, stocks could be used as a hedge for foreign exchange investment during this period. Note that the independent relationship of both considered variables has been found over the crisis period. This may indicate that the foreign exchange and stock markets become more efficient during the crisis period, and one market cannot also serve as a base for policy intervention for stabilising the other market during this period. Moreover, a certain degree of "predictive ability" of these variables to each other has also been found. The empirical evidence in general supports the traditional approach, suggesting that exchange rates can granger cause or

lead stock price changes. Our findings establish the links between exchange rates and stock prices in Hong Kong and have important implications for investors and multinational corporations to make investment decisions. Especially, the policy makers can relay on this information to predict the behaviour of market and take effective preventive actions before the spread of a crisis.

Summing up this thesis, the subtopics addressed in this research fully evaluate the exchange rate regime and exchange rate performance in East Asia. The behaviours of Asian currencies, especially their recent trends, have been embedded in this research. Findings of this research generate important implications for the East Asian exchange rate management and policy.

7.3 Future Work

A number of issues that we do not consider in this thesis are worth being pursued for further research. This section discusses several directions of future work related to each chapter of thesis:

Chapter 2 provides an empirical investigation on the exchange rate arrangements on the basis of the observed exchange rate before and after the 1997/98 financial crisis. The regional coordination in the post-crisis exchange rate management has been preliminarily discussed as an aspect of assessing the possibility of an optimal currency area in East Asia. Nevertheless, the feasibility of optimal currency area deserves further comprehensive research. Exploring the factors such as intra-regional trading pattern, factor mobility as well as the monetary transmission mechanism would be interesting for the future study in this field.

The analysis in Chapter 3 implies a significant role for the exchange rate regime in determining the importance of base interest rate to the local interest rate. In fact, there are other factors might affect the estimation of the sensitivity of the local interest rate to

foreign interest rate. For example, the level of industrialisation seems to have a considerable impact on the correlation between local and base rates; the worldwide or regional shocks could also cause a certain correlation between these two interest rates. In addition, there is one factor that may affect the relationship between U.S. and domestic interest rates: volatility in international financial markets or the international risk premium. Since this research aims to highlight the implications of exchange rate regime choice, the basic model described in Chapter 3 is adequate for the purpose of testing the impact of exchange rate regime on the independence of monetary policy. Although a formal testing on other factors that may influence the correlation between local and base interest rates is beyond the scope of this work, in future research, incorporating a wider range of control variables in the current model might provide an interesting point of comparison to the present study.

The study in Chapter 4 focuses on the exchange rate volatility contagion/spillover effect from Hong Kong and Korea to other East Asian economies. It would be interesting to extend the current model to a multivariate GARCH framework. Another possible extension of this study is to replicate the same methodology for stock market and examine the inter-market linkages. These extensions require a more complicated methodological approach and will be a possible future extension of this Chapter.

The empirical findings of Chapter 5 provide evidence on the diversity of the interactions between monetary policy and EMP of the five studied countries after 1997-1998 crises. Areas for future research may include an alternative measure to EMP and a more detailed model of the possible channels of monetary policy to examine the effectiveness of the traditional theory. For instance, we may incorporate the output growth variable to the current model. The underlying idea is that the literature about monetary transmission suggests some indirect effects and possible interactions between variables when the output growth is taken into account.

Chapter 6 deals with the statistical relations based on the Granger causality and impulse response (IR) analysis. Granger *et al*. (2000) point out the difficulty in interpretation of

some underlying fundamental economic relation based on the Granger causality. They further suggest that the results are likely to be generated from other structure relations such as through interest rate parity condition or IS-LM related polices. For instance, the recessionary signals or unfavourable shocks may lead a decrease in stock prices or a deprecation of exchange rates. In such circumstance, the causal relation between the stock prices and exchange rates will be generated from the relative efficiency of the stock market and foreign exchange market, and the Granger causality and IR approaches may not play an influencing role in generating the relation. Considering these, this research might be further improved by taking into account other factors or variables for which exchange rates and stock prices can be conintegrated in order to re-examine the causal relationship of both variables.

References:

Abdalla, I. and Murinde, V., (1997), "Exchange Rates and Stock Price Interactions in Emerging Financial Markets: Evidence on India, Korea, Pakistan and the Philippines", *Applied Financial Economics*, vol.7, issue1, pp. 25-35.

Aggarwal, R., (1981), "Exchange Rates and Stock Prices: A Study of the US Capital Markets under Floating Exchange Rates", *Akron Business and Economic Review*, vol. 12, pp. 7-12.

Aghion, P., Bacchetta, P., and Banerjee, A., (2001), "Currency Crises and Monetary Policy in An Economy with Credit Constraints", European Economic Review, vol. 45, issue 7, pp. 1121–1150.

Aguirre, M. and Saidi, R., (1998), "Evidence of Forward Discounts Determinants and Volatility Behavior", *Journal of Economic Studies,* vol. 25, issue 6, pp. 538-552.

Aguirre, M. and Saidi, R., (2000), "Volatility Behavior of Exchange Rate Future Contracts", *Atlantic Economic Journal*, vol. 28, issue 4, pp. 396-411.

Ahluwalia, P., (2000), "Discriminating Contagion: An Alternative Explanation of Contagious Currency Crises in Emerging Markets", IMF Working Paper WP/00/14.

Ajayi, R., Friedman, J. and Mehdian, S., (1998), "On the Relationship between Stock Returns and Exchange Rates: Tests of Granger Causality", *Global Finance Journal*, vol. 9, issue 2, pp. 241-251.

Ajayi, R. and Mougoue, M., (1996), "On the Dynamic Relation between Stock Prices and Exchange Rates", *Journal of Financial Research*, vol. 19, pp. 193-207.

Akaike, H., (1969), "Fitting Autoregressive Models for Prediction", Annals of the Institute of Statistics Mathematics, vol. 21, issue 1, pp. 243–247.

Alper, C. and Yilmaz, K., (2004), "Volatility and Contagion: Evidence from the Istanbul Stock Exchange", *Economic Systems*, vol. 28, No. 4, pp. 353-367.

Ariyoshi, A., Haberrneier, K., Laurens, B., Otker-Robe, I., Canales-Kriljenko, J. and Kirilenko, A., (2000), "Capital Controls: Country Experiences with Their Use and Liberalizations", IMF Occasional Paper 190, Washington, D.C.

Azman-Saini, W., Habibullah, M. and Azali, M., (2003), "Stock Price and Exchange Rate Dynamics: Evidence from Thailand", *Savings and Development*, vol. 27(3), pp. 245-258.

Azman-Saini, W., Habibullah, M., Law, S. and Dayang-Afizzah, A., (2006), "Stock Prices, Exchange Rates and Causality in Malaysia: A Note", MPRA Paper, No. 656, University Library of Munich, Germany.

Baak, S., (2001), "Japanese Yen and East-Asian Currencies: Before and After the Asian Financial Crisis", Working Paper No.7, International University of Japan.

Backus, D. and Driffill, J., (1985), "Rational Expectations and Policy Credibility Following a Change in Regime", *Review of Economic Studies*, vol. 52, issue 2, pp. 211-221.

Bahmani-Oskooee, M. and Domac, I., (1997), "Turkish Stock Prices and the Value of the Turkish Lira", *Canadian Journal of Development Studies,* vol. 18, pp. 139-150.

Bahmani-Oskooee, M. and Shiva, R., (1998), "A Method of Detecting Whether a Central Bank Engages in the Black Market for Foreign Exchange: Evidence from Iran", *Economics Letters*, vol.60, issue 1, pp. 97-103.

Bahmani-Oskooee, M. and Sohrabian, A., (1992), "Stock Prices and the Effective Exchange Rate of the Dollar", *Applied Economics*, vol. 24, issue 4, pp. 459-464.

Baig, T., (2001), "Characterizing Exchange Rate Regimes in Post-Crisis East Asia", IMF Working Paper No.01/152.

Baig, T. and Goldfajn, I., (1998), "Monetary Policy in the Aftermath of Currency Crisis: The Case of Asia", IMF Working Paper 98/170.

Baig, T. and Goldfajn, I., (1999), "Financial Market Contagion in the Asian Crisis", IMF Staff Papers vol. 46, issue 2, pp. 167–195.

Baillie, R. and Bollerslev, T., (1989), "The Message in Daily Exchange Rates: A Conditional Variance Tale", *Journal of Business and Economic Statistics*, vol. 7, issue 3, pp. 297-305.

Banerjee, A., Dolado, J., Galbraith, J, and Hendry, D., (1993), "Co-integration, Error Correction, and the Econometric Analysis of Non-Stationary Data", Oxford University Press, New York.

Bartov, E. and Bodnar, G., (1994), "Firm Valuation, Earnings Expectations, and the Exchange Rate Exposure Effect", *Journal of Finance*, vol. 49, issue 5. pp. 1755-1785.

Basurto, G. and Ghosh, A., (2000), "The Interest Rate-Exchange Rate Nexus in the Asian Crisis Countries", IMF Working Paper No. 00/19.

Bayoumi T., (1994), "A Formal Model of Optimum Currency Areas," IMF Staff Papers, vol.41, issues, 4, pp.537-554.

Bayoumi, T. and Eichengreen, B., (1998), "Exchange Rate Volatility and Intervention: Implications of the Theory of Optimum Currency Areas", *Journal of International Economics*, Elsevier, vol. 45, issue 2, pp. 191-209.

Bayoumi, T., Eichengreen, B. and Mauro, P., (2000), "On Regional Monetary Arrangements for ASEAN", *Journal of the Japanese and International Economies*, vol. 14(2), pp.121-148.

Bertoli, S., Gallo, G. and Ricchiuti, G., (2006), "Exchange Market Pressure: Some Caveats in Empirical Applications", University of Florence, Econometrics Working Papers Archive No. wp2006_17.

Bénassy-Quéré, A., (1999a), "Optimal Pegs for Asian Currencies", *Journal of the Japanese and International Economies*, vol.13, pp. 44-60.

Bénassy-Quéré, A., (1999b), "Exchange Rate Regimes and Policies: An Empirical Analysis", in Collignon, S., Pisani-Ferry, J. and Park, Y. (eds.), "Exchange Rate Policies in Emerging Asian Countries", Routledge: London, pp. 40-64.

Bernanke, B. and Blinder, A., (1992), "The Federal Funds Rate and the Channels of Monetary Transmission", *American Economic Review*, vol.82, pp. 901-921.

Black, F., (1976), "Studies in stock price volatility changes", Proceedings of the 1976 Business Meeting of the Business and Economics Statistics Section, American Statistical Association, pp. 177-181.

Bleaney, M. and Francisco, M., (2002), "The Choice of Exchange Rate Regime: How Valid is the Binary Model?", CREDIT Research Paper, No. 05/02.

Bleaney, M. and Francisco, M., (2005), "Exchange Rate Regimes and Inflation: Only Hard Pegs Make a Difference", *Canadian Journal of Economics*, vol. 38, No. 4, pp. 1453-1471.

Bodnar, G. and Gentry, W., (1993), "Exchange Rate Exposure and Industry Characteristics: Evidence from Canada, Japan and the USA", *Journal of International Money and Finance*, vol. 12, issue 1, pp. 29-45.

Bollerslev, T., (1986), "Generalised Autoregressive Conditional Heteroskedasticity", *Journal of Econometrics,* vol.31, issue 3, pp. 307–327.

Bollerslev, T., (1987), "A Conditionally Heteroskedastic Time Series Model for Speculative Prices and Rates of Return", *Review of Economics and Statistics*, vol. 69, issue 3, pp. 542-547.

Bollerslev, T., (1990), "Modelling the Coherence in Short-Run Nominal Exchange Rates: A Multivariate Generalised ARCH Model", *Review of Economics and Statistics,* vol. 72, issue 3, pp. 498–505.

Bollerslev, T., Chou, R. and Kroner, K., (1992), "ARCH Modeling in Finance: A Review of the Theory and Empirical Evidence", *Journal of Econometrics,* vol. 52, issue 1-2, pp. 5–59.

Bollerslev, T., Engle, R. and Nelson, D., (1994), "ARCH Models", Handbook of Econometrics, vol. 4, Chapter 49.

Bollerslev, T. and Wooldridge, J., (1992), "Quasi-Maximum Likelihood Estimation and Inference in Dynamic Models with Time-Varying Covariances", *Econometric Reviews*, vol. 11, issue 2, pp. 143-172.

Boorman, J., Lane, T., Schulze-Ghattas, M., Bulir, A., Ghosh, A., Hamann, J., Mourmouras, A., and Phillips, S., (2000), "Managing financial crises: The experience in East Asia", IMF Working Paper, WP/00/107.

Bordo, M., Christl, J., Just, C. and James, H., (2004), "Exchange Rate Regimes Past, Present and Future", Oesterreichische Nationalbank Working Papers, No.92.

Borensztein, E., Zettelmeyer, J. and Philippon, T., (2001), "Monetary Independence in Emerging Markets: Does the Exchange Rate Regime Make a Difference?", IMF Working Paper No. 01/1.

Branson, W., (1983), "Macroeconomic Determinants of Real Exchange Rate Risk", in Herring, R. (eds.), "Managing Foreign Exchange Rate Risk", Cambridge University Press, Cambridge, MA.

Branson, W. and Henderson, D., (1985), "The Specification and Influence of Assets Markets", in Jones, R. and Kenen, P. (eds.), "Handbook of International Economics", Elsevier, vol. 2, pp. 179-201, Amsterdam.

Broda, C., (2004), "Terms of Trade and Exchange Rate Regimes in Developing Countries", *Journal of International Economics,* vol.63, issue 1, pp. 31-58.

Broome, S. and Morley, B., (2003), "Stock Prices as a Leading Indicator of the East Asian Financial Crisis", Economics, Finance and Accounting Department Working Paper Series, No. n1311103.

Brown, R., Durbin, J. and Evans, J., (1975), "Techniques for Testing the Constancy of Regression Relationships Over Time", *Journal of the Royal Statistical Society*, Series B, vol. 37, No. 2, pp. 149-192.

Brown S. and Warner, J., (1985), "Using Daily Stock Returns: The Case of Event Studies", *Journal of Financial Economics,* vol.14, issue 1, pp. 3-31.

Buiter, W., (1995), "Macroeconomic Policy during a Transition to Monetary Union," Centre for Economic Policy Research, No. 1222.

Buiter, W., Corsetti, G. and Pesenti, P., (1998), "Financial Markets and European Monetary Cooperation: The Lessons of the 1992-93 Exchange Rate Mechanism Crisis", Cambridge: Cambridge University Press.

Burns, P., (2005), "Multivariate GARCH with Only Univariate Estimation", Working Papers Section of the Burns Statistics.

Calvo, G., and Mendoza, E., (1996), "Mexico's Balance-of-Payments Crisis: A Chronicle of a Death Foretold", *Journal of International Economics,* vol. 41, pp. 235–264.

Calvo, S. and Reinhart, C., (1996), "Capital Flows to Latin America: Is There Evidence of Contagion Effects?", Policy Research Working Paper Series 1619, The World Bank.

Calvo, G. and Reinhart, C., (2002), "Fear of Floating", *Quarterly Journal of Economics*, vol. 117, issue 2, pp. 379-408.

Cavoli, T. and Rajan, R., (2003), "Designing Appropriate Exchange Rate Regimes for East Asia: Inflation Targeting and Monetary Policy Rules", Centre for International Economic Studies, Discussion Paper, No. 0309.

Cavoli, T. and Rajan, R., (2005), "Have Exchange Rate Regimes in Asia Become More Flexible Post Crisis? Re-visiting the Evidence", SCAPE Policy Research Working Paper Series 0519, Department of Economics, National University of Singapore.

Caporale, G., and Pittis, N., (1998), "Cointegration and Predictability of Asset Prices", *Journal of International Money and Finance,* vol. 17, No.3, pp. 441-453.

Chan, K., Chan, Y. and Fong, W., (2004), "Free Float and Market Liquidity: Evidence from Hong Kong Government's Intervention", *Journal of Financial Research*, vol. 27,

pp. 179-197.

Chang, R. and Velasco, A., (1998), "Financial Crises in Emerging Markets: A Canonical Model", Working Paper 98-10, Federal Reserve Bank of Atlanta, July.

Cho, D. and West, K., (2001), "Interest Rates and Exchange Rates in the Korean, Philippine, and Thai Exchange Rate Crises", Paper prepared for the National Bureau of Economic Research Conference on Management of Currency Crises.

Chou, R., Ng, V. and Pi, L., (1994), "Cointegration of International Stock Market Indices", IMF Working Paper 94/94.

Chow, E., Lee, W. and Solt, M., (1997), "The Exchange Rate Risk Exposure of Asset Returns", *Journal of Business*, vol. 70, issue 1, pp. 105-123.

Christie, A., (1982), "The stochastic behaviour of common stock variances: value, leverage and interest rates", *Journal of Financial Economics*, vol.10, pp. 407-432.

Christl, J., (2006), "Regional Currency Arrangements: Insights from Europe", *International Economics and Economic Policy*, vol. 3, No. 3-4, pp. 209-219.

Cole, H. and Kehoe, T., (1996), "A Self-Fulfilling Model of Mexico's 1994-1995 Debt Crisis", *Journal of International Economics,* vol.41,issues 3, No.4, pp. 309-330.

Connolly, M. and Dantas da Silveira, J., (1979), "Exchange Market Pressure in Postwar Brazil: An Application of the Girton-Roper Monetary Model", *American Economic Review,* vol. 69, issue 3, pp. 448-454.

Connolly, M. and Taylor, D., (1984), "The Exact Timing of the Collapse of and Exchange Rate Regime and its Impact on the Relative Price of Traded Goods",*Journal of Money, Credit, and Banking*, vol. 16, pp. 194-207.

Corsetti, G., Pesenti, P. and Roubini, N., (1998), "What Caused the Asian Currency and Financial Crisis? Part II: The Policy Debate", NBER Working Paper No. 6834.

Corsetti, G., Pesenti, P. and Roubini, N., (1999), "Paper Tigers? A Model of the Asian Crisis", *European Economic Review*, vol. 43, No. 7, pp. 1211-1236.

De Brouwer, G., (2001), "Does a Common-Basket Peg in East Asia Make Economic Sense? Financial Markets and Policies in East Asia", Routledge, Chapter 12, London.

De Gregorio, J. and Valdés, R., (2001), "Crisis Transmission: Evidence from the Debt, Tequila and Asian Flu Crises", *World Bank Economic Review,* vol. 15, issue 2, pp. 289-314.

DeJong, D., Nankervis, J., Savin, N. and Whiteman, C., (1992), "Integration versus Trend Stationarity in Time Series", *Econometrica*, vol. 60, issue 2, pp. 423-433.

Dickey, D.and Fuller, W., (1979), "Distributions of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of American Statistical Association*, vol. 74, No. 366, pp.427-431.

Dickey, D. and Fuller, W., (1981), "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", *Econometrica*, vol. 49, issue 4, pp.1057-1072.

Diebold, F. and Nerlove, M., (1989), "The Dynamics of Exchange Rate Volatility: A Multivariate Latent Factor ARCH Model", *Journal of Applied Econometrics*, vol. 4, issue 1, pp. 1-21.

Diebold, F. and Pauly, P., (1988), "Endogenous Risk in a Rational Expectations Portfolio-Balance Model of the Deutschmark/Dollar Rate", *European Economic Review*, vol. 32, pp. 27-54.

Dimitrova, D., (2005), "The Relationship between Exchange Rates and Stock Prices: Studied in a Multivariate Model", *Political Economy*, vol. 14, August.

Dionisio, A., Menezes, R. and Mendes, D., (2006), "On the Integrated Behaviour of Non-Stationary Volatility in Stock Markets", Elsevier Science, February.

Dooley, M., Folkerts-Landau, D. and Garber, P., (2003), "An Essay on the Revived Bretton Woods System," NBER Working Paper No. 9971, September.

Dornbusch, R., (1976), "Expectations and Exchange Rate Dynamics", *Journal of Political Economy*, vol. 84, issue 6, pp. 1161-1176.

Dornbusch, R. and Fisher, S., (1980), "Exchange Rates and the Current Account", *American Economic Review*, vol. 70, issue 5, pp. 960-971.

Ebeid, S. and Bedeir, G., (2004), "Volatility Modeling and Forecasting of the Egyptian Stock Market Index using ARCH Models", Working Paper Series, Cairo University, Egypt, (October).

Edison, H., (2003), "Are Foreign Exchange Reserves in Asia too High?", *World Economic Outlook*, International Monetary Fund, chapter 2, pp. 76-92.

Edwards, S., (1998a), "Capital Flows, Real Exchange Rates and Capital Controls: Some Latin American Experiences", NBER Working Paper, No. 6800.

Edwards, S., (1998b), "Interest Rate Volatility, Contagion and Convergence: An Empirical Investigation of the Case of Argentina, Chile and Mexico", *Journal of Applied Economics,* I, 1, 55-86 (November).

Edwards, S., (1998c), "The Mexican Peso Crisis: How Much Did We Know? When Did We Know It?", *The World Economy*, vol. 21, issue 1, pp. 1-30.

Edwards, S. and Susmel, R., (2000), "Interest Rate Volatility and Contagion in Emerging Markets: Evidence from the 1990s", NBER Working Paper No. 7813.

Eichengreen, B., (1994), "International Monetary Arrangements for the 21st Century", Washiongton, D.C.: The Brookings Institution.

Eichengreen, B., Rose, A. and Wyplosz, C., (1996), "Contagious Currency Crises: First Tests", *Scandinavian Journal of Economics*, vol. 98, issue 4, pp. 463–484.

Eichengreen, B., and Wyplosz, C., (1993), "The Unstable EMS", Brookings Papers on Economic Activity, No. 1: 51-124.

Engle, R., (1982), "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation", *Econometrica*, vol. 50, issue 4, pp. 987-1008.

Engle, R. and Bollerslev, T., (1986), "Modeling the Persistence of Conditional Variance", *Econometrics Review*, vol. 5, issue 1, pp. 1-50.

Engle, R. and Granger, C., (1987), "Co-integration and Error Correction: Representation, Estimation, and Testing", *Econometrica,* vol. 55, issue 2, pp. 251-276.

Engel, R., (2001), "GARCH 101: The Use of ARCH/GARCH Models in Applied Econometrics", *Journal of Economic Perspective*, vol. 15, No. 4, pp. 157-168.

Fama, E., (1965), "The Behavior of Stock Market Prices", *Journal of Business*, vol. 38, pp. 34-105.

Feldstein, M., (1998), "Refocusing the IMF", *Foreign Affairs*, vol. 77, No. 2, pp. 20–33.

Fernandez-Izquierdo, A. and Lafuente, J., (2004), "International Transmission of Stock Exchange Volatility: Empirical Evidence from the Asian Crisis", *Global Finance Journal*, Elsevier, vol. 15, issue 2, pp. 125-137.

Fischer, S., (1999), "On the Need for an International Lender of Last Resort", *Journal of Economic Perspective*, vol. 13, issue 4, pp. 85–104.

Fischer, S., (2001), "Exchange Rate Regimes: Is the Bipolar View Correct?", *Journal of Economic Perspectives*, vol. 15, No. 2, pp. 3-24.

Fleming, M., (1971), "On Exchange Rate Unification," *Economic Journal,* vol. 81, pp. 467-488.

Flood, R. and Garber, P., (1984), "Collapsing Exchange Rate Regimes: Some Linear Examples", *Journal of International Economics*, vol. 92, No. 1, pp. 99-107.

Flood, R., Garber, P. and Kramer, C., (1996), "Collapsing Exchange Rate Regimes: Another Linear Example", *Journal of International Economics,* vol. 41, issue 3-4, pp.

223–234.

Flood, R. and Jeanne, O., (2000), "An Interest Rate Defense of Fixed Exchange Rates?", IMF Working Paper No. 00/159.

Flood, R. and Rose A., (1995), "Fixing Exchange Rates: A Virtual Quest for Fundamentals", *Journal of Monetary Economics*, vol. 36, pp.3-37.

Forbes, K. and Rigobón, R., (2002), "No Contagion, Only Interdependence: Measuring Stock Market Co-Movements", *Journal of Finance*, vol. 57, issue 5, pp. 2223-2261.

Frankel, J., (1979), "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials", *American Economic Review*, vol. 69, issue 4, pp.610-622.

Frankel, J., (1983), "Monetary and Portfolio Balance Models of Exchange Rate Determination", NBER Reprints No. 0387, in Bhandari, J. and Putnam, B. (eds.), "Economic Interdependence and Flexible Exchange Rates", MIT Press, pp. 84-114. Cambridge, MA.

Frankel, J., (1999), "No Single Currency Regime is Right for All Countries or At All Times", NBER Working Paper, No. W7338.

Frankel, J., and Froot, K., (1987), "Using Survey Data to Test Standard Propositions Regarding Exchange Rate Expectations", *American Economic Review*, vol. 77, issue 1, pp. 133-153.

Frankel, J. and Schmukler, S., (1996), "Crisis, contagion, and country funds: effects on East Asia and Latin America", Pacific Basin Working Paper Series 96-04, Federal Reserve Bank of San Francisco.

Frankel, J., Schmukler, S. and Serven, L., (2002), "Global Transmission of Interest Rates: Monetary Independence and Currency Regime", NBER Working Paper 8828.

Frankel, J. and Wei, S., (1994), "Yen Bloc or Dollar Bloc?: Exchange Rate Policies of the East Asian Economies", Pacific Basin Working Paper, No. 93-01. Federal Reserve Bank of San Francisco.

Fratzscher, M., (1998), "Why are currency crises contagious? A Comparison of the Latin American Crisis of 1994–1995 and the Asian Crisis of 1997–1998", *Weltwirtschaftliches Archiv* 134: 664–691.

Frenkel, J., (1976), "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence", *Scandinavian Journal of Economics*, vol. 78, issue 2, pp. 200-224.

Friedman, M., (1968), "The Role of Monetary Policy", *American Economic Review*, vol. 58, issues 1, pp. 1-17.

Friedman, M., (1988), "Money and the Stock Market", *Journal of Political Economy*, vol. 96, pp. 221-245.

Fukuda, S., (2002), "Post-Crisis Exchange Rate Regimes in East Asia", CIRJE F-Series, No. CIRJE-F-181, Faculty of Economics, University of Tokyo.

Fukuda, S. and Ohno, S., (2003), "Exchange Rate Regimes in East Asia after the Crisis: Implications from Intra-Daily Data", CIRJE F-Series, No. CIRJE-F-247, Faculty of Economics, University of Tokyo.

Furman, J. and Stiglitz, J., (1998), "Economic Crises: Evidence and Insights from East Asia", Brookings Papers on Economic Activity, vol. 29, issue 2, pp. 1-136.

Garcia, C. and Malet, N., (2005), "Exchange Market Pressure, Monetary Policy and Economic Growth: Argentina in 1993-2004", Working Paper Series No. wp99, University of Massachusetts at Amherst.

Gavin, M., (1989), "The Stock Market and Exchange Rate Dynamics", *Journal of International Money and Finance*, vol. 8, issue 2, pp. 181-200.

Gertler, M., Gilchrist, S. and Natalucci, F., (2000), "External Constraints on Monetary Policy and the Financial Accelerator", New York University Working Paper.

Ghosh, A., Gulde, A., Ostry, J. and Wolf, H., (1995), "Does the Nominal Exchange Rate Regime Matter?", IMF Working Paper 95/121.

Girton, L. and Roper, D., (1977), "A Monetary Model of Exchange Market Pressure Applied to the Postwar Canadian Experience", *American Economic Review,* vol. 67, issue 4, pp. 537-548.

Glick, R. and Hutchison, M., (2001), "Banking and Currency Crises: How Common Are Twins?", in Glick, R., Moreno, R. and Spiegel, M. (eds.), "Financial Crises in Emerging Market", New York: Cambridge University Press.

Glick, R. and Rose, A., (1999), "Contagion and Trade: Why are Currency Crises Regional?", *Journal of International Money and Finance*, vol. 18, issue 4, pp. 603-617.

Glick, R. and Wihlborg, C., (1997), "Real Exchange Rate Regimes and International Trade", in Benjamin, C. (editor), International Trade and Finance, New Frontiers for Research, Essays in Honor of Peter Kenen, Cambridge University Press.

Gochoco-Bautista, M. and Bautista, C., (2005), "Monetary Policy and Exchange Market Pressure: the Case of the Philippines", *Journal of Macroeconomics*, vol. 27, issue 1, pp. 153-168.

Goldfajn, I. and Gupta, P., (1999), "Does Monetary Policy Stabilize the Exchange Rate Following a Currency Crisis?", IMF Working Paper No. 99/42.

Goldstein, M., Kaminsky, G. and Reinhart, C., (2000), "Assessing Financial Vulnerability: An Early Warning System for Emerging Markets", Washington, DC: Institute for International Economics.

Goto, J. and Kawai, M., (2001), "Macroeconomic Interdependence in East Asia," paper presented to the International Conference on "Economic Interdependence: Shaping Asia- Pacific in the 21st Century", International Monetary Fund and World Bank, Tokyo.

Gould, D. and Kamin, S., (1999), "The Impact of Monetary Policy on Exchange Rates During Financial Crisis", Paper presented at the 1999 Pacific Basin Conference, San Francisco, September.

Grambovas, C., (2003), "Exchange Rate Volatility and Equity Markets", *Eastern European Economics*, vol. 41, issue 5, pp. 24-48.

Granger, C., Huang, B. and Yang, C., (2000), "A Bivariate Causality between Stock Prices and Exchange Rates: Evidence from Recent Asian Flu", *The Quarterly Review of Economics and Finance*, vol. 40, issue 3, pp. 337-354.

Granger, C. and Newbold, P., (1974), "Spurious Regressions in Econometrics", *Journal of Econometrics,* vol. 2, issue 2, pp. 111-120.

Granger, C. and Weiss, A., (1983), "Time Series Analysis of Error-Correction Models", in Karlin, S., Amemiya, T. and Goodman, L. (eds.), "Studies in Econometrics, Time Series and Multivariate Statistics, in Honor of T.W. Anderson", Academic Press, pp. 255-278, San Diego.

Guo，H., Neely, C. and Higbee, J., (2004), "Foreign Exchange Volatility is Priced in Equities", Research Division, Working Paper Series, 2004-029F, Federal Reserve Bank of St. Louis.

Haberler, G., (1970), "The International Monetary System: Some Recent Developments and Discussions", in Halm, GN. (eds.), "Approaches to greater flexibility of exchange rates", Princeton University Press, Princeton.

Habib, M., (2002), "Financial Contagion, Interest Rates and the Role of the Exchange Rate as Shock Absorber in Central and Eastern Europe", BOFIT Discussion Papers, No.7, Bank of Finland.

Haile, F., and Pozo, S., (2006), "Exchange Rate Regimes and Currency Crises: An Evaluation Using Extreme Value Theory", *Review of International Economics*, vol. 14, issue 4, pp. 554-570.

Hamao, Y., Masulis, R. and Ng, V., (1990), "Correlations in Price Changes and Volatility across International Stock Markets", *Review of Financial Studies*, vol. 3, issue 2, pp. 281–307.

Hamilton, J., (1989), "A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle", *Econometrics*, vol. 57, No. 2, pp. 357-384.

Hansen, L., (1982), "Large Sample Properties of Generalised Method of Moments Estimators", *Econometrics*, vol. 50, issue 4, pp. 1029-1054.

Harvey, C., (1995), "Predictable Risk and Returns in Emerging Markets", *Review of Financial Studies*, vol. 8, issue 3, pp. 773-816.

Hatemi-J, A., (2002), "Export Performance and Economic Growth Nexus in Japan: A Bootstrap Approach", *Japan and the World Economy*, vol. 14, issue 1, pp. 25-33.

Hatemi-J, A. and Roca, E., (2005), "Exchange Rates and Stock Prices: Interaction during Good and Bad Times: Evidence from the ASEAN4 Countries", *Applied Financial Economics*, vol. 15, issue 8, pp. 539–546.

Hau, H. and Rey, H., (2002), "Exchange Rates, Equity Prices and Capital Flows", NBER Working Papers, No. 9398.

Hausmann, R., Gavin, M., Pages-Serra, C. and Stein, E., (1999), "Financial Turmoil and the Choice of Exchange Rate Regime", Inter-American Development Bank Working Paper, No. 400.

Hausmann, R., Panizza, U. and Stein, E., (2001), "Why Do Countries Float the Way They Float?", *Journal of Development Economics*, vol. 66, issue 2, pp. 387-414.

Hekman, C., (1985), "A Financial Model of Foreign Exchange Exposure", *Journal of International Business Studies*, vol.16, issue 2, pp. 83–99.

Helpman, E. and Razin, A., (1982), "A Comparison of Exchange Rate Regimes in the Presence of Imperfect Capital Markets", *International Economic Review*, vol. 23, No. 2.

Hernández, L. and Montiel, P., (2001), "Post-Crisis Exchange Rate Policy in Five Asian Countries: Filling in the 'Hollow Middle'?", IMF Working Paper, No.01/170.

Hernández, L. and Valdés, R., (2001), "What Drives Contagion: Trade, Neighborhood, or Financial Links?", *International Review of Financial Analysis*, vol. 10, issue 3, pp. 203-218.

Ibrahim, M., (2000), "Cointegration and Granger Causality Tests of Stock Price and Exchange Rate Interactions in Malaysia", *ASEAN Economic Bulletin,* vol.17, pp. 36-47.

Ishiyama, Y., (1975), "The Theory of Optimum Currency Areas: A Survey," Staff Papers International Monetary Fund, vol. 22, pp. 344-383.

Ito, T. and Hashimoto, Y., (2004), "High-Frequency Contagion between the Exchange Rates and Stock Prices", NBER Working Paper, No. 10448.

Ito, T., Ogawa, E. and Sasaki, Y., (1998), "How Did the Dollar Peg Fail in Asia?", *Journal of the Japanese and International Economies*, vol. 12, No. 4, pp. 256-304.

Johansen, S., (1988), "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, vol. 12, issue 2-3, pp. 231-254.

Johansen, S. and Juselius, K., (1990), "Maximum Likelihood Estimation and Inference on Cointegration, with Applications to the Demand for Money", *Oxford Bulletin of Economics and Statistics*, vol. 52, issue 2, pp. 169-210.

Johnson, H., (1972), "The Monetary Approach to Balance-of-Payments Theory", *The Journal of Financial and Quantitative Analysis*, vol. 7, No. 2, pp. 1555-1572.

Jung, J., (2008), "Regional Financial Cooperation in Asia: Challenges and Path to Development", BIS Papers, No 42.

Kamaly, A. and Erbil, N., (2000), "A VAR Analysis of Exchange Market Pressure: A Case Study for the MENA Region", Economic Research Forum Working Paper, No. 2025.

Kaminsky, G., Lizondo, S. and Reinhart, C., (1998), "Leading Indicators of Currency Crises", IMF Staff Papers, vol. 45, issue 1, pp. 1–48.

Kaminsky, G. and Reinhart, C., (1999), "The Twin Crises: Causes of Banking and Balance-of-Payments Problems", *American Economic Review,* vol. 89, pp. 473-500.

Kaminsky, G. and Reinhart, C., (2000), "On Crises, Contagion, and Confusion", *Journal of International Economics*, Elsevier, vol. 51, issue 1, pp. 145-168.

Kaminsky, G. and Schmukler, S., (2001), "On Booms and Crashes: Financial Liberalization and Stock Market Cycles", draft, World Bank.

Kasman, S., (2003), "The Relationship between Exchange Rates and Stock Prices: A Causality Analysis", Dokuz Eylül Universitesi, Sosyal Bilimler Enstitusu Dergisi.

Kawai, M., (2002), "Exchange Rate Arrangements in East Asia: Lessons from the 1997-98 Currency Crises", *Monetary and Economic Studies*, vol. 20, issue S1, pp. 167-204.

Kawai, M., (2004), "Financial Interdependence and Exchange Rate Regimes in East Asia", Policy Research Institute, Ministry of Finance, pp.157-203, Tokyo.

Kawai, M. and Akiyama, S., (1998), "The Role of Nominal Anchor Currencies in Exchange Rate Arrangements", *Journal of the Japanese and International Economies*, vol. 12, issue 4, pp.334-387.

Kenen, P., (1969), "The Theory of Optimum Currency Areas: An Eclectic View", in Mundell, R. and Swoboda, A. (eds.), "Monetary Problems of the International Economy", University of Chicago Press, Chicago.

Khalid, A. and Kawai, M., (2003), "Was Financial Market Contagion the Source of Economic Crisis in Asia? Evidence using a Multivariate VAR Model", *Journal of Asian Economics,* vol. 14, issue 1, pp. 131–156.

Khalid, A. and Rajaguru, G., (2006), "Financial Market Contagion or Spillovers Evidence from Asian Crisis using Multivariate GARCH Approach", Paper presented at the Asian Finance Association Conference 2006, Auckland, New Zealand, 16-18 July.

Kim, C. and Lee, J., (2004), "Exchange Rate Regime and Monetary Independence in the Post-Crisis East Asia: An Application of Regime-Switching Model with Endogenous Explanatory Variables", International Centre for the Study of East Asian Development (ICSEAD), April.

Kim, I., (1985), "Exchange Market Pressure in Korea: An Application of the Girton-Roper Monetary Model", *Journal of Money, Credit and Banking*, vol.17, issue 2, pp.258-263.

Kim, K., (2003), "Dollar Exchange Rate and Stock Price: Evidence from Multivariate Cointegration and Error Correction Model", *Review of Financial Economics*, vol. 12, issue 3, pp. 301-313.

King, M. and Wadhwani, S., (1990), "Transmission of Volatility between Stock Markets", *Review of Financial Studies*, vol. 3, issue 1, pp. 5-33.

Klein, M. and Shambaugh, J., (2004), "Fixed Exchange Rates and Trade", manuscript, Tufts University.

Komulainen, T. and Lukkarila, J., (2003), "What Drives Financial Crises in Emerging Markets?", *Emerging Markets Review,* vol. 4, issue 3, pp. 248-272.

Kraay, A., (2000), "Do High Interest Rates Defend Currencies During Speculative Attacks?", World Bank Policy Research Working Paper Series No. 2267.

Krueger, A., (1999), "Nominal Anchor Exchange Rate Policies as a Domestic Distortion", in Saxonhouse, G. and Srinivasan, T. (eds.), "Development, Duality, and the International Economic Regime", University of Michigan Press.

Krueger, M., (1999), "Dynamic Hedging in Currency Crisis", *Economics Letters*, Elsevier, vol. 62, issue 3, pp. 347-350.

Krugman, P., (1979), "A Model of Balance-of-Payments Crises", *Journal of Money, Credit and Banking,* vol. 11, issue 3, pp. 311–325.

Krugman, P. (1998), "Will Asia bounce back?", MIT, Cambridge, MA Working Paper, pp. 2.

Kwan, C., (1995), "Economics of the Yen Zone: A Perspective on Currency Union in Asia", Nihon Keizai shimbunsha (written in Japanese).

Kwiatkowski, D., Phillips, P., Schmidt, P. and Shin, Y., (1992), "Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure Are We That Economic Time Series Have a Unit Root?", *Journal of Econometrics*, vol. 54, issue 1-3, pp. 159-178.

Lahiri, A. and Vegh, C., (2000), "Delaying the Inevitable: Optimal Interest rate Policy and BOP Crises", NBER Working Paper, No. 7734.

Lahiri, A. and Vegh, C., (2001), "Living with the Fear of Floating: An Optimal Policy Perspective", NBER Working Paper No. 8391.

Lean, H., Narayan, P. and Smyth, R., (2006), "Exchange Rate and Stock Price Interaction in Major Asian Markets: Evidence for Individual Countries and Panels Allowing for Structural Breaks", Discussion Paper 25, Business and Economics, Monash University.

Lehmann, E. and D'Abrera, H., (1998), "Nonparametrics: Statistical Methods Based on Ranks", Prentice-Hall, Englewood Cliffs, NJ.

Levy-Yeyati, E. and Sturzenegger, F., (2001), "Exchange Rate Regimes and Economic Performance", IMF Staff Papers, vol. 47, pp. 62–98.

Levy-Yeyati, E. and Sturzenegger, F., (2005), "Classifying Exchanges Rate Regimes: Deeds vs. Words", *European Economic Review*, vol. 49, issue 6, pp. 1603-1635.

Li, M., (2003), "Wealth, Volume and Stock Market Volatility: Case of Hong Kong (1993-2001)", Trinity Economics Papers, No. 20035.

MacDonald, R. and Taylor, M., (1992), "Exchange Rate Economics: A Survey", IMF Staff Papers, No. 39, No.1, pp. 1-57.

MacKinnon, J., (1996), "Numerical Distribution Functions for Unit Root and Cointegration Tests", *Journal of Applied Econometrics*, John Wiley & Sons, Ltd., vol. 11, issue 6, pp. 601-618.

MacKinnon, J., Haug, A. and Michelis, L., (1999), "Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration", *Journal of Applied Econometrics*, John Wiley & Sons, Ltd., vol. 14, issue 5, pp. 563-577.

Mah, J., (1998), "Exchange Market Pressure in Korea: Dynamic Specifications", *Applied Economics Letters*, vol.5, issue 12, pp.765-768.

Mandelbort, B., (1983), "The Variation of Certain Speculative Prices", *Journal of Business*, vol. 36, pp. 394-419.

Markiewicz, A., (2005), "Choice of Exchange Rate Regime in Central and Eastern European Countries: An Empirical Analysis", Center for Economic Studies Discussion papers, No. 0501.

Markiewicz, A., (2006), "How Central and Eastern European Countries Choose Exchange Rate Regimes", Focus on European Economic Integration, No. 2/06.

Masson, P., (1999), "Contagion: Macroeconomic Models with Multiple Equilibria", *Journal of International Money and Finance*, vol. 18, issue 4, pp. 587-602.

McKibbin, W., and Le, H., (2002), "Which Exchange Rate Regime for Asia?", A paper prepared for AJRC, CCER conference on "Future Financial Arrangements in East Asia" held in Beijing on March 24-25.

McKinnon, R., (1963), "Optimum Currency Areas", *American Economic Review*, vol. 53, No. 4, pp. 717-725.

McKinnon, R., (2000), "The East Asian Dollar Standard, Life after Death?", Economic Notes, vol. 29, No. 1, pp. 31-82.

McKinnon, R., (2001), "After the Crisis: The East Asian Dollar Standard Resurrected: An Interpretation of High Frequency Exchange Rate Pegging", HKIMR Working Paper, No.04/2001.

McKinnon, R. and Schnabl, G., (2004), "The East Asian Dollar Standard, Fear of Floating, and Original Sin", *Review of Development Economics*, vol. 8, issue 3, pp. 331-360.

McNelis, P., (1993), "The Response of Australian Stock, Foreign Exchange and Bond Markets to Foreign Asset Returns and Volatilities", RBA Research Discussion Paper, No. 9301.

Mishkin, F., (1999), "Lessons from the Asian Crisis", NBER Working Paper No. 7102.

Mishra, A., (2004), "Stock Market and Foreign Exchange Market in India: Are they Related?", *South Asia Economic Journal,* vol. 5, No.2, pp. 209-232.

Moreno, R., (1999), "Did a Boom in Money and Credit Precede East Asia's Recent Currency Crisis?", *Federal Reserve Bank of San Francisco Economic Review*: 23-41.

Morley, B. and Pentecost, E., (2000), "Common Trends and Cycles in G-7 Countries Exchange Rates and Stock Prices", *Applied Economic Letters*, vol. 7, issue 1, pp. 7–10.

Muhammad, N. and Rasheed, A., (2002), "Stock Prices and Exchange Rates: Are they Related? Evidence from South Asian Countries", *The Pakistan Development Review*, vol. 41, issue 4, pp. 535 -550.

Mundell, R., (1961), "A Theory of Optimum Currency Areas", *American Economic Review,* vol. 51, No. 4, pp. 657-665.

Mussa, M., Masson, P., Swoboda, A., Jadresic, E., Mauro, P. and Berg, A., (2000), "Exchange Rate Regimes in an Increasingly Integrated World Economy", IMF Occasional Paper, No.193.

Nadal-De-Simone, F. and Razzak, W., (1999), "Nominal Exchange Rates and Nominal Interest Rate Differentials", IMF Working Paper WP/99/141, October.

Nagayasu, J., (2001), "Currency Crisis and Contagion: Evidence from Exchange Rates and Sectoral Stock Indices of the Philippines and Thailand", *Journal of Asian Economics*, vol. 12, issue 4, pp. 529-546.

Narayan, P. and Smyth, R., (2005), "Exchange Rates and Stock Prices in South Asia: Evidence from Granger Causality Tests", *ICFAI Journal of Applied Finance*, vol. 11, issue 3, pp. 31-37.

Nelson, D., (1991), "Conditional Heteroskedasticity in Asset Returns: A New Approach", *Econometrica*, vol. 59, issue 2, pp. 347-370.

Nelson, C. and Plosser, C., (1982), "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications", *Journal of Monetary Economics*, vol. 10, pp. 139-162.

Neumeyer, P., (1998), "Currencies and the Allocation of Risk: The Welfare Effects of a Monetary Union," *American Economic Review*, vol. 88, No.1, pp. 246-259.

Newey, W. and West, K., (1987), "A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix", *Econometrica*_vol. 55, issue 3, pp.703-708.

Nieh, C. and Lee, C., (2001), "Dynamic Relationship between Stock Prices and Exchange Rates for G7 Countries", *Quarterly Review of Economics and Finance*, vol. 41, issue 41, pp. 477-490.

Nitithanprapas, E. and Willett, T., (2000), "A Currency Crisis Model That Works: A Payments Disequilibrium Approach", Working Papers in Economics No. 2000-25, Claremont Colleges.

Nguyen, H., (2005), "An Empirical Study of East Asian Exchange Rate Arrangements", mimeo, Center for International Research on The Japanese Economy, The University of Tokyo.

Obstfeld, M., (1986), "Rational and Self-Fulfilling Balance-of-Payments Crises", *American Economic Review*, vol.76, pp. 72-91.

Obstfeld, M., (1994), "The Logic of Currency Crises", Working Paper 4640, National Bureau of Economic Research, September.

Obstfeld, M., (1996), "Models of Currency Crises with Self-Fulfilling Features", *European Economic Revie*w, vol. 40, issues 3, pp. 1037-1047.

Ogawa, E. and Ito, T., (2000), "On the Desirability of a Regional Basket Currency Arrangement", NBER Working Paper, No. 8002.

Ogawa, E. and Sun, L., (2001), "How were Capital Inflows Stimulated under the Dollar Peg System?", in Ito, T. and Kruger, A. (eds.), "Regional and Global Capital Flows: Macroeconomic Causes and Consequences", University of Chicago Press, Chicago, 151-195.

Ohno, K., (1999), "Exchange Rate Management in Developing Asia: Reassessment of the Precrisis Soft Dollar Zone", ADB Institute Working Paper Series, No.1.

Ohno, K., Shirono, K. and Sisli, E., (1999), "Can High Interest Rates Stop Regional Currency Falls?", ADB Institute Working Paper Series, No. 6.

Osterwald-Lenum, M., (1992), "A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics", *Oxford Bulletin of Economic and Statistics*, vol. 54, issue 3, pp. 461-472.

Pakko, M., (2000), "Do High Interest Rates Stem Capital Outflows?", *Economics Letters,* vol. 67, issue 2, pp. 187-192.

Park, Y., Chung, C., and Wang, Y., (2001), "Fear of Floating: Korea's Exchange Rate Policy after the Crisis", *Journal of the Japanese and International Economics,* vol. 15, issue 2, pp. 225-251.

Park, Y. and Song, C., (2001), "Financial Contagion in the East Asian Crisis-With Special Reference to the Republic of Korea", in Claessens, S. and Forbes, K. (eds.), "International Financial Contagion", Kluwer Academic Publishers, USA.

Parrado, E. and Velasco, A., (2002), "Optimal Interest Rate Policy in a Small Open Economy", NBER Working Paper No. 8721.

Pentecost, E., Van Hooydonk, C. and Van Poeck, A., (2001), "Measuring and Estimating Exchange Market Pressure in the EU", *Journal of International Money and Finance,* vol. 20, issue 3, pp. 401-418.

Perron, P., (1989), "The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis", *Econometrica*, vol. 57, issue 6, pp.1361-1401.

Pesaran, M., Shin, Y. and Smith, R., (2001), "Bounds Testing Approaches to the Analysis of Level Relationships", *Journal of Applied Econometrics*, vol. 16, issue 3, pp. 289-326.

Pesenti, P., and Tille, C., (2000), "The Economics of Currency Crises and Contagion: An Introduction", *FRBNY Economic Policy Review*, September.

Phillips, P., (1986), "Understanding Spurious Regressions in Econometrics", *Journal of Econometrics*, vol. 33, issue 3, pp. 311-340.

Phillips, P. and Perron, P., (1988), "Testing for a Unit Root in Time Series Regression", *Biometrika*, vol. 75, No. 2, pp. 335-346.

Phylaktis, K. and Ravazzolo, F., (2005), "Stock Prices and Exchange Rate Dynamics", *Journal of International Money and Finance*, vol. 24, issue 7, pp. 1031-1053.

Pontines, V. and Siregar, R., (2004), "Exchange Market Pressure and Extreme Value Theory: Incidence of Currency Crises in East Asia and Latin America", Econometric Society 2004 Australasian Meeting, No 181.

Radelet, S. and Sachs, J., (1998a), "The East Asian Financial Crisis: Diagnosis, Remedies, Prospects", Brookings Papers on Economic Activity, vol. 29, issue 1, pp. 1-90.

Radelet, S. and Sachs, J., (1998b), "The Onset of the East Asian Financial Crisis", NBER Working Paper No. 6680.

Rajan, R., (2002), "Exchange Rate Policy Options for Post-Crisis Southeast Asia: Is There a Case for Currency Baskets?", *The World Economy*, vol. 25, issue 1, pp.137-163.

Rajan, R., Sen, R. and Siregar, R., (2002), "Hong Kong, Singapore and the East Asian Crisis: How Important were Trade Spillovers?", *The World Economy*, vol. 25, issue 4, pp. 503-537.

Ramasamy, B. and Yeung, M., (2002), "The Relationship between Exchange Rates and Stock Prices: Implications for Capital Controls", *Asia Pacific Journal of Economics and Business*, vol. 6, No. 2, pp. 46–60.

Ramasamy, B. and Yeung, M., (2005), "The Causality between Stock Returns and Exchange Rates: Revisited", *Australian Economic Papers*, vol. 44, No. 2, pp. 162-169.

Rana, P., (1998), "The East Asian Financial Crisis-Implications for Exchange Rate Management", Asian Development Bank, Economics and Development Resource Center, EDRC Briefing Notes No. 5.

Reimers, H., (1992), "Comparisons of Tests for Multivariate Cointegration", Statistical Papers, vol. 33, pp. 335-359.

Reinhart, C. and Rogoff, K., (2004), "The Modern History of Exchange Rate Arrangements: A Reinterpretation", *The Quarterly Journal of Economics,* vol. 119, issue 1, pp. 1-48.

Reinhart, K. and Rajan, R., (2008), "Fear of Floating", *Princeton Encyclopedia of the World Economy*, Princeton University Press: Princeton, NJ (with Slavi Slavov), forthcoming.

Ricci, L., (1997), "A Model of an Optimum Currency Area," IMF Working Paper 97/76.

Roll, R., (1992), "Industrial Structure and the Comparative Behaviour of International Stock Market Indices", *Journal of Finance*, vol. 47, issue 1, pp.3-41.

Roper, D. and Turnovsky, S., (1980), "Optimal Exchange Market Intervention in a Simple Stochastic Macro Model", *Canadian Journal of Economics*, vol. 13, issue 2, pp. 296–309.

Rose, A., (2000), "One Money, One Market: Estimating the Effect of Common Currencies on Trade", Economic Policy, vol. 30, pp. 7-46.

Sachs, J., Tornell, A. and Velasco, A., (1996), "Financial Crises in Emerging Markets: The Lessons from 1995", *Brookings Papers on Economic Activity*, No. 1, pp. 147-215.

Salant, S., and Henderson, D., (1978), "Market Anticipations of Government Polices and the Price of Gold", *Journal of Political Economy*, vol.86, pp.627-648.

Schwert, G., (1987), "Effects of Model Specification on Tests for Unit Roots in Macroeconomic Data", *Journal of Monetary Economics,* vol. 20, issue 1, pp. 73-103.

Sercu, P. and Vanhulle, C., (1992), "Exchange Rate Volatility, International Trade and the Value of Exporting Firms", *Journal of Banking and Finance*, vol. 16, issue 1, pp. 155–182.

Shambaugh, J., (2004), "The Effect of Fixed Exchange Rates on Monetary Policy", *Quarterly Journal of Economics*, vol. 119, issue 1, 300-351.

Sill, K., (2000), "Understanding Asset Values: Stock Prices, Exchange Rates, and the 'Peso Problem'", *Federal Reserve Band of Philadelphia, Business Review*, September, pp. 3-13.

Smyth, R. and Nandha, M., (2003), "Bivariate Causality between Exchange Rates and Stock Prices in South Asia", *Applied Economics Letters*, vol. 10, issue 11, pp. 699–704.

Soenen, L. and Hennigar, E., (1988), "An Analysis of Exchange Rates and Stock Prices: The US Experience between 1980 and 1986", *Akron Business and Economic Review*, vol. 19(4), pp. 7–16.

Spolander, M., (1999), "Measuring Exchange Market Pressure and Central Bank Intervention", Bank of Finland Studies E:17.

Stavárek, D., (2005), "Stock Prices and Exchange Rates in the EU and the USA: Evidence on their Mutual Interactions", *Czech Journal of Economics and Finance*, vol. 55, issue 3-4, pp. 141-161.

Stiglitz, J., (1999), "Interest Rates, Risk, and Imperfect Markets: Puzzles and Policies", *Oxford Review of Economic Policy,* vol. 15, issue 2, pp. 59-76.

Stiglitz, J., (2002), "Capital Market Liberalization and Exchange Rate Regimes: Risk without Reward," In George S. Tavlas and Michael K. Ullan (eds), *The Annals of the American Academy of Political and Social Science*, vol. 579, Thousand Oaks, CA, pp. 219–248.

Svensson, L., (2000), "Open-Economy Inflation Targeting", *Journal of International Economics*, vol. 50, issue 1, pp.155-183.

Tabak, B., (2006), "The Dynamic Relationship between Stock Prices and Exchange Rates: Evidence for Brazil", *International Journal of Theoretical and Applied Finance*, vol. 9, No. 8, pp. 1377-1396.

Taguchi, H., (2004), "The Post-Crisis Exchange Rate Management in Selected East Asian Countries: Flexibility of Exchange Rate and Sensitivity", Working Paper No.8, COE-CAS, Waseda University.

Tang, Q. and Chen, J., (2002), "On Analysis of the Volatility of the Stock Markets in China", *USA-China Business Review*, vol. 2, No.1, (Serial No.2).

Tanner, E., (2001), "Exchange Market Pressure and Monetary Policy: Asia and Latin America in the 1990s", IMF Staff Papers, vol. 47, issue 3. pp. 2.

Tavlas, G., (1993), "The 'New' Theory of Optimum Currency Areas", The World Economy, vol.16, issue 6, pp. 663-685.

Taylor, S., (1986), "Modelling Financial Time Series", John Wiley and Sons Ltd, Chichester.

Toda, H. and Yamamoto, T., (1995), "Statistical Inference in Vector-Autoregressions with Possibly Integrated Processes", *Journal of Econometrics*, vol. 66, issue 1-2, pp. 225–250.

Tornell. A., (1999),"Common Fundamentals and the Tequila and Asia Crises", National Bureau of Economic Research Working Paper 7139.

Tsang, S., (1999), "The Currency Board Arrangement in Hong Kong, China: Viability and Optimality through the Crisis", Rising to the Challenge in Asia: A Study of Financial Markets, Asian Development Bank, vol. 3, pp.21-53.

Van Rijckeghem, C. and Weder, B., (1999), "Sources of Contagion: Finance or Trade?", IMF Working Papers 99/146.

Venkateshwarlu, M. and Tiwari, R., (2005), "Causality between Stock Prices and Exchange Rates: Some Evidence for India", *ICFAI Journal of Applied Finance,* vol. 11, pp. 5-15.

Vrontos, I., Dellaportas, P., and Politis, D., (2003), "A Full-Factor Multivariate GARCH Model", *The Econometrics Journal*, vol. 6, issue 2, pp. 312–334.

Weymark, D., (1995), "Estimating Exchange Market Pressure and the Degree of Exchange Market Intervention for Canada", *Journal of International Economics*, vol. 39, issue 3-4, pp. 273-295.

Weymark, D., (1997), "Measuring the Degree of Exchange Market Intervention in a Small Open Economy", *Journal of International Money and Finance*, vol. 16, issue 1, pp. 55-79.

Weymark, D., (1998), "A General Approach to Measuring Exchange Market Pressure", Oxford Economic Papers, vol. 50, issue 1, pp. 106-121.

Wickremasinghe, G., (2006), "Dynamic Relations between Stock Prices and Exchange Rates in Sri Lanka: Some Empirical Evidence", 11th FINSIA-Melbourne Centre for Financial Studies Banking and Finance Conference, September 25-26.

Willett, T., Nitithanprapas, E., Nitithanprapas, I. and Rongala, S., (2005), "The Asian Crises Re-examined", Asian Economic Papers, vol. 3, issue 3, pp. 32-87.

Williamson, J., (1999), "The Case for a Common Basket Peg for East Asian Currencies", In Collignon, S., Pisani-Ferry, J. and Park, Y. (eds.), "Exchange Rate Policies in Emerging Asian Countries", London and New York: Routledge, pp. 327-343.

Williamson, J., (2000), "Exchange Rate Regimes for Emerging Markets: Reviving the Intermediate Option", Institute for International Economics, (September), Washington, DC.

Wong, J., Ho, F. and Fung, L., (2002), "Liquidity of the Hong Kong Stock Market since the Asian Financial Crisis", Market Research Division, Research Department, Hong Kong Monetary Authority.

Wu, R., (2005), "International Transmission Effect of Volatility between the Financial Markets during the Asian Financial Crisis", *Transition Studies Review,* vol. 12, issue 1, pp. 19-35.

Wu, Y., (2000), "Stock Prices and Exchange Rates in a VEC Model – The Case of Singapore in the 1990s", *Journal of Economics and Finance,* vol. 24, No. 3, pp. 260-274.

Wu, Y., and Zhang, H., (1997), "Do Interest Rates Follow Unit-Root Processes? Evidence from Cross- Maturity Treasury Bill Yields", *Review of Quantitative Finance and Accounting*, vol.8, issue 1, pp. 69-81.

Yam, J., (1998), "Review of Currency Board Arrangements in Hong Kong", Hong Kong Monetary Authority, December.

Yang, S. and Doong, S., (2004), "Price and Volatility Spillovers between Stock Prices and ExchangeRates: Empirical Evidence from the G-7 Countries", *International Journal of Business and Economics,* vol. 3, No. 2, pp.139-153.

Yang, S. and Doong, S., (2004), "The Dynamic Relationship between Stock Prices and Exchange Rates and the Spillovers Effect", Financial Management Association Annual Meeting, New Orleans, USA.

Yang, T. and Lim, J., (2004), "Crisis, Contagion, and East Asian Stock Markets", *Review of Pacific Basin Financial Markets and Policies*, vol. 7, No. 1, pp.119-151.

Yau, H. and Nieh, C., (2006), "Interrelationships among Stock Prices of Taiwan and Japan, and NTD/Yen Exchange Rate", *Journal of Asian Economics*, vol. 17, issue 3, pp. 535-552.

Yong, O. and Isa, Z., (2000), "Exchange Rate Changes and Stock Market Reactions: A Special Case of Currency Depreciation and Its Influence on the Local Stock Market: The Malaysian Experience", *Banker's Journal Malaysia*, No.113, pp. 56-63.

Younus, S., (2005), "Exchange Market Pressure and Monetary Policy", *Policy* Analysis Unit (PAU), Working Paper Series: WP 0603, Research Department, Bangladesh Bank.

Yu, Q., (1995), "Stock Prices and Exchange Rates: Experiences in Leading East Asian Financial Centers – Tokyo, Hong Kong and Singapore", *Singapore Economic Review*, vol. 41, No. 1, pp. 47-56.

Yücel, T. and Kurt, G., (2003), "Foreign Exchange Rate Sensitivity and Stock Price: Estimating Economic Exposure of Turkish Companies", European Trade and Study Group Fifth Annual Conference, Madrid-İspanya.

Zhang, X. and Wu, X., (2006), "The Analysis: the Influence of RMB Exchange Rate Fluctuation on Real Estate Price in China", XXIII FIG Congress, Munich, Germany.

Zhang, Y., (1999), "Good Governance: The Lessons of the Asian Crisis", *World Economy and China*, No. 5.

Zivot, E. and Andrews, D., (1992), "Further Evidence on the Great Crash, the Oil-Price Shock and the Unit-Root Hypothesis", *Journal of Business and Economic Statistics*, vol. 10, issue 3, pp. 251–270.