FOREIGN EXCHANGE MARKET EFFICIENCY: ASIA-PACIFIC FOCUS

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ABSTRACT

The foreign exchange market is the largest financial market in the world. According to the Bank for International Settlements (BIS) 2010 Triennial Central Bank Survey, the annual turnover in the foreign exchange markets is estimated to be around USD1,000 trillion. Hence, a slight distortion in foreign exchange market efficiency represents a significant profit opportunity. From the review of market efficiency literature, it is found that the empirical evidence in respect of market efficiency has been mixed and inconclusive. In addition, there is also a serious neglect in the study of foreign exchange market efficiency especially in the Asia-Pacific region. This thesis investigates foreign exchange market efficiency using the Asia-Pacific currencies. We adopt the forward unbiasedness hypothesis and an event-study analysis in the investigation of the foreign exchange market efficiency. To the best of our knowledge, this is the first study which employs these two approaches jointly in a single research using the Asia-Pacific currencies as the core sample. This combination provides us with a more comprehensive view on the state of foreign exchange market efficiency. Ultimately, we find that the Asia-Pacific foreign exchange markets are generally efficient over the whole sample period but with some signs of market inefficiency only in some subsample periods in selective markets. It is also reported that the uncovered interest-rate parity generally holds true and hence the forward bias puzzle is further reinforced as a statistical artefact. The differences in the institutional characteristics such as a country's income level and the extent of foreign exchange market liberalization causes heterogeneous results in the state of foreign exchange market efficiency over subsample periods. This thesis has discovered some evidence indicating that the Asian financial crisis (AFC) of 1997/98 is the more disturbing event as compared to the global financial crisis (GFC) 2008/09 in terms of impact on foreign exchange market efficiency in the Asia-Pacific. We have shown that the currencies

managed under the free-float exchange rate regime as more resilient than those administered under the managed-float regime in the face of crisis. The empirical results have also confirmed that the exchange rates respond to both the United States and regional macroeconomic shocks. Finally, we have shown that those macroeconomic shocks related to the interest-rate announcements carry a larger impact to the exchange rates returns. Collectively, these findings bear several important implications for various stakeholders in the foreign exchange markets. It enables researchers to make a safe assumption of market efficiency in their future research work. For policymakers, they may want to take into account the resilience of free-float exchange regime in confronting a crisis when considering which regime to be adopted as the preferred currency management system. To market participants, they may have to be very cautious in applying a currency carry trade strategy, which aims to exploit the failure of the uncovered interest-rate parity, in the Asia-Pacific foreign exchange markets as the empirical results show that the parity condition generally holds true in the long run.

ABSTRAK (*Malay Language Version*)

Pasaran matawang asing adalah pasaran kewangan yang terbesar di dunia. Menurut laporan daripada *Bank for International Settlement 2010 Triennial Central Bank Survey*, nilai dagangan tahunan dalam pasaran matawang asing adalah dianggarkan berjumlah sekitar USD1,000 trilion. Rentetan itu, segelintir kacauan dalam effisiensi pasaran matawang asing akan memberikan peluang keuntungan yang cukup besar. Tesis ini meninjau effisiensi pasaran matawang asing dengan menggunakan matawang dari rantau Asia Pasifik. Daripada liputan literasi dalam kajian pasaran matawang asing, kami mendapati bahawa bukti empirikal berkaitan dengan effisiensi pasaran adalah bercampuran dan tidak muktamad. Tambahan pula, kajian dalam effisiensi pasaran matawang terutamanya dari rantau Asia Pasifik amatlah terabai. Kami menggunakan dua pendekatan utama yakni '*forward unbiasedness hypothesis'* dan '*event-study analysi*s' dalam tesis ini. Dalam pengetahuan kami, ini adalah kajian pertama yang menggunakan kedua-dua pendekatan ini dalam satu kajian tunggal. Dengan cara ini, kami berupaya memberikan suatu gambaran yang lebih menyeluruh dalam effisiensi pasaran matawang asing. Secara keseluruhannya, kami mendapati bahawa pasaran matawang asing di rantau Asia Pasifik adalah effisien dalam tempoh masa sampel yang penuh tetapi menunjukkan cirri-ciri ineffisien dalam beberapa subsampel tempoh masa. Tesis ini juga menunjukkan bahawa '*uncovered interest-rate parity*' adalah rata-ratanya benar dan justeru itu '*forward bias puzzle*' merupakan suatu artifak statistik. Kami melaporkan bahawa perbezaan dari segi karektor institusi seperti aras pendapatan negara dan kadar liberalisasi pasaran matawang asing sesebuah negara adalah faktor penyebab dalam ketidaksamaan dalam keputusan yang diperoleh daripada ujian empirikal. Tesis ini juga menjumpai bukti yang mencadangkan bahawa krisis kewangan Asia 1997/98 sebagai peristiwa yang lebih mangacau berbanding dengan krisis kewangan global 2008/09 dari segi impak kepada effisiensi pasaran matawang

asing di rantau Asia-Pasifik. Kami menunjukkan bahawa matawang yang dikendalikan di bawah rejim *'free-float*' adalah lebih berdaya-tahan berbanding dengan matawang yang diuruskan di bawah rejim '*managed-float*' dalam mengharungi krisis. Hasil penyelidikan kami juga mengesahkan bahawa matawang asing sememangnya dipengaruhi oleh kejutan makroekonomi dari Amerika Syarikat and serantau. Akhirnya, kami mendapati bahawa kejutan makroekonomik yang berkaitan dengan pengumuman kadar faedah memberikan impak yang lebih besar kepada pulangan matawang asing. Secara kolektifnya, hasil kajian kami memberikan beberapa implikasi penting kepada pelbagai pihak yang berkepentingan dalam pasaran matawang asing. Kesimpulan tesis ini membolehkan para penyelidik untuk menggunakan andaian effisiensi pasaran matawang asing dalam kerja-kerja penyelidikan pada masa depan. Dari perspektif penggubal polisi, mereka boleh menggunakan hasil penyelidikan kami yang berkaitan dengan kelebihan rejim '*free-float'* dalam mengharungi krisis sekiranya mereka ingin mempertimbangkan rejim mana yang lebih bersesuaian. Peserta pasaran matawang asing pula harus berwas-was dalam menggunakan strategi 'c*arry-trade*' yang mengeksploitasikan kegagalan '*uncovered interest-rate parity*' pada matawang Asia Pasifik kerana hasil penyelidikan kami menunjukkan bahawa hubungan '*parity*' ini adalah benar dalam jangka masa panjang.

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In my opinion, this is one of the most important and meaningful sections in the whole thesis. This thesis will not come to fruition without the parties whom I am going to mention in this section shortly. First of all, my heartfelt gratitude goes to both of my supervisors, Associate Professor Dr. Rubi Ahmad and Professor Dr. Mohamed Ariff. Their dedication and encouragement have spurred me to stretch beyond my conservative boundary in order to achieve greater heights. I am also especially grateful to Professor Dr. Ghon Rhee, the Editor of Pacific Basin Finance Journal (PBFJ) from the University of Hawaii who visited my university twice as a visiting professor during my PhD program. His generous guidance has tremendously helped me to increase the quality of my thesis. Special thanks also go to the reviewers and Co-Editor of the Journal of International Money and Finance (JIMF) for their constructive suggestions and comments on parts of my work. The inputs from the participants of the Asian Finance Association Conference 2012, Malaysian Finance Association Conference 2012 and the European Financial Management Symposium 2011, especially the discussants of my works who include Dr. Zhang Wei from Deakin University (Australia), Professor Dr. Catherine Ho from the UiTM (Malaysia) and Professor Dr. Goh Soo Khoon from the USM (Malaysia), are also duly acknowledged. I would also like to thank my market intelligence providers, Mr Tang Vern Yang from the UOB Bank, Mr Tay Choon Siang from the Commerzbank and Ms Catherine Tan from the Thomson-Reuters. Last, but definitely not least, my deepest gratitude goes to my family members. Without the constant support from my beloved wife, Yee Sok Ling and my ever-giving mother, Chin Lai Hing, my PhD journey will never be so fulfilling and joyful. Thanks to my late father, Wong Kok Keong, for initiating me to embark on this route. I am also grateful to my sister, Wong Choy Yee, and her husband, my brother-in-law, Mr Yeoh Chia Hung, for bringing faith and happiness to our family.

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LIST OF ABBREVIATIONS

AUD ..... Australian dollar
CNY ..... Chinese yuan
IDR ..... Indonesian rupiah
INR ..... Indian rupee
JPY ..... Japanese yen
KRW ..... South Korean Won
MYR ..... Malaysian ringgit
NZD ..... New Zealand dollar
PHP ..... Philippines peso
SGD ..... Singapore dollar
THB ..... Thai baht
TWD ..... Taiwanese dollar
USD ..... United States of America dollar

FOREIGN EXCHANGE MARKET EFFICIENCY: ASIA-PACIFIC FOCUS

CHAPTER 1

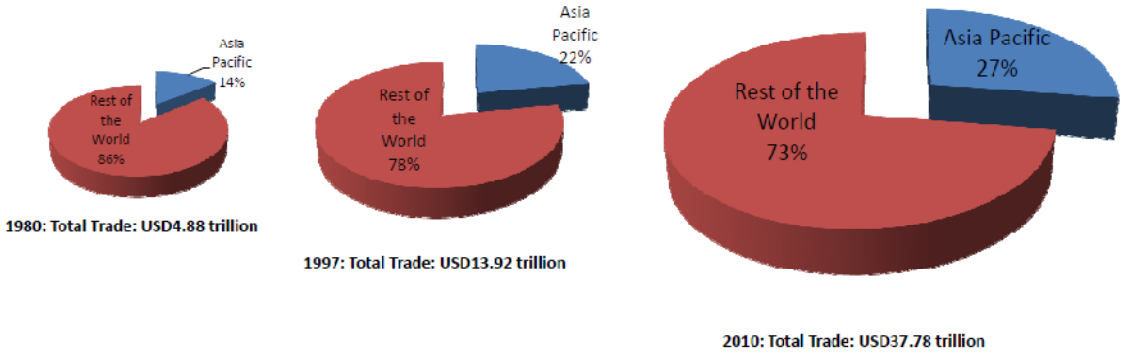
INTRODUCTION

The foreign exchange market is touted as the largest financial market in the world with an average daily turnover of USD 4 trillion (BIS, 2010). This number translates into an annual turnover of about USD 1,000 trillion by assuming a 250-trading-day-year. This figure is also amounted to about 13 times of the world GDP of 2010! The large volume of turnover in the foreign exchange markets cannot be attributed to the global trade alone because the trade statistics are a far cry from this amount. The total world trade for both merchandise and services in 2010 as reported by the World Trade Organization (WTO) was only USD37.8 trillion. Figure 1.1, which is presented on the following page, shows the growing pie of the global trade in the last three decades. An interesting point to note from Figure 1.1 is the steady increase of the Asia-Pacific share of the total global trade, from 14% in 1980 to 27% in 2010. Despite the increase in the total global trade, the numbers are still miniscule in relative to the annual turnover in the foreign exchange markets. Hence we suggest that the big bulk of the foreign exchange markets turnover is made up of speculative positions.

The efficient market hypothesis (EMH) postulates that the involvement of large numbers of profits-driven participants is a necessary, but not a sufficient, condition for a market to be efficient (Fama, 1970). With this large turnover, a slight distortion in the foreign exchange market efficiency could open up a window of large profit opportunity to some quick-thinking market participants. For example, assume a distortion occurs in the foreign exchange market efficiency and consequently causes a profit opportunity of 1.5 percentage-points from the total volume of the annual turnover. This miniscule

distortion will provide a colossal profit opportunity which is about equivalent to the size of the U.S. GDP, the world's largest economy, in 2010. Notwithstanding the economic significance of the foreign exchange markets, most of the studies related to the notion of EMH are concentrated in the capital markets (i.e. equity and bond markets). In comparison, the foreign exchange market is seriously neglected. The economic significance of the foreign exchange markets justifies more research efforts in this area of interest.

Figure 1.1: Total World Trade, 1980 – 2010



The pie charts depict the growing size in the global world trade from 1980 to 2010. Total trade is the summation of both the export and import for merchandise and services. The Asia-Pacific portion is made up of the 12 countries selected in this thesis. These countries are Australia, China, India, Indonesia, Japan, South Korea, Malaysia, New Zealand, Philippines, Singapore, Thailand and Taiwan.
Source: World Trade Organization (WTO)

In the following subsection, the related financial theories are presented to show that this thesis is well-grounded with established theories. Next, we assert the problem statement by showing that there is a real issue yearning to be addressed. This research problem is the pivotal motivation for the whole thesis. The research objectives are presented next. Following the research objectives, some research questions are pondered upon and these questions are then translated into some testable research hypotheses. Subsequently, the justifications for using the Asia-Pacific data as the core sample are elaborated. In the next subsection, the importance of this research topic is emphasised from several points of view and this is then followed by a brief discussion on the underlying philosophy supporting this research effort. Finally, the main contributions

and the related implications of this thesis are succinctly communicated in the following subsection before the chapter is summarised.

1.0 Underlying Financial Theories

In this thesis, there are three main underlying financial economic theories functioning as the guiding principles. First is the efficient markets hypothesis (EMH) (Fama, 1970), second, the uncovered interest-rate parity (UIP) or more specifically, forward unbiasedness hypothesis (Hansen & Hodrick, 1980) and third is the fundamental exchange rate model (Dornbusch, 1975). These are established theories and have been subjected to vigorous empirical tests for decades. There are supporting as well as opposing evidence for these three theories. There are even several economic puzzles borne out from some of the anomalous results in the literature. These puzzles remain largely unresolved to this day (Sarno, 2005). We briefly review these theories and their related puzzles in the following paragraphs while their empirical evidence is presented in Chapter 2: Literature Review. Therefore this thesis is an important effort which contributes towards a resolution of these exchange rate puzzles.

Firstly, the modern concept of the EMH takes its root from Fama (1970). But the essence of the EMH can be traced back to the origin of human trade. In its simplest form, an efficient market dictates that the prices of goods are always in equilibrium where demand meets supply. A distortion in market prices will not last long as well-informed investors will transact in the markets to arbitrage away the profit opportunity. Bachelier (1900) (in Dimson & Mussavian, 1998) is often quoted as the first study which provides a formal scientific framework for the testing of market efficiency. Applying the same concept to modern financial markets, Fama (1970) asserts that security prices must reflect all available information in an efficient market and hence the EMH is also known as an informational efficiency condition. It is important not be

confused over the concept of EMH with the other efficiency models such as allocative efficiency or operational efficiency in other areas of research. Fama (1970) categorises the EMH into three forms namely, weak-, semi-strong- and strong-form efficiency. In a weak-form efficient market, security prices reflect all historical information and past prices are not useful in predicting future prices. While in a semi-strong-form efficiency, security prices have already discounted all current, publicly available information into their price formation process and hence there is no room for excess returns from using the fundamental analysis. The market in its strongest form says that the security prices have reflected all available, including private, information and hence there is an absence of profits for insider-trading activity. Most of the early empirical evidence generally supports the notion for weak- and semi-strong forms efficiency (Jensen, 1978) but the strong-form efficiency is usually violated as shown by the continuous cases of insider-trading.[1] The concept of EMH usually comes under the spotlight after a financial crisis or economic recession. The popular media[2] likes to quote this type of event as glaring evidence for the failure of EMH. This view is sometimes shared by academic researchers too through their rigorous efforts in debunking the EMH (e.g. Grossman & Stiglitz, 1980). As a result, the EMH remains a controversial theory.

Secondly, when the efficient market concept is applied to the foreign exchange market, uncovered interest-rate parity (UIP) is usually used as the benchmark principle for the testing of the efficiency condition. Unlike the capital markets, there is no clear categorisation of form of efficiency in the foreign exchange markets. The UIP postulates that any interest-differential between two currencies should be offset by the subsequent changes in the exchange rates. As the forward rate is a mathematical derivation of the interest-rate differential between two currencies, it should be an

[1] A recent sensational case of insider-trading is the conviction of Raj Rajaratnam, a U.S hedge fund manager, in October 2011 by the U.S Court to serve an imprisonment of 11 years.
[2] The Economist, "Efficiency and Beyond", July 16, 2009.

unbiased predictor of the future spot exchange rate in an efficient market (Sarno & Taylor, 2002). Assuming risk neutrality and rational expectations, an investor will buy or sell a forward contract of a particular currency if she has an expectation of a future spot exchange rate which is different from the forward exchange rate. Hence the test of UIP is also known as the forward unbiasedness hypothesis. This is the cornerstone theory used to test for the foreign exchange market efficiency. However, there is a wide body of evidence (e.g. Fama, 1984; Clarida, Davis & Pedersen, 2009) which points to the failure of the forward exchange rate to act as an unbiased predictor of the future spot exchange rate. According to Froot & Thaler (1990), the forward exchange rate is not only biased but also systematically wrong in predicting the direction of the future spot exchange rate. This phenomenon is referred as the 'forward bias puzzle' (Sarno, 2005).

The final theory used in this thesis is the fundamental exchange rate theory. According to this theory, a currency is instinctively assumed to derive its value from the issuing country's economic fundamentals (e.g. Dornbusch, 1975). A strong economy should justify for a strong currency. Since the flotation of global currencies in the early 1970's, the behaviour of the exchange rates never fails to mesmerize even among the earnest of financial economists. Many exchange rate models, such as the portfolio balance model, the monetary model and the purchasing power parity (PPP) model, have been proposed to explain the behaviour of the exchange rates. However, most, if not all, of these models fail to outperform a random walk model (Meese & Rogoff, 1983; Cheung, Chinn & Pascual, 2005) and this reflects the failure of the fundamental exchange rate theory. Hence this anomaly is now called the fundamental-disconnect puzzle (Obstfeld & Rogoff, 2000).

1.1 Research Problem

The efficient markets hypothesis (EMH) is a classic issue in the field of finance. It remains an outstanding issue with equally strong voices from both sides of the camps. On the proponent camp, the leading pioneers are among others, Nobel Laureate Paul Samuelson (Samuelson, 1965, 1973), Eugene Fama (Fama, 1970, 1991, 1998), Burton Malkiel (Malkiel, 2003) and Stephen Brown (Brown, 2011) , while on the other side of the fence, some notable researchers are Sanford Grossman and Nobel Laureate Joseph Stigliz (Grossman & Stiglitz, 1980), Andrew Lo and Craig MacKinlay (Lo & MacKinlay, 1988) and Robert Shiller (Shiller, 2003). Both the proponents and opponents of the EMH have presented solid evidence and valid propositions regarding the state of efficiency in the markets. The paper by Fama (1970) is often seen as the pinnacle of EMH but the concept subsequently received vigorous attacks from all fronts. Grossman & Stiglitz (1980) presented a seminal paper in proposing that the EMH is impossible to be achieved. In defending the EMH, Fama (1991, 1998) has convincingly disputed the empirical evidence against market efficiency as a matter of chance. He explains that those anomalies found in the markets are not persistent phenomena and would likely disappear over time or through alteration in the techniques.

However, these explanations are not enough to sooth the fierce critics of EMH. The attacks against EMH become stronger especially after each financial or economic crisis. The bursting of the internet technology (IT) bubble in 2001, the subprime crisis in 2008 and most recently the Eurozone sovereign debt crisis in 2011 have all presented good opportunity for the attackers of EMH. Shiller (2003) argues that the markets are simply not efficient because the markets are made up of human beings. And being human, the market participants could be easily driven by emotion. He argues that the

anomalies reported by so many research papers cannot be just dismissed as chance results. There must be better ways to explain these market anomalies or puzzles. Therefore he suggests that behavioural finance is a better approach in understanding the markets. By combining the theories from psychology with the economic theories, Shiller believes behavioural finance may provide the solutions to the many puzzles found in the financial markets. Again, the proponents of EMH prominently surface another time to answer to these critics. Malkiel (2003) and Brown (2011) have come out with strong defence for the EMH. They argue that the evidence against the EMH is mostly due to the narrow interpretation and misunderstanding of the EMH. We are indeed living in exciting times to witness so much of intellectual debates on the EMH. Therefore the EMH may be a classic issue but definitely not a stale one. There is indeed a persistently good 'tension' in this area of research. This situation presents an obvious problem that remains unresolved. This thesis is intended to provide more empirical evidence in resolving this problem.

1.2 Research Objectives

There are three key objectives which we would like to achieve through this thesis. The main objective of this thesis is to investigate the state of foreign exchange markets efficiency. Unlike most of the previous studies in the literature, the core samples for this thesis are picked from the Asia-Pacific markets. There is a critical need to produce more studies which are related to this important region. The relatively long sample period coupled with a wide variety of countries from the Asia-Pacific region enable this thesis to provide a more solid view on the state of market efficiency. As briefly explained, the notion of EMH is an intricate concept and hence the markets might not be continuously efficient or inefficient. Therefore it is interesting to divide the

whole sample period into several subsample periods in order to have a closer look at whether the state of market efficiency is a time-varying concept.

The next objective of this thesis is to examine and, hopefully, contribute towards a resolution of the forward bias puzzle. The forward bias puzzle, as explained, is borne out of the failure of the uncovered interest-rate parity (UIP). This puzzle has been reported as a pervasive and persistent phenomenon (Sarno, 2005) and we intend to find out whether the forward bias puzzle exists in the Asia-Pacific foreign exchange markets. Furthermore, the use of such a diversified set of currencies from the Asia-Pacific region facilitates the examination of whether the forward bias puzzle can be explained by some institutional characteristics. This approach is stimulated by the findings from Bansal & Dahlquist (2000) and Frankel & Poonawala (2010). However, this thesis introduces a novel proxy to represent an important institutional characteristic which is the extent of foreign exchange market liberalization. The existence of an offshore non-deliverable forward (NDF) market signifies a particular currency as restricted and the absence of it, otherwise. This thesis is also intended to reconcile the frequently reported conflicting results of the forward unbiasedness hypothesis from the use of different techniques. The results from Fama regression and the Johansen cointegration technique, both of which are popularly used to test for the forward unbiasedness hypothesis, often yield contradictory results and there is no deliberate work on reconciling this inconsistency in the results. This thesis will fill the gap.

Lastly, the final objective of this thesis is to provide evidence whether there is any trace of link between the macroeconomic fundamental and the exchange rate. This objective is intended to indirectly address the fundamental disconnect puzzle. According to Obstfeld & Rogoff (2000), one of the big puzzles in exchange rate economics is the fundamental disconnect puzzle which refers to the failure of

macroeconomic fundamentals in predicting exchange rate movements. In this thesis, the event-study analysis is utilised to investigate the link between macroeconomic fundamentals and exchange rates. Macroeconomic fundaments are represented by the shocks in the respective macroecnomic announcements.[3] In addition, the event-study analysis approach also allows us to measure the exact impact of the macroeconomic shocks on foreign exchange rates. The impacts of the macroeconomic shocks are compared with each other. A ranking of the most impactful macroeconomic fundamentals is provided following the comparison exercise. In addition to this ranking, this thesis also offers a ranking of the most reactive exchange rates to macroeconomic shocks among the Asia-Pacific currencies. There are some studies which have shown that U.S. macroeconomic shocks are more significant than domestic macroeconomic shocks in influencing the foreign exchange rates (e.g. Almeida, Goodhart & Payne, 1998; Pearce & Solakoglu, 2007). This finding implies that foreign exchange rates are less reactive to domestic macroeconomic shocks. This conclusion is reassessed in this thesis with information from the Asia-Pacific currency markets.

1.3 Research Questions and Hypotheses

In order to achieve the three-pronged objectives as set out above, five research questions have been asked in this thesis. These are very prevalent questions and all of them are inter-related. Each of these questions is translated into a corresponding testable hypothesis. The formulation of the research hypotheses is necessary to facilitate the quest for answers to all the research questions. Some established econometric techniques are employed to empirically test each of the research hypotheses. The first research question is, "Are the Asia-Pacific foreign exchange markets efficient?". As explained in the earlier section, the results on market efficiency are mixed and hence

[3] We select 107 macroeoconomic announcements from all the sample countries and broadly categorise them into three groups according to the nature of the information the announcement conveys. The groups are namely (i) Inflation, money and prices (IPM), (ii) Production and business activity (PBA) and (iii) Total output, international trade and employment (TOITE). The details of these announcements are given in Table 3.8 under Chapter 3.

there should not be any assumption to the effect that the market is efficient or otherwise. The possible answer to the first research question could either be a 'yes' or 'no' or perhaps a mixture of both. This research question is translated into the following research hypothesis:

Hypothesis 1:

H_0: Asia-Pacific foreign exchange markets are efficient.

H_1: Asia-Pacific foreign exchange markets are not efficient.

As this is a neutral research hypothesis, there is no preference for either H_0 or H_1 to be correct. A rejection of the null hypothesis indicates market inefficiency while a failure to reject H_0 supports the notion of market efficiency in the Asia-Pacific foreign exchange markets. There are two main analyses which we use to test for the EMH in the foreign exchange market. The first one is the forward unbiasedness hypothesis which is based on the UIP theory. The market is efficient if the forward exchange rates are unbiased predictors of future spot exchange rates. Meanwhile, the second test is through the event-study analysis. The market is informationally efficient if exchange rates respond only to the surprise elements of some macroeconomic shocks.

Next, the second research question is related to the pervasive finding of the failure of the forward unbiasedness hypothesis based on the Fama regression technique. Research question two asks, "Does the forward bias puzzle exist in the Asia-Pacific foreign exchange market?". This question places the focus on the pervasiveness of the forward bias puzzle. There are a large number of papers (e.g. Fama, 1984; Froot & Thaler, 1990; Clarida, Davis & Pedersen 2009) which document the failure of the forward unbiasedness hypothesis when it is tested through the Fama regression. The forward bias puzzle specifically refers to the finding of a negative beta coefficient from

the Fama regression. The theoretical value of the beta estimate is supposed to be positive unity. As the past literature mostly employed those currencies from advanced economies, this thesis is different in the sense that it focuses on the geographical region of the Asia-Pacific foreign exchange markets. The research question is translated into a testable research hypothesis as follows:

Hypothesis 2:

H_0: The forward bias puzzle occurs in all of the Asia-Pacific foreign exchange markets.

H_1: The forward bias puzzle does not occur in all of the Asia-Pacific foreign exchange markets.

Once again, this is a neutral hypothesis as we do not have a preference for either H_0 or H_1. However, the null hypothesis is a more stringent statement because the forward bias puzzle must be identified in all of the 12 Asia-Pacific currency markets in order to be true. If there is only one currency market in the region which does not report evidence in favour of the forward bias puzzle, H_0 will be rejected and the puzzle is indeed a pervasive phenomenon.

Moving on, the third research question directs attention to whether the foreign exchange markets are consistently efficient under different economic circumstances (e.g. crisis and non-crisis periods). From the literature review, it is found that the conflicting evidence presented could be due to the use of different sample period. Therefore research question three asks this: "Are the foreign exchange markets consistently efficient throughout the sample period?". In order to answer this research question, the following research hypothesis is tested:

Hypothesis 3:

H_0: The foreign exchange markets are consistently efficient under different economic conditions.

H_1: The foreign exchange markets are not consistently efficient under different economic conditions.

As mentioned, the different findings reported in the literature could possibly be due to changing economic conditions. This perception makes the alternative hypothesis as the more likely result. This hypothesis conjectures that foreign exchange market efficiency is different under varying conditions and perhaps more efficient during non-crisis than during the crisis periods. The whole sample period from January 1, 1997 to December 31, 2010 is partitioned into six subsample periods to test for Hypothesis 3. If the results on market efficiency are consistent for all the subsample periods, the null hypothesis is accepted while the finding of at least one inconsistent result favours the alternative hypothesis. On top of that, this thesis is also interested to find out whether there is any coherent pattern in the changes of market efficiency for countries with different institutional characteristics.

Next, the fourth research question is related to whether domestic macroeconomic shocks are influential in affecting exchange rates; "Are the Asia-Pacific currencies muted to the surprises of their respective macroeconomic indicators?". As most of the international currencies are quoted against the USD, the exchange rate movement may just react to the U.S. macroeconomic shocks and the domestic macroeconomic announcements may be neglected. Moreover, some of the domestic economies are relatively very small in comparison to the U.S. economy and therefore may not contain much significant impact on the determination of the exchange rates.

The fourth research question is translated into the following research hypothesis to facilitate an empirical test:

Hypothesis 4:

H_0: Asia-Pacific currencies react to domestic macroeconomic surprises.

H_1: Asia-Pacific currencies do not react to domestic macroeconomic surprises.

In order to test for Research Hypothesis Four, the selected macroeconomic shocks are segregated into two categories namely the U.S. and domestic shocks. If exchange rates react to shocks from domestic macroeconomic announcements, the null hypothesis is supported and if there is no reaction, H_0 is rejected in favour of H_1. This research hypothesis is tested on each of the selected 12 Asia-Pacific currency markets. We believe H_0 will likely be supported but perhaps the reaction of the exchange rate to domestic macroeconomic shocks may not be as large as those reactions to U.S. macroeconomic shocks due to the relative size of the economies concerned.

The last research question brings the fundamental exchange rate theory into this thesis. It asks, "What are the key macroeconomic shocks that greatly affect the exchange rate movement?". It must be noted, however, that we do not directly test the fundamental exchange rate theory like most past studies (e.g. Meese & Rogoff, 1983; Cheung, Chinn & Pascual, 2005) which compared the forecasting performance of the proposed fundamental exchange rate model with a naive random walk model. In this thesis, we select a broad range of macroeconomic shocks and measure their relationships with the exchange rates. From the fundamental exchange rate theory, it is inferred that exchange rates should react to macroeconomic surprises. Therefore we run a regression of changes in the spot exchange rates on the macroeconomic surprises for

each announcement to identify the impact of such shocks to exchange rates. The relevant hypothesis for research question five is as follows:

Hypothesis 5:

H_0: Macroeconomic shock *'X'* has the highest impact in affecting foreign exchange returns.

H_1: Macroeconomic shock *'X'* is not the strongest factor in affecting foreign exchange returns.

In Research Hypothesis Five, we do not only measure the impact of a particular macroeconomic shock in isolation. The macroeconomic shocks for each announcement are standardized before the regression analysis and hence the resulting beta coefficient estimates are comparable to one another. Subsequently, the macroeconomic shocks are ranked according to their relative impact on exchange rates.

By employing appropriate techniques, all research hypotheses have been properly tested and in the process, some additional important insights to this area of research are also uncovered. In short, the research objectives as set out in the beginning of this thesis are successfully achieved.

1.4 Asia-Pacific Data as Core Sample

This thesis employs Asia-Pacific data as the core sample. The Asia-Pacific markets continue to gain a larger proportion of global markets trade transactions. Figure 1.1 on Page 2 shows the share of global trade from the twelve (12) Asia-Pacific countries selected for this thesis has almost doubled from 14% in 1980 to 27% in 2010. The 12 countries selected are Australia, China, India, Indonesia, Japan, Republic of Korea, Malaysia, New Zealand, Philippines, Singapore, Taiwan and Thailand. It is also often said that this region is the growth engine of the world economy in recent times. As

the Asia-Pacific region gains a larger share of the global economy, more research must be conducted to understand market conditions in this part of the world. Many research papers in the area of foreign exchange markets have focused on the advanced economies (e.g. Lothian & Wu, 2011; Clarida, Davis & Pedersen, 2009). Therefore most of the inferences from these past studies may be limited to only rich nations in Europe and North America. The findings from these past studies must be interpreted with caution and the resulting theories must not be treated as conventional wisdom without putting them to test with a wider range of empirical data especially with those data from the Asia-Pacific region. Researchers must be more actively engaged with the financial markets in this region to catch up with the large amount of research from more advanced countries.

Besides the growing importance of Asia-Pacific markets, another attraction of this region is that the countries within this region are undergoing various stages of development. There are advanced economies like Japan, Australia and New Zealand, newly-industrialised nations like Singapore, South Korea and Taiwan, newly-emerging large economies like China and India as well as developing countries like Malaysia, Thailand, Indonesia and Philippines. The advanced economies adopt a free-float exchange rate regime while the others adopt a variation of restricted regimes towards the management of their respective currencies. The diverse nature of this region is a very interesting case to research. Some of the common findings from this thesis will likely be easily generalized because if they appear in this diversity, it is likely they will appear in other situations or time periods. Therefore the inferences derived from this thesis which employs the Asia-Pacific data are much stronger.

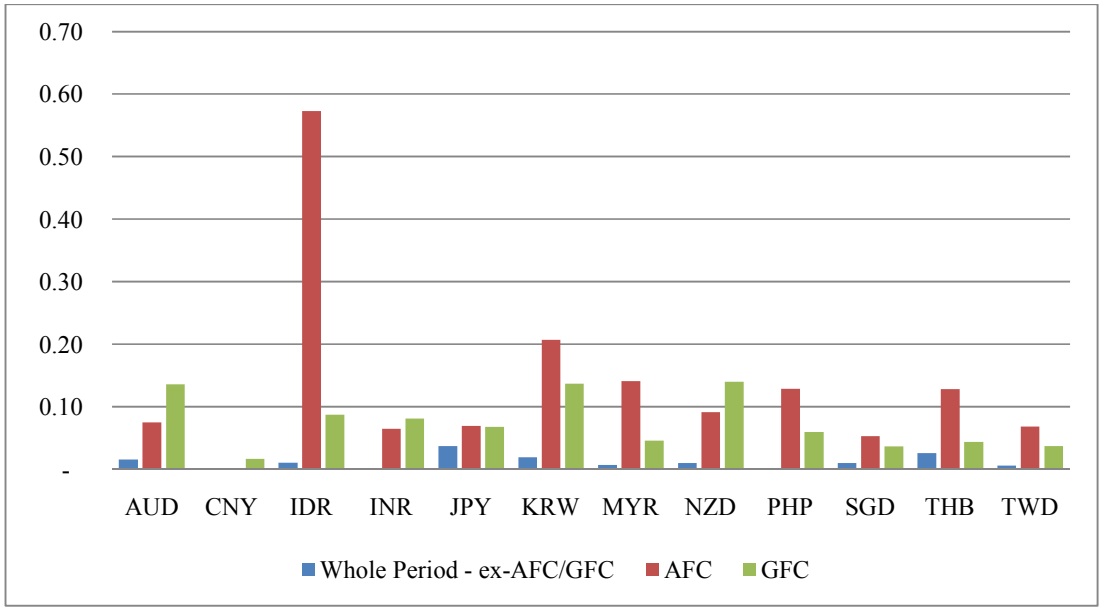
With the exception of the advanced economies in the region such as Australia, New Zealand, Japan, and to a lesser extent, Singapore, most of the other countries in

this region adopted a de-facto peg against the USD prior to the Asian financial crisis (AFC) in 1997/98. In the official pronouncement, the central banks of countries such as Malaysia, Thailand, Indonesia, South Korea and the Philippines stated that their currencies are managed under the free-float regime. But in reality, the exchange rates of these currencies hardly moved against the USD and researchers have argued that these currencies are in fact managed under a de-facto peg against the USD (Baig, 2001). In the height of the onslaught on the Asia-Pacific currency markets in 1997 and 1998, most of the central banks in this region had reverted to an actual free-float regime due to a pre-condition imposed by the International Monetary Fund (IMF) for the extension of aid package. Malaysia is an odd exception as it shifted the exchange rate policy to a fixed peg regime and snubbed the aid package from the IMF. This unorthodox approach by the Malaysian government in responding to the speculative attacks on its currency remains a controversial subject. Soon after the affected countries recovered from the AFC and were back on the growth path, the central banks of the respective countries have again shifted to some sort of managed-float regime. The developing nations of this region seem to be very reluctant to relieve their controls on the determination of their currencies' value purely to the market forces.

Since then, the Asia-Pacific financial markets have generally undergone a period of rejuvenation. The Asia-Pacific countries grow again strongly on the back of solid economic fundamentals. The banking system has improved while the corporate governance movement has also gained attention in these countries. The central banks have also mostly become very cautious and embarked on building up high level of foreign exchange reserves. Unfortunately, the period of robust growth did not last long as the global financial crisis (GFC) of 2008 and 2009 brought about by the meltdown of the subprime mortgage market in the U.S caused global economic growth to falter. The currencies in this region are not absolved from the crisis as evidenced by the high

volatility of these currencies during the GFC. Figure 1.2 below shows the volatility of selected Asia-Pacific currencies for the period of January 1, 1997 to December 31, 2005 (ex-AFC and GFC) and the two subsample periods which represent the AFC and GFC respectively.

Figure 1.2: Volatility of (Log) Spot Exchange Rates in Asia-Pacific: 1997 - 2010



The bar chart above shows the volatility (as measured by the standard deviation) of the spot exchange rates of the selected 12 Asia-Pacific currencies for the period from January 1, 1997 to December 31, 2010. The crisis subperiods namely the Asian financial crisis (AFC –Jul. 1, 1997 to Dec. 31, 1998) and global financial crisis (GFC – Jan. 1, 2008 to Dec. 31, 2009) are treated separately in order not to distort the volatility during normal time.

The volatility of the spot exchange rates is measured by taking the standard deviation of the exchange rate series for the particular period. For the whole period, we have excluded the observations from both the AFC and GFC. The observations for the AFC and the GFC subsample periods run from July 1, 1997 to December 31, 1998 and from January 1, 2008 to December 31, 2009, respectively. It is interesting to note that the volatilities for the whole period are miniscule in comparison to the volatilities recorded during the crisis subperiods. We also note that the IDR records the highest volatility among the selected Asia-Pacific currencies during the AFC. Meanwhile, in the

GFC, the advanced countries' currencies tend to record a higher level of volatility as compared to their developing counterparts.

Notwithstanding the comparisons between the advanced and developing countries within the region, the main result from Figure 1.2 is the obvious elevation of the level of volatility among the Asia-Pacific exchange rates during the crisis subsample periods. This observation could be due to the fact that most of the currencies of the Asia-Pacific countries are still viewed as susceptible to speculative attacks and hence carry a higher risk profile. Despite the improving economic fundamentals, we suspect that the foreign exchange markets in the Asia-Pacific are still relatively fragile to shocks in the global economy due to the high volatilities recorded during the GFC. This is one of the prime motivations which stimulated us to focus on the Asia-Pacific foreign exchange markets. There could be some distinctive and interesting results from using data from the Asia-Pacific region. The following subsection reiterates the importance of this research topic by putting the key points into a more organised perspective. A short description of the underlying philosophy is also offered in the same subsection.

1.5 Importance of this Topic and Underlying Philosophy

The constant debate related to the EMH is also a good testimony to the fervent interest among various sections of society in this topic. Academic researchers are quite divergent in their opinions about the veracity of the EMH in financial markets. The opposing view among academicians, however, is not something surprising. Meanwhile many fund managers, especially those who subscribe to the active funds management style, vehemently deny the concept of EMH. These fund managers believe that they possess the technical skills and analytical prowess to generate excess returns, or in the investment lingo – alpha, for clients who put up money with them. It is not hard to comprehend their distaste for the concept of EMH as they are largely motivated by the

potential monetary rewards. Not forgetting, the policy makers especially those from the political base, tend to put the blame on the blind faith of EMH for the failure in the financial markets. Instead of acknowledging their policy shortcomings, they may conveniently dismiss recession and collapse in the markets to the breakdown of EMH. Therefore a bona fide study like this thesis is important to shed more light on the factual evidence about the EMH.

This research topic is important in at least three ways. Firstly, markets efficiency is a core assumption in many economic theories (e.g. International Parity Theory) and asset pricing models (e.g. exchange rate forecasting model). If the markets are actually efficient as assumed, those theories and models may work fine and help us to explain the behaviour of financial markets. However, if the assumption of market efficiency is violated, those theories and models may not hold. Since EMH is an unresolved issue, it is important to channel more research efforts in this area. The results from this thesis show that the EMH generally holds true in the Asia-Pacific foreign exchange markets. Therefore most of the economic models and theory may be applicable to explain the exchange rates movements. However, the testing of the validity of any exchange rate model which assumes market efficiency must be conducted with caution. As the results from this thesis have shown, the state of efficiency is not constant throughout the sample period. Moreover, the currency markets under different exchange rate regimes may also experience different state of efficiency depending on the prevailing dominant economic conditions. Certain institutional characteristics may also affect the states of market efficiency. All these criteria must be taken into considerations if a useful model is to be proposed.

Secondly, the investigation of markets efficiency may also provide an indication on whether or not excess returns are possible to be obtained from the markets. If the

markets are efficient, it is not economical for a lay investor to put in time and other resources trying to beat the market. It would be an effort in futility. Average investors are better off just putting in their money in a portfolio of passive investments which suit their risk capacity. On the other hand, if the markets are inefficient, it may be profitable for an ardent investor to dedicate time and money in identifying the most profitable investment opportunity. In addition, institutions with strong financial resources may also be interested to set up an investment division to actively dabble in the market and subsequently exploit the inefficiency to earn an excess return. This research helps to ascertain whether there is any such opportunity for the average investors. As the results have shown, there is scant profitable opportunity because the foreign exchange markets are generally efficient. Even though the state of efficiency is broken intermittently, it is difficult to identify when the opportunity will arise until it is over (ex-ante against ex-post). Therefore it may not be advisable to speculate too heavily in the foreign exchange markets.

Thirdly, this research work is also important as it investigates whether there is any solid link between economic fundamentals and exchange rates. There is increasing evidence pointing to the decoupling of the exchange rates from economic fundamentals (Obsfeld & Rogoff, 2000; Sarno 2005). There are even some market participants who tend to believe that macroeconomic fundamentals do not affect exchange rates at all. They subscribe to the belief that the trend of historical prices is able to tell a better story about the future direction of prices. This group of investors, or rather speculators, are popularly known as chartists or technicians. In a not-so-extreme end, there are some market participants who believe that domestic macroeconomic fundamentals are weaker determinants as compared to the U.S. macroeconomic fundamentals in influencing exchange rates movements. Some investors in relatively small economies like Malaysia, Thailand and Philippines may think that the economic data from the distant U.S. have

stronger explanatory power than domestic data in characterising the returns on their investments. This research probes the authenticity of this belief by directly testing the reaction of exchange rates to various macroeconomic fundamentals. The results from this thesis dispel this belief by showing that exchange rates did respond significantly to the surprises in the macroeconomic shocks. It is also shown that domestic macroeconomic shocks are as important as U.S. macroeconomic shocks. Therefore market participants who wish to dabble in the foreign exchange markets must also pay attention to both the domestic and the U.S. macroeconomic announcements. In addition, we also provide a ranking of the most significant events which have the highest impact on the Asia-Pacific foreign exchange markets. This ranking helps the investors to zoom down into the macroeconomic announcements which truly matters in moving the exchange rates.

Next, a short discussion of the philosophical ground for this research is provided. This brief, yet important, discussion is crucial to ensure that this thesis tackles the correct fundamental questions of the financial markets and not to produce a piece of work based purely on rhetoric. This thesis provides reflexivity on the epistemological and methodological aspects of the financial markets. Similar to most mainstream finance researchers, we also subscribe to an objective ontological assumption. The application of appropriate quantitative techniques enables us to uncover the reality of the financial markets. By this assumption, the inferences from the results must be supported with empirical evidence. Meanwhile the epistemological assumption employed in this thesis borders between the objective and subjective perspectives. This thesis does not subscribe to naive empiricism whereby all interpretations of the findings are to be presented without critical evaluation. In other words, the empirical results must not be presented solely based on statistical figures. A deeper understanding of the financial markets in general and the sample currencies in particular, is necessary in

order to produce a more meaningful interpretation of the results. It is also acknowledged that our prior prejudices as well as the mainstream biases may influence the way we form the research questions and subsequently interpret the results. Therefore the interpretation of the findings and discussion of the inferences must be read with a certain level of caution. The emphasis of this research is to produce some practical guidance and incremental knowledge to financial market researchers and participants. In conclusion, the philosophical ground underlying this thesis is a mixture of positivism and pragmatic-critical realism. The following subsection summarises the significant contributions of this thesis.

1.6 Significant Contributions

This thesis has contributed in several ways to the academic literature as well as to the practical aspects of the foreign exchange markets. First and foremost, the empirical evidence shows that the foreign exchange markets in the Asia-Pacific region are generally efficient. This research is the first which uses both the forward unbiasedness hypothesis and the event-study analysis jointly in a single study to investigate the foreign exchange markets efficiency. The results from these two views are generally consistent with one another and hence our conclusion on market efficiency is well supported. This finding provides an affirmation to research question number one.

More importantly, this finding offers critical implications in several ways. One, an efficient foreign exchange market implies that the exchange rate movement is hard to predict and there is no excess profit to be earned in such a market. The excessive speculation of the foreign exchange markets, especially by retail investors, may end up with just a normal return and worse still, if the transaction costs are to be taken into account, the speculative trades may even end up in a loss. Investors are reminded to beware of the audacious claims made by certain foreign exchange gurus promising high

returns by simply subscribing to their so-called fool-proof trading strategies. In an efficient market, such a claim cannot be true. Two, the concept of EMH is a fair assumption to be used in the study of the foreign exchange market behaviour. This finding is especially important to financial economists. Many financial economists are working diligently to explain the behaviour of exchange rates by coming out with various exchange rate models. They may seek comfort from this thesis in applying the assumption of market efficiency in their research work because this assumption is supported by our empirical results. Three, this thesis lends further credence to the concept of EMH in the foreign exchange markets. We do not naively claim that our thesis brings the debate of the EMH to a closure but we believe, at the least, the evidence offered in this thesis has slightly tilted the balance in favour of the EMH generally.

Secondly, this thesis contributes, to a limited extent, towards the resolution of the forward bias puzzle. The forward unbiasedness hypothesis is tested through the conventional Fama regression as well as the Johansen cointegration. As expected, these two techniques provide conflicting results. The results from the Fama regression show violation of the notion of market efficiency. However, these results came as no surprise as there is already a huge volume of evidence indicating the rejection of market efficiency using the conventional Fama regression (e.g. Engel, 1996; Chinn, 2006; Lothian & Wu, 2011). Moreover, the estimated beta from the Fama regression sometimes yield negative values which is a more severe rejection of the forward unbiasedness hypothesis and this phenomenon is now popularly called the forward bias puzzle (Sarno, 2005). Upon compartmentalization of the whole sample period into several subsample periods, the results show that the forward bias puzzle is not a uniform phenomenon across time. This finding provides an answer to the research question

number two. The forward bias puzzle exists in different time periods and also among different set of currencies.

Meanwhile, the results from the Johansen cointegration technique have generally supported the case for an efficient foreign exchange market. In view of these contrasting results between the conventional Fama regression and the Johansen cointegration technique, we have adopted the models proposed by Pilbeam & Olmo (2011) to reconcile the results. According to Pilbeam & Olmo (2011), the conventional Fama regression suffers from a negative bias due to the marked difference in the volatilities between the spot and forward exchange rates. They propose an enhanced model to address the inherent econometric weaknesses of the Fama regression. We apply their models with the sample of this thesis. The results indicate strong evidence in support of market efficiency in the Asia-Pacific foreign exchange markets. The forward bias puzzle disappears with the modification in the Fama regression as recommended by Pilbeam & Olmo (2011). This thesis confirms the robustness of the Pilbeam & Olmo's (2011) models. The original Pilbeam & Olmo (2011) paper employed only advanced countries' currencies whereas this thesis adopts a wider variety of currencies. Upon reconciliation, the results are now consistent. Hence this thesis provides a conclusion that the foreign exchange markets are efficient and the forward bias puzzle is once again proven as a statistical artefact.[4]

Thirdly, motivated by Bansal & Dahlquist (2000), this thesis finds that the foreign exchange market efficiency condition is contingent upon the institutional characteristics of the particular markets. Two institutional characteristics are selected for testing whether they have any role in influencing the state of market efficiency. The first institutional characteristic is the national income level. The sample currencies are

[4] Pilbeam & Olmo (2011) have first claimed that the forward bias puzzle is a statistical artifact through the empirical testing conducted by them with the advanced nations' currencies. This thesis reaffirms this conclusion with a different set of currencies.

categorised into two groups differentiated by the level of national income as provided by the World Bank database in 2009. This institutional characteristic has also been used in Bansal & Dahlquist (2000) and it is shown to be an important feature in affecting the state of market efficiency. This thesis once again confirms the robustness of this institutional characteristic as a distinguishing attribute. Rich and medium income nations display different results under different economic conditions. The second institutional characteristic adopted in this thesis is the extent of foreign exchange market liberalization. This characteristic is represented by the non-deliverable forward (NDF) market. A currency which is traded in the NDF market is considered restricted while the ones which do not, are considered liberalized. This characteristic is a novel introduction in this thesis and it is shown that it is another key feature which could explain the changing state of the foreign exchange market efficiency. Chapter 4 reports how these institutional characteristics affect the foreign exchange market efficiency in greater detail.

Fourthly, this thesis shows that there are slightly more disturbances during the crisis than the non-crisis periods but this differentiation is not very substantial. This finding answers the research question number three in the affirmative again. However, a more interesting finding emerges when the results from different subsample periods are compared with one another. The evidence indicates that the Asian financial crisis (AFC) 1997/98 was a more disturbing event than the global financial crisis (GFC) of 2008/09 for the countries in the sample. Through the results from the bivariate cointegration test and the Pilbeam & Olmo (2011)'s model (2), it is shown that the AFC is a more severe event in affecting the Asia-Pacific foreign exchange markets. There are more signs of market inefficiency during the AFC than the GFC. We do not have a definite answer on what cause the AFC to be more disturbing. This is an interesting question which warrants for further research. From the results, we suggest that the AFC is more

disturbing because it was hitting the region directly at its heart. To begin with, the AFC was emanated from the attack on currencies in Southeast Asia and spread like crossfire to the bigger part of Asia-Pacific. Meanwhile, the GFC was originated from the U.S. and transmitted to the other countries rapidly. During the AFC, many local financial institutions filed for bankruptcy or were forced to merge with a bigger entity. Hence the disappearing of financial institutions, which were crucial players in the market, could have affected the state of foreign exchange market efficiency. Another explanation for this observation could be due to improved monetary policy from the Asia-Pacific authorities. Since the AFC, most of the central banks from the Asia-Pacific region were aggressively building up huge buffer in the form of international reserves to withstand external shocks. Moreover, these central banks also boasted about the reforms being undertaken to strengthen the local financial systems in their respective countries. The stronger fundamentals coupled with the huge buffer during the GFC could have averted the markets from falling into inefficiency.

Fifthly, this thesis adds to the literature which shows that the flexible foreign exchange regime as the more optimal choice of currency management system. The 12 Asia-Pacific currencies used in this thesis are broadly categorised into free-float and managed-float regimes respectively. The results indicate that the free-float currencies are more resilient than the managed-float currencies in term of market efficiency during a financial crisis. This finding lends credence to Edwards & Levy Yeyati (2005) who claim that flexible exchange rates are shock absorbers. Policy makers who have difficulty in deciding which of the foreign exchange rate regimes to adopt may use this thesis as a reference point. The evidence here provides an indication that a flexible exchange rate regime is more favourable in helping an economy to absorb certain shocks. However, this thesis does not recommend a blind adoption of a flexible exchange rate regime. It must be noted that the market efficiency is only one of the key

aspects and thus the policy makers must weigh all the other criteria objectively in deciding which of the foreign exchange regimes is best for their country.

Sixthly, through the event-study analysis, this thesis finds that exchange rates react to domestic macroeconomic shocks as much as to U.S. macroeconomic shocks. This finding helps to provide an answer to research question number four. Even though the local economies may be small in relation to the size of the U.S., exchange rates are still responsive to the shocks emanating from the local economy. This finding represents a departure from the results reported by Cai, Joo & Huang (2009) which state that domestic macroeconomic shocks are less significant in affecting the exchange rates. Market participants must pay close attention not only to macroeconomic announcements from the U.S. but also those from domestic economies. This finding also supports the fundamental exchange rate theory. There is significant a relationship between macroeconomic fundamentals and exchange rates. Hence the currency is not exactly wandering without proper direction. The demonstration of some random behaviour of exchange rates could be due to the differing views in the interpretations of the economic impact on the exchange rates. There are always competing theories in the field of economics. For example, during times of crisis, Keynesian economists propagate for a fiscal stimulus package in order to avoid further contraction while neo-classical economists promote fiscal austerity for long-run benefits. There is no definite right answer. Therefore it is these differing views which could likely cause exchange rates to appear as moving up and down without a clear direction.

Finally, this thesis has provided a useful ranking of the relative impact of macroeconomic shocks on the exchange rates. In a novel approach, we have conducted a pooled regression analysis of all the 12 Asia-Pacific exchange rates on each macroeconomic event. The results from this regression analysis provide an answer to

research question number five. From the results, we have ranked all the 107 macroeconomic shocks selected in this thesis by their relative impact. The most impactful event is identified as the shocks in the Federal Open Market Committee (FOMC)'s announcement on the Federal Fund Reserves (FFR) rate and followed by the shocks in the Reserve Bank of Australia (RBA)'s announcement on the Cash Target Rate. This finding implies that shocks in interest-rate setting announcements are very important in affecting exchange rates movements. This finding is logical because most of the monetary authorities in the Asia-Pacific region adopt an inflation-targeting rather than an exchange-rate targeting policy.[5] In comparison to the literature, many research papers (e.g. Almeida, Goodhart & Payne, 1998; Andersen et al., 2003; Pearce & Solakoglu, 2007) have cited shocks in the U.S. Non-farm payroll (NFP) announcement as the most important event. While the shock in the NFP is still an important event in our ranking, its significance is overstated if we generalised the results from the literature to the Asia-Pacific currencies. Therefore these results provide an important insight especially to the foreign exchange markets in Asia-Pacific.

As academic and industry researchers are continuously working to produce a comprehensive exchange rate model, this ranking helps them to determine which macroeconomic fundamentals should carry a bigger weight in the proposed model or theory. Therefore this research functions as an important reference point to the foreign exchange modelling or forecasting exercise. The ranking of the most significant macroeconomic shocks is also useful to market participants in zooming down their focus to the shocks which are significant and not to waste precious resources on those insignificant ones. Besides the ranking of the relative impact of the macroeconomic shocks on the exchange rates, we have also provided a ranking on the most reactive currencies in the Asia-Pacific region. The AUD has been identified as the most elastic

[5] An obvious exception is the Monetary Authority of Singapore (MAS) which adopts the exchange-rate targeting as its monetary policy.

currency, ahead of JPY, in the Asia-Pacific region to the shocks in the selected macroeconomic indicators. NZD and JPY are the next most reactive currencies to the shocks in the macroeconomic indicators.

In a nutshell, the findings from this thesis have collectively contributed significantly to the literature. Besides answering all the research questions, this thesis has also provided some useful guides and informative results to the market participants, policy makers and other researchers.

1.7 Chapter Summary

In this chapter, we introduce the main theme of the thesis and present the research problem and the potential gaps which this thesis intends to resolve and fill. The foreign exchange market is the largest and most integrated financial market in the world. Unfortunately, the notion of markets efficiency in the foreign exchange markets remains a long-standing unresolved issue in international finance. As set out in the research objectives, this thesis aims to provide some resolutions to the theory of EMH in foreign exchange markets. The research objectives would be achieved if this thesis is able to provide answers to the necessary research questions. The research questions which are pondered upon in this thesis have all been translated into testable hypotheses. Some appropriate econometric techniques, which will be detailed in later chapter, are employed to test for those research hypotheses.

Unlike most of the past studies, this thesis employs the currencies from the Asia-Pacific region which consist of a wide variety of samples with different nature and characteristics. Some justifications regarding the choice of the core sample are provided in this chapter too. The importance of this research topic is emphasised from three perspectives are described at length in this chapter. In the same subsection, we also shared the philosophical grounds of this thesis. The significant contributions of this

thesis are impressed upon by relating how the research findings add value to the existing academic literature. Some of the findings are also able to provide useful guides to market practitioners as well as policy makers alike.

The outline of the remaining chapters of this thesis is as follows: In Chapter 2: Literature Review, some notable previous works of other researchers in similar areas of interest is discussed. Upon an extensive, and almost exhaustive, review of the literature, the research gaps are recognised. This thesis surfaces with an ambitious intention to fill up these gaps. In Chapter 3: Research Methodologies, we explain at length and in great detail about the research methods which are employed in this thesis. The appropriate types of tests used to analyse the research questions are laid out in Chapter 3. The full sets of results and discussions are conveyed in Chapter 4: Results and Discussions. Some selected notable findings uncovered from the analyses are put forward for discussions. We relate and compare our important findings to other research papers in the literature. Lastly, in Chapter 5: Conclusions, the summary of the whole thesis is recalled. The research problem, questions and hypothesis and how these hypotheses are tested in order to achieve the research objectives are recollected in this chapter. In the same chapter, the readers are cautioned with some of the potential pitfalls contained within the thesis. These limitations, however, should not alter the results in a significant way. We have in fact suggested ways to further improve on this thesis by tackling each of the potential pitfalls. Overall, the methodologies used in this thesis are considered optimum in providing answers to the research questions. Chapter 5 ends with some recommendations on some worthy topics for future research.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The literature related to the concept of market efficiency is vast. The focus of this thesis is however limited in scope to foreign exchange market efficiency. We present the past research works based on their common conceptual framework. As a start, we update the literature related to the classical model of the efficient markets hypothesis (EMH) popularised by Fama (1970). Then the chapter zooms into the specific conceptual frameworks conventionally used to test for foreign exchange markets efficiency. The related conceptual frameworks are the forward unbiasedness hypothesis and the event-study analysis. We review, as comprehensively as possible, the literature related to the forward unbiasedness hypothesis and the event-study analysis. The forward unbiasedness hypothesis, arising from the uncovered interest-rate parity (UIP) condition, is the distinctive theory used in the literature of foreign exchange market efficiency. Under the forward unbiasedness hypothesis, there are two popular techniques, namely the Fama regression and Johansen cointegration analysis, employed to test for the unbiasedness hypothesis. On the other hand, the event-study analysis, which is customarily used to test for the semi-strong form market efficiency, is also applicable in the research on the foreign exchange market efficiency. Before the chapter is concluded, we spell out the research gaps and establish the connection between this thesis and the past research works.

2.1 Efficient Markets Hypothesis

The concept of market efficiency has been in existence since the beginning of human intelligence. This simple but yet confounding concept has been elegantly put into context by Eugene Fama in his 1970 seminal paper entitled 'Efficient Capital Markets: A Review of Theory and Empirical Work' (Fama, 1970). This paper was followed by a sequel in 1991 (Fama, 1991) and a 'triquel' in 1998 (Fama, 1998) in which the three papers are collectively known as the 'Trilogy of Efficient Markets Hypothesis'. The theoretical framework presented in Fama (1970) is now popularly known as the efficient markets hypothesis (EMH) and has become a must-learn chapter in most, if not all, of the finance courses taught in the university. From the outset, we must take note that the concept of EMH is different from the notions of economic efficiency and perfect markets. The latter two concepts are related to allocative efficiency of economic resources and the perfect substitutability of goods in the market. Meanwhile, EMH is about informational efficiency of the market in which the security prices should have already discounted all possibly available information and there is no opportunity for excess returns in the long run. It is apparent from this perspective that the EMH is more closely related to the field of finance rather than economics.

The set of information has been categorized as historical, current and private (or privileged) information. Based on this categorization of information, Fama (1970) has proposed three forms of market efficiency to facilitate empirical work. The most basic form of market efficiency is the weak-form efficiency. In a weak form efficient market, the prices of securities have already impounded all the historical information (e.g. past prices and past profits). There should not be any profitable opportunity to make abnormal profit by studying the historical information in a weak-form efficient market. Prices in a weak form efficient market follow a random pattern and are independently

and usually identically distributed. This form is mostly supported in the literature. The second form of market efficiency is the semi-strong efficient market. In a semi-strong-form efficient market, the prices of securities should have reflected all current publicly-available information, including past information. The prices in a semi-strong-form efficient market should adjust promptly to the arrival of new information. This is the most popular form for empirical research and testing. The strong form efficiency is a condition where all information, including private and privileged information, is reflected in the securities' prices. This form is the most difficult condition to test as the private information is not easily available. In fact, the definition of privileged information is very restrictive because a piece of information which subsequently becomes available to a researcher is no longer considered privileged. This represents a difficulty to the researchers to convince the audience about their claim on the authenticity of the privileged information.

Despite the numerous academic research papers in support of market efficiency especially in the weak- and semi-strong form categories (e.g. Malkiel, 2003; Fama, 1998), most market practitioners, especially 'technicians', dispute the validity of the theory. They prefer to rely on charts which display the historical price movements or the study of the historical financial information to identify any under-priced asset. Unfortunately, most of the claims by this group of anti-EMH practitioners lack rigour and most likely fail the test of time (i.e. their claims on superior returns are usually period-dependent) (Cialenco & Protopapadakis, 2011; Lee, Pan & Liu 2001). It is not difficult to understand why constant criticisms are levelled against the EMH by these practitioners. The market has to be inefficient in order for them to add value and subsequently charge exorbitant fees. For some, the economic temptations seem too hard to resist. Nevertheless, there are also some credible attacks against the EMH (e.g. Grossman & Stiglitz, 1980; Lo & MacKinlay, 1988; Shiller, 2003) from academic

circles. These papers presented both the theoretical and empirical evidence regarding the failure and, even the impossibility, of EMH. In defending the EMH, Fama (1998), Malkiel (2003) and Brown (2011) have provided convincing replies to these critics. These well-learned scholars have argued that the attacks on EMH are mainly borne out of misunderstanding of its true meaning. The misconception usually lies with the assumption about the 'correctness' of security prices in an efficient market. While correct prices may imply an efficient market, the reverse implication does not follow (Brown, 2011). Therefore the case for EMH is strong and a proper understanding of the concept is important to avoid potential misconception.

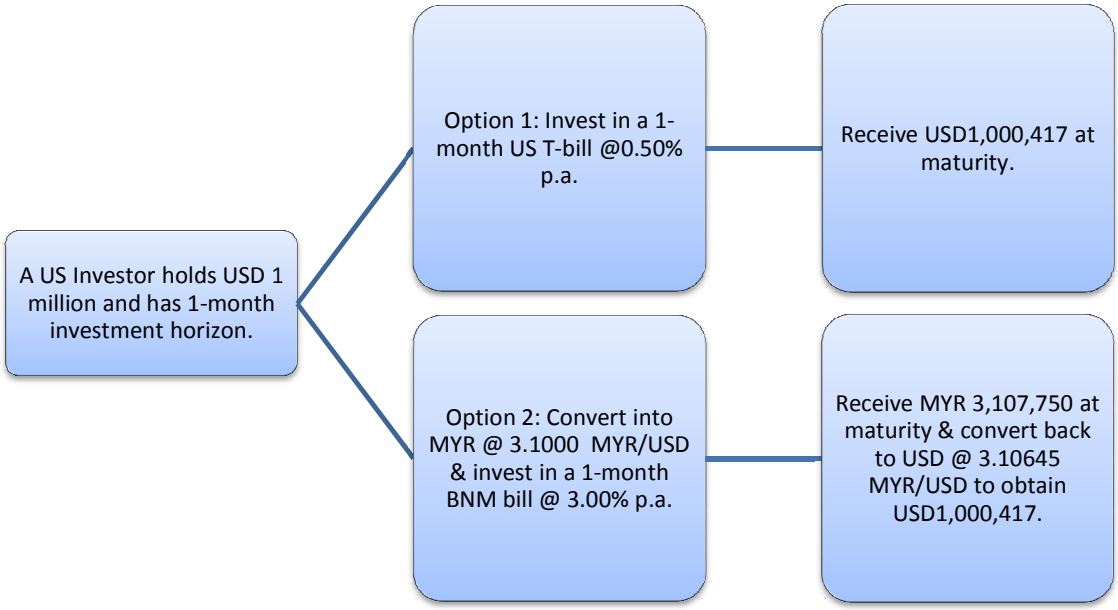
As the above explanations implied, there are various techniques which could be used to test for market efficiency. The test of random walk property of the exchange rates is one of those techniques which are popularly used. In a weak-form efficient market, the exchange rate series must fulfil the property of a random walk. According to the random walk hypothesis, the returns of a series are independently and identically distributed (IID). It is often tested with a few widely-known types of tests such as the variance-ratio test, the autocorrelation coefficient test and a runs test. There is a widespread support for market efficiency from these techniques (e.g. Azad, 2009; Aroskar, Sarkar & Swanson, 2004). Since this is quite a well-established area, we do not employ this technique in our thesis. We have limited our techniques to those related to the forward unbiasedness hypothesis and the event-study analysis.

2.2 Forward Unbiasedness Hypothesis and Markets Efficiency

Even though the EMH is typically illustrated using capital markets, it is equally applicable to foreign exchange markets. The testing of foreign exchange markets efficiency has been evolving with improvements in econometric techniques. The earlier version of tests of foreign exchange markets efficiency is based on the unbiasedness

hypothesis of the forward rate as predictor of future spot rate. The forward unbiasedness hypothesis is derived from the uncovered interest-rate parity (UIP). According to the UIP, a similar risk profile investment should provide similar return regardless of the currency of denomination.

Figure 2.1: Investor's Options when Uncovered Interest-rate Parity Holds True.



An investors holds USD1 million is indifferent to the two investment options whether to invest in a 1-month US Treasury bill which yields 0.05% per annum or convert the principal into Malaysian ringgit (MYR) and invest in a 1-month Bank Negara Malaysia (BNM) bill which yields 3.00% per annum if uncovered interest-rate parity (UIP) holds. According to the UIP, the interest rate differential advantage of BNM bill will be exactly offset by the depreciation of the MYR against the USD in the same quantum. Hence the returns at maturity are the same for the two options. In the scenario above, the MYR has to depreciate, or expected to depreciate, to 3.10645 MYR/USD for the UIP to be true.

As an illustration, assume a U.S. investor owns USD1,000,000 and has a one-month investment horizon. He has the option to invest this money in 1-month U.S. treasury bills which pay 0.50% per annum or to convert them into Malaysian ringgit (MYR) and invest them in the equivalent Malaysian treasury bills which pay 3.00% per annum. Which investment alternative gives higher returns? Even though there is an interest differential advantage of 2.50% per annum for the Malaysian treasury bills, the investor is not better off if UIP holds. According to the UIP, the investor should be indifferent to these two options because the exchange rate changes should offset

whatever interest differentials (i.e. 2.50% p.a.) between the two instruments. In this scenario, the MYR should depreciate by about 0.208% over the one-month investment horizon. Figure 2.1 in the previous page illustrates this scenario. The condition illustrated in Figure 2.1 has been frequently tested with the Fama regression and Johansen cointegration technique.

Before we discuss UIP further, it is beneficial for us to explain an inter-related theory: the covered interest-rate parity (CIP). The CIP is used to derive the forward exchange rate and this forms a pertinent link between exchange rates and interest rates. The CIP is an arbitrage condition and must hold true in most circumstances (Baillie & Chang, 2011; Pilbeam & Olmo, 2011). The CIP condition is given by equation 2.1.

$$F_t = \frac{S_t(1+r^*)}{(1+r)} \tag{2.1}$$

F denotes the forward exchange rate determined at time *t* for maturity one-period ahead, *S* is the spot exchange rate at time *t* while *r* denotes the one-period ahead interest rate with the sign * signifies foreign interest rate. Both the *F* and *S* are quoted in terms of domestic currency per one-unit of foreign currency. In research, the equation above is usually converted to logarithms by taking log of both sides of the equation. After taking the logarithm and proper rearrangement of the terms in equation 2.1, we obtain equation 2.2.

$$f_t - s_t = r^* - r \tag{2.2}$$

From equation 2.2, it is obvious that the forward premium[6] is approximately the interest-rate differential between the two countries. The main difference between the CIP and the UIP lies in the arbitrage condition. The UIP is not an arbitrage condition

[6] The forward premium is derived when the forward rate is higher than the spot rate. If the opposite is true, the difference between the forward and spot exchange rates will be known as a forward discount. In order to avoid confusion and to maintain consistency, we will only use the term forward premium to describe the differential between the forward and spot exchange rates.

because the equilibrium between the forward and future spot exchange rate is dependent upon the expectation of the agent with regards to the future spot exchange rate. Meanwhile, the CIP will present an arbitrage opportunity if the forward premium does not equal to the interest-rate differential. For illustration, we refer back to Figure 2.1. If the forward exchange rate at the inception of Option 2 is lower than 3.10645 (say 3.1010), the investor can simply sell the USD at spot rate (3.1000), invest the proceeds (MYR3,000,000) in BNM bills and buy the USD at the forward rate (i.e. 3.1010). Upon maturity of the forward contract, the investor will receive MYR3,107,750 and convert the sum back to USD at the contracted forward rate of 3.1010 which yields an amount of USD1,002,177. This final amount is more than what the investor will get if the USD is used to buy the U.S. T-bill (i.e. USD1,000,417) during the inception. The USD1,760 represents an arbitrage profit because it virtually involves no risk to the investor. If there is such an arbitrage opportunity, the investors will collectively transact in the same direction until the forward exchange rate equal to the interest-rate differentials between the two countries.[7] Therefore it is highly unlikely that the large financial institutions will let this window of opportunity lingers in the foreign exchange markets. However, there are some research papers which show that the CIP does not hold continuously and as a result, the breakdown of CIP presents a short window of opportunity (Akram, Rime & Sarno, 2008). Moreover, Baba & Packer (2009) have shown that there is a serious dislocation between the forward premium and the interest-rate differentials in the foreign exchange swap market during the height of the global financial crisis (GFC) of 2007 – 2008. Despite this meek evidence against CIP, it is still largely a true relationship. Like in most papers (e.g. Baillie & Chang, 2011; Chinn, 2006), we assume that CIP holds true and we have chosen to use the forward premium instead of the interest-rate differentials. In the following sections, we discuss tests of UIP and related

[7] In practice, the market participants will most likely transact in the foreign exchange swap (FX swap) market to reap the arbitrage opportunity. This is evidenced by the higher daily transaction volume in the FX swap market (i.e. USD1.8trillion) than the spot market (i.e. USD1.5trillion) (BIS, 2010).

works in this area. We deliberate firstly about the Fama regression followed by the cointegration technique.

2.2.1 Forward Unbiasedness Hypothesis and Fama Regression

In a rational expectation situation, the forward exchange rate will be equal to the expected future spot rate. Any deviation of market expectation from the forward exchange rate, which is represented by the interest-rate differential between two currencies, would have caused market participants to transact in the market until the forward exchange rate is equal to the market expectation of the future spot exchange rate. Basically, the market participants can either transact in the spot foreign exchange market or alternatively, the money market to move the interest rate in order to make the forward rate equal to the expected future spot exchange rate. The former method is usually preferred as it is relatively easier to access the foreign exchange market than the money market. Using the information described in the earlier example, market participants who expect that MYR would not depreciate against the USD by more than 0.208% in one-month time would buy MYR against USD and vice versa. In an efficient market, this situation will equilibrate the forward exchange rate to the market expectation of the future spot exchange rate. This is the underlying fundamental of the forward unbiasedness hypothesis. Equation 2.3 below captures the essence of the relationship between the forward exchange rate and the expected future spot exchange rate.

$$f_t^m = s_{t+m}^e \tag{2.3}$$

f and *s* are the log forward and spot exchange rates respectively. The superscript *e* is to signify the unconditional expectation of spot exchange rate in *m* period. The above equation also implies risk neutrality of market participants. Since S^e_{t+m} is an unobservable variable, we have to make an assumption that market participants are

rational and they form their expectation based on all current and past information available in the market in order to quantify the variable. With the rational expectation assumption, we can rewrite equation 2.3 as follows:

$$f_t^m = E(s_{t+m}|\Omega_t) \tag{2.4}$$

E_t (/) is the mathematical notation for conditional expectation and Ω_t denotes all available information up to time *t*. If the forward unbiasedness hypothesis holds true, the market is efficient and the forward exchange rate is an unbiased predictor of the future spot exchange rate. The two key assumptions in the testing of foreign exchange market efficiency through the forward unbiasedness hypothesis are (i) market participants are risk neutral to foreign exchange risks, and (ii) market participants are rational in forming their expectation of the future spot exchange rate. The combined assumptions of risk neutrality and rational expectation make this version of EMH known as the risk-neutral efficient markets hypothesis (RNEMH) (Chinn, 2006). Therefore the test of RNEMH is in fact a joint test of risk neutrality and rational expectation (Frankel & Poonawala, 2010; Sarno & Taylor, 2002). RNEMH is usually tested by regressing the changes of spot exchange rates on the lagged forward premium (see Sarno & Taylor, 2002). The resulting regression equation is given as follows:

$$\Delta s_{t+m} = \alpha + \beta\left(f_{t+m,t} - s_t\right) + \varepsilon_t \tag{2.5}$$

The null hypothesis for an efficient market is the condition in which α and β in equation 2.5 are jointly equal to zero and unity respectively against the alternative of at least one of the equality is not true. It must be noted that the test of the unbiasedness is always on the null hypothesis and not the usual alternative hypothesis as in most statistical exercises. In other words, the failure to reject the null hypothesis indicates market efficiency while the rejection of the null implies the opposite. This regression test has been widely employed in the investigation of RNEMH for decades (e.g. Lothian

& Wu, 2011; Frankel & Poonawala, 2010; Baillie & Bollerslev, 2000; Bansal & Dahlquist, 2000; Froot & Thaler, 1990; Fama, 1984; Bilson, 1981). This regression is now popularly known as the Fama regression (Clarida, Davis & Pedersen, 2009; Gilmore & Hayashi, 2008) due to Fama (1984). Even though the application of this regression preceded the seminal paper by Fama (1984), this regression is named as such because of Fama's contribution in decomposing the β coefficient of the equation. The null hypothesis of the Fama regression has been pervasively and persistently rejected in most empirical studies. The finding is pervasive because it is found to occur in many currency markets (Frankel & Poonawala, 2010; Bansal & Dahlquist, 2000). The finding is also persistent because it is has been in existence since the 1970s until now (e.g. Hansen & Hodrick, 1980; Frankel & Poonawala, 2010). In the early 1980s, most of the evidence against the forward unbiasedness hypothesis is derived from the 1970s exchange rate data and therefore there was a popular belief that the forward bias puzzle is a temporary phenomenon as the foreign exchange markets were still adjusting from the shift of Bretton Woods exchange rate system to a floating exchange rate regime (Fama, 1984). Researchers believed that the rejection of the null hypothesis would disappear once market participants learn about it and subsequently execute some trading strategy to correct the anomaly. However, this belief is found to be a false hope as the phenomenon is still persistent and the same results are reported until today (Sarno, 2005).

The β coefficient is not only significantly different from unity but also found to be closer to negative unity. This has a puzzling implication. The negative unity β coefficient implies that the prediction provided by the forward premium to the future changes in the spot exchange rates is not only biased but also systematically wrong! According to Froot & Thaler (1990), the average β coefficient of the Fama regression from 75 published papers is -0.88. This finding means that it is profitable to trade

against the prediction provided by the forward premium (Villanueva, 2007). This phenomenon is now known as the forward bias puzzle (Engel, 1996; Sarno, 2005). The forward bias puzzle is generally attributed to the failure of either one or both of the assumptions (i.e. risk neutrality and rational expectation) underlying the testing of RNEMH. The mystery is why this phenomenon is so persistent. Researchers have proposed a few explanations to this question. In the late 1980s and early 1990s, the most popular of all the proposed explanations is the distortion in the Fama regression caused by the existence of a risk premium. Most researchers in this direction have found it hard to reconcile the risk premium with the high risk aversion parameter usually reported in the test of the UIP (Engel, 1996). This puzzle is often considered the equivalence of the equity premium puzzle. Wu (2007), who utilizes the term structure of interest rate to extract the possible currency risk premium, shows that even after adjusting for the risk premium, the findings of forward bias puzzle are still reported. Engel (1996) provides a lengthy but exemplary survey on the extent of success by using the risk premium explanation for the pervasive findings of the forward bias puzzle. He concludes that the risk premium explanation fails in this purpose.

Chinn (2006) has provided a review of some of the promising explanations to the forward bias puzzle. He shows evidence that the UIP usually holds true when long-horizon data are employed or when alternative expectations theories are adopted. Chinn also reports that there is less rejection of UIP among the emerging market currencies. Some of the recent papers which emerge after Chinn (2006) provide vindications to his claims (e.g. Lothian & Wu, 2011). Burnside, Eichenbaum & Rebelo, (2009) shift the emphasis to explain the forward bias puzzle to the failure of market expectations. They have adopted a market microstructure approach to show that the forward bias puzzle is explainable with the adverse-selection problem between the market makers and informed traders. They argue that the forward bias puzzle will be reported as long as the

two important adverse-selection conditions are present: (i) exchange rates are hard to predict from public information and (ii) there are informed traders who can successfully register positive excess returns from the foreign exchange markets. These two conditions are widely reported to be present in real life. Chakraborty & Evans (2008) have also focused on the failure of the market expectation to explain the forward bias puzzle phenomenon. They propose a model of perpetual learning of market participants as an explanation to the observation of forward bias puzzle. They claim that their proposal is superior because besides accounting for the negative Fama beta, the perpetual learning model is also able to mimic other salient features of the data such as positive autocorrelation in the forward premium and the vanishing of the puzzle when tested in other forms.

A number of recent alternative explanations have also emerged to address the phenomenon of the forward bias puzzle. Explanations such as rational inattention (Bacchetta & Van Wincoop, 2005), volatility regimes artefact (Clarida, Davis & Pedersen, 2009), the use of long time-span data (Lothian & Wu, 2011), more easily identifiable trends of depreciation of emerging market currencies (Frankel & Poonawala, 2010), the small-sample bias and persistent autocorrelation in the forward premium (Baillie & Bollerslev, 2000) and improper treatment of different volatility between forward and spot exchange rates (Pilbeam & Olmo, 2011) have been rendered to explain the widespread rejection of the null hypothesis of the Fama regression. Bachetta & Van Wincoop (2005) refer to rational inattention as the limited capacity of market agents in processing information as well as the costs involved in collecting such information. They show that their model of rational inattention is able to better explain the forward bias puzzle phenomenon. This method is considered part of the microstructure approach. Meanwhile, Clarida, Davis & Pedersen (2009) observe that high interest-rate currencies tend to depreciate against their lower interest-rate

counterparts during crisis periods. Their suspicion became stronger in the wake of the global financial crisis 2007-2008 with the massive unwinding in the currency carry trade activities. They have conducted an econometric test to show that the forward bias puzzle is dependent on market volatility. Firstly they define the realised volatility and the realised returns of G10[8] currencies as an exponentially-weighted moving-average process and break the observations into two volatility regimes: (i) high (top 25% of observations) and (ii) low (the bottom 25% of observations). The results show a markedly different estimated Fama beta between the two regimes. The forward bias puzzle is found to be prevalent in the low-volatility regime and disappears in the high-volatility regime. Backed by their results, Clarida, Davis & Pedersen (2009) write off the forward bias puzzle as a volatility artefact.

Lothian & Wu (2011), who have utilised two centuries of data to investigate the forward unbiasedness hypothesis, show that the results fail to reject the UIP. The estimated α and β of the Fama regression are insignificantly different from zero and unity respectively over the period from 1798 to 1999. They have further shown that the forward bias puzzle is predominantly a modern phenomenon. By utilising a rolling regression method, it is revealed that the finding of negative Fama beta appears when the data are dominated by observations from middle of the 1970s to 1980s. There are also some findings which report that the forward bias puzzle is *less biased* among the emerging market currencies. Bansal & Dahlquist (2000) have pooled a set of currencies and run a Fama regression to estimate the beta coefficient. They have reported that the forward bias puzzle is less severe (i.e. less negative or slightly positive but still significantly less than the hypothesized value of one) when the currencies are pooled than the individual currency regression. They have further divided their sample of currencies based on the country's income level and found that the forward bias puzzle is

[8] G10 refers to the Group of 10 which consists of ten developed countries with strong economic presence. The members are Belgium, Canada, France, Italy, Japan, the Netherlands, the United Kingdom, the United States, Germany and Sweden.

only restricted to the currencies of high income economies and only to states when the U.S. interest rate is higher than its foreign counterparts. The lower income countries are mainly the developing or emerging economies and hence the claim that the situation of forward bias puzzle is less biased among these group of currencies. These results are generally supported by subsequent studies.

Frankel & Poonawala (2010) have also reported that the forward bias puzzle is less evident among the emerging market currencies. This finding does not support the conclusion that the forward bias puzzle is a pervasive phenomenon. From their findings, Frankel & Poonawala (2010) have further asserted that one of the two popular justifications for the finding of negative β coefficient does not hold. As reviewed, some of the classical papers have proposed that the finding of negative β coefficient is due to the presence of a currency risk premium in the foreign exchange market and a substantial number of studies have been conducted to identify these risk premia (e.g. Froot & Frankel, 1989; Cavaglia et al., 1994; Engel, 1996). Frankel & Poonawala (2010) claim that this justification is counterintuitive as shown by their results with the emerging market currencies. Emerging market currencies are logically viewed as currencies of higher risk than those developed market currencies. Therefore intuitively the β coefficient in the Fama regression for emerging market currencies should be more biased. However, this intuition is not supported by empirical evidence. A logical explanation to this result is that the justification is faulty and hence efforts towards the identification of risk premium are not going to be fruitful. Frankel & Poonawala (2010) suggest that the emerging market currencies are more prone to a situation of high inflation and hence more predictable with the forward premium.

Baillie & Bollerslev (2000) calibrated a stylized UIP model which implies a zero risk premium and generated the data which are able to reproduce the widely reported

results in the literature. They claim that the finding of the negative beta coefficient is due to a small sample bias and the hence the rejection of the forward unbiasedness hypothesis is less than persuasive. They dismiss the forward bias puzzle as a statistical phenomenon. Villanueva (2007) provides further evidence in support of Baillie & Bollerslev's (2000) finding regarding the small sample bias. Meanwhile, Pilbeam & Olmo (2011) have also come to the same conclusion that the forward bias puzzle is a statistical phenomenon after they examine four developed markets' currencies. They have, however, adopted a different technique to reach to this conclusion. Pilbeam & Olmo (2011) claim that the conventional Fama regression which regresses log changes of spot exchange rate (Δs_{t+1}) on forward premium (f_{+}-s_t) will likely result in spurious regression because the volatility of Δs_{t+1} is usually much larger than the forward premium. They have subsequently employed a Taylor expansion of the log-returns of the exchange rate series, which is also known as the delta method, in order to propose a solution to the potential bias of the conventional Fama regression. They use two forms of regression models to test for the forward unbiasedness hypothesis. The data used are in levels instead of the usual form in logarithm. Pilbeam & Olmo (2011) find efficiency for four major currencies (Swiss franc; Japanese yen; Euro; and Pound sterling) during the period of 1978 to 2006 in stark contrast to the conventional regression approach.

What is the implication of the forward biased puzzle to the market participants in the foreign exchange markets? There is evidence to suggest that the forward bias puzzle has been exploited in the foreign exchange markets (Hochradl & Wagner, 2010; Galati, Heath & McGuire, 2007). The forward bias puzzle implies that high interest-rate currencies will appreciate against the low interest-rate currencies. Therefore it is profitable to borrow the low interest-rate currencies to invest in the high interest-rate currencies. Investors will be able to enjoy the interest-rate differential advantage as well as the capital appreciation in the invested capital when the high interest-rate currencies

rise in value. This method is popularly known as the currency carry trade strategy. In the 2000's, the JPY is a favourite funding currency in the carry trade strategy due to its low level of interest rate for an extended period of time (Peltomaki, 2008). Meanwhile, the AUD and NZD are the two popular target currencies due to their substantially higher level of interest rates. Hochradl & Wagner (2010) show that the forward bias puzzle is able to generate economically significant excess returns. Hence they are convinced that this profit opportunity is exploited by speculative capitals. Hochradl & Wagner (2010) who study the carry trade phenomenon for the period of 1995 to 2005 show that this strategy does not only provide positive returns but also a higher Sharpe ratio than investments in the equity market. They also report that the returns on carry trade contain no evidence of systematic risks. Due to the superior risk-adjusted returns from currency carry trade, Hochradl & Wagner (2010) suggest that this set of investments provide a promising extension to portfolio managers in enhancing their performance.

Further in support of the findings from Hochradl & Wagner (2010), Villanueva (2007) has also shown that the carry trade strategy generates attractive excess returns and provides diversification benefits for enhanced portfolio returns. Villanueva (2007) has tested the directional accuracy of the prediction given by the forward bias puzzle for the period from 1981 to 1998 and finds that the profits from trading against the UIP are statistically significant. He further simulates five forward bias puzzle trading models by using the data from 1981 to 1989 while treats the period from 1990 to 1998 as out-of-sample data. He compares the performance of these models with two benchmark models: (i) zero excess returns (implied by strict UIP) and (ii) constant returns. The results show that the forward bias models are superior to the benchmark models in terms of mean square forecast error (MSFE) and trading profitability. Villanueva (2007) also illustrates that the returns for the carry trade strategy are not compensation for bearing systematic risks.

Gilmore & Hayashi (2008) have added further insight by showing that the carry trade strategy can offer better returns by the inclusion of the emerging markets currencies. Even though the emerging market currencies are individually volatile, they are less volatile when managed as a portfolio. They suggest that active management of currency portfolios by using the forward premium as a signal will provide attractive excess returns and superior Sharpe ratio. Burnside, Eichenbaum & Rebelo, (2007) offer more support for the excellent performance of the carry trade with emerging markets currencies. They compare the performance between two currency carry trade portfolios for the period October 1997 to November 2006. The first portfolio consists of only the developed country currencies and the second one a mixture of currencies from both the developed and emerging markets. The second portfolio, which includes the emerging markets currencies, shows a substantially higher Sharpe ratio than the pure developed country currencies. Even though the average payoff for the two portfolios is the same, the inclusion of emerging markets currencies reduces the standard deviation for the second portfolio and hence provides a better Sharpe ratio. This finding demonstrates that the carry trade strategy which combines both the developed country and emerging markets currencies will provide diversification benefits to the investors. Burnside, Eichenbaum & Rebelo, (2007) have further shown that the returns on the carry trade portfolios are not correlated with the US stock market returns. Hence they infer that the returns from the carry trade are not compensation for bearing systematic risks and this finding is consistent with Villanueva (2007). However, Burnside, Eichenbaum & Rebelo, (2007) caution that the biggest drawback of their research is the exclusion of major financial crises from their sample period. Notwithstanding the caution, the various findings on the superiority of the carry trade strategy represent a serious violation to the efficient market hypothesis. However, we suspect that if we include the data from the 2007 – 2008 GFC period, their conclusions may be reversed.

Galati, Heath & McGuire (2007) attribute the marked increase in foreign exchange market trading activities during the early part of 2000s partly due to the carry trade activities or also called the leverage cross-currencies trading strategy. They measure the attractiveness of the carry trade strategy through the carry-to-risk ratio which is the ratio between the interest-rate differentials and the implied volatility of the foreign exchange option. They show that the carry trade strategy has been an increasingly attractive investment opportunity during the period 2000 to 2007. However, they have also rightly warned that the sudden massive unwinding of the carry trade activities would greatly affect global financial stability. This strategy is indeed a highly risky strategy and has been described in the mainstream finance as "*picking up nickels in front of steamrollers*" (The Economist, 2007). Gyntelberg & Remolona (2007) discuss the importance of using the appropriate risk measure for the carry trade strategies. The Sharpe ratio which relies on the volatility (i.e. standard deviation of returns) may obscure the inherent risk in the carry trade activity. The usually reported superior Sharpe ratio for carry trade, as claimed by Gyntelberg & Remolona (2007), may give a misleading picture of the actual risk borne by the investors. They suggest that the downside risk measures are better tools to capture the amount of risk inherent in the carry trade. Using five popular target currencies (i.e. AUD, IDR, NZD, INR and PHP) and two common funding currencies (i.e. JPY and CHF), they demonstrate that the returns on carry trade are positively correlated with the downside risks undertaken. The measures for the downside risks used by them are the expected shortfall and value-at-risk (VaR). Therefore the returns on the carry trade are consistent with modern portfolio theory and the efficient markets hypothesis as the higher returns from carry trade are the results of higher risks. The often reported superior Sharpe ratio may be due to the unrealised portion of this downside risks.

As cautioned by Burnside, Eichenbaum & Rebelo, (2007), the high returns from carry trade must be investigated through a full economy and business cycle. Therefore it is not wise to conclude that carry trade is a superior strategy by only focusing on the uptrend business cycle. The earlier studies which preclude the 2007-2008 GFC period suggest that carry-trade activities are profitable and worthy of being pursued (e.g. Hochradl & Wagner, 2010; Villanueva, 2007). However, the inclusion of the data from the GFC period may draw a somewhat different conclusion. Olmo & Pilbeam (2009) show that currency carry trades do not register a significant excess returns over the long run. Meanwhile, Clarida, Davis & Pedersen (2009) who employed data from October 1996 to January 2009 show positive carry trade returns but upon segregating the observations according to the level of volatility, they suggest that the carry trade returns are a phenomenon of the volatility regimes. Brunnermeier et al. (2008) discussed the crash risks inherent in the carry trade strategy. They report that the returns to the carry trade are a function of the speculators' liquidity positions and the market risk sentiment, as measured by the Standard and Poor's 500 (S&P 500) volatility index (VIX). They also show that the currency crashes happen when the liquidity positions of the speculators dry up which is followed by a massive unwinding in the carry trades. Therefore the build-up in carry trades destabilises the general health of the economy and financial markets. These findings collectively imply that carry trade activities, which bet against the UIP, are not that profitable after all, a result which is consistent with the efficient markets hypothesis.

2.2.2 Forward Unbiasedness Hypothesis and Cointegration

Besides the Fama regression, researchers have also employed cointegration technique in the testing of the forward unbiasedness hypothesis. This technique is originally introduced by Engle & Granger (1987) and further developed by Johansen (1988; 1991). Cointegration happens when the linear combination of two or more nonstationary variables is stationary (Baillie & Bollerslev, 1989). This cointegrating relationship implies that there is at least one cointegrating factor that exists in binding the variables. This cointegrating vector is a long-run relationship and represented by an 'error correction term' (ECT) in the econometric model. If the spot and forward exchange rates are found to be cointegrated, the forward rates are said to be unbiased predictors of the future spot exchange rates. Thus this finding implies market efficiency. Most published papers which employed this approach found that spot and forward exchange rates are cointegrated and this finding testified to the '*within-country*' market efficiency (e.g. Baillie & Bollerslev, 1989; Jeon & Seo, 2003; Kan & Andreosso-O'Callaghan, 2007). Baillie & Bollerslev (1989) have utilised the daily spot and thirty-day forward exchange rate series for seven developed countries' currencies (i.e. British Pound (GBP), Deutsche Mark (DEM), French Franc (FFR), Italian Lira (ITL), Swiss Franc (CHF), Japanese yen (JPY) and Canadian dollar (CAD)) for the period from March 1, 1980 to January 28, 1985. They report that both the daily spot and forward exchange rates series are integrated of order one, I(1). Any time series which is integrated of any order higher than zero is deemed as non-stationary and hence cannot be applied in the pervasively used regression technique of ordinary-least-square. The non-stationary series must either be modified to stationary before it can be used for regression analysis or a technique other than OLS must be employed in the analysis. Therefore instead of using the regression technique, Baillie & Bollerslev (1989) utilise the two-step Engle & Granger (1987) cointegration technique to uncover the

relationship between the spot and forward exchange rates. They find that the spot and forward exchange rates for all the seven spot and forward exchange rates series are cointegrated. They claim that this finding support the notion of the forward unbiasedness hypothesis: the forward exchange rates are unbiased predictor of future spot exchange rates.

In most of the more recent research papers, researchers have mainly utilised the Johansen (1991, 1995) cointegration technique. Apparently, the two-step Engle-Granger cointegration technique contains some weaknesses and Johansen (1991, 1995) has proposed measures to improvise on the cointegration technique. Hence the newer papers usually employ the Johansen cointegration technique rather than the conventional cointegration technique. Jeon & Seo (2003) use the Johansen cointegration technique to test for the forward unbiasedness hypothesis for three Asian currencies (i.e. THB, MYR and KRW) for the period from January 1997 to February 2001. Due to the shift in the foreign exchange regime in Malaysia, Jeon & Seo (2003) limited the sample period for Malaysia to only September 1998. They report a cointegrated relationship between the spot and forward exchange rates for both the THB and KRW for the whole period. However, the MYR spot and forward exchange rates are not cointegrated. Since the sample period for MYR is cut short, we should read the finding related to MYR with serious caution. Jeon & Seo (2003) have also split the full sample period into two subperiods to capture the pre-crisis and post-crisis periods. They report a more stable cointegrated relationship in the post-crisis period and also show that market efficiency was violated in the period immediately after the Asian financial crisis (AFC). Jeon & Seo (2003) support their claim regarding the disturbance in the market efficiency immediately after the AFC by utilising the fully-modified (FM) least square estimator to run a regression of log spot exchange rates on lagged forward exchange rates. Their results are consistent with their earlier findings from using the Johansen cointegration.

As an extension, Kan & Andreosso-O'Callaghan (2007) have studied the cointegration relationship for ten Asia-Pacific currencies (i.e. KRW, TWD, THB, IDR, MYR, PHP, JPY, SGD, AUD and NZD) for the period from December 1996 to May 2003. Upon establishing that all the 10 currencies are integrated of order one, Kan & Andreosso-O'Callaghan (2007) run the Johansen cointegration test on the spot and forward exchange rates for each currency pair. They report a stable cointegrating relationship between the spot and forward exchange rates for all the currencies under investigation. Hence they conclude that the foreign exchange markets are efficient *within-country*. There seems to be a general consensus regarding the *within-country* market efficiency through the use of the cointegration technique.

The cointegration technique described thus far has been applied to test for the forward unbiasedness hypothesis which investigates the relationship between the spot and forward exchange rates within a same country. Hence this analysis is also known as the *within-country* market efficiency test. The cointegration technique has also been conveniently extended to test for the *across-country* market efficiency. If we take a few series of spot exchange rates of different currencies and run cointegration analysis, the presence of a cointegrating factor implies market inefficiency because a cointegrated system of spot exchange rates entails causality relationships within the system. Therefore at least one of the exchange rates series is predictable using current information (Crowder, 1994) and this implication is a direct violation of EMH which states that all current information is already impounded in the security prices and hence should not be predictable with any existing information or variables. Baillie & Bollerslev (1989) are among the pioneer researchers who have extended the cointegration technique to test for *across-country* market efficiency. Besides the use of the conventional Engle-Granger two-step cointegration method to test for *within-country* market efficiency, Baillie & Bollerslev have also applied a similar technique to

investigate the state of efficiency in a system of seven exchange rates series. They report six stochastic trends in the system which in turn implies one common cointegrating factor binding this system of exchange rates and thus they conclude that the weak form EMH is violated *across-country*.

Studies which employed Johansen (1988; 1991) multivariate cointegration tests (e.g. Crowder, 1994; Kan & Andreosso-O'Callaghan, 2007) have generally found similar results to Baillie & Bollerslev (1989). Crowder (1994) employs the multivariate Johansen cointegration technique to test for the long-run relationship among a system of three spot exchange rates (i.e. GBP, DEM, and CAD) for monthly observations from January 1974 to December 1991. The results show that there is one cointegrating vector among the three exchange rate series and this finding in turn implies two common stochastic trends governing their relationships. Kan & Andreosso-O'Callaghan (2007) use the same technique to test for the cointegrating relationship among the 10 Asia-Pacific currencies as described in the earlier paragraph for a more recent period which include the Asian financial crisis (AFC). They have applied the Johansen cointegration technique in the *across-country* setting through two perspectives: bivariate and multivariate. For the bivariate cointegration test, each of the currency pairs is tested for cointegration with another currency pair while for the multivariate test, all of the currencies are tested for cointegration as a whole. They do not find any cointegration in the bivariate cointegration test and they suggest that the foreign exchange markets are efficient in general. Unlike the bivariate results, the multivariate cointegration results show that there is evidence of cointegration among the set of spot exchange rates and this finding, again, indicates a violation of market efficiency. The results on the multivariate cointegration are consistent with the literature (e.g. Baillie & Bollerslev, 1989; Crowder, 1994).

In a similar study, Jeon & Seo (2003), who employ relatively fewer currencies as compared to Kan & Andreosso-O'Callaghan (2007), have apportioned their whole sample period into several subperiods. They report different findings from Baillie & Bollerslev (1989), Crowder (1994) and Kan & Andreosso-O'Callaghan (2007) as Jeon & Seo (2003) do not find any cointegrating vector in a system of four exchange rate series in Asia for the period from January 1996 to February 2001. Through the apportionment of the whole sample period, they show that foreign exchange market efficiency in these countries was disturbed only during the 1997/98 AFC as there is presence of cointegrating vectors in the system at that time period. From the research papers reviewed thus far, we find that there is no conclusive evidence regarding the state of *across-country* foreign exchange market efficiency.

Further on cointegration, Crowder (1994) has mooted the idea that the existence of cointegrating vector in a system of spot exchange rates does not necessarily imply market inefficiency if we can treat the error correction term (ECT) as a proxy for the risk premium. In a risk-averse environment, the relationship between the forward exchange rate and expected future spot exchange rate as given by the uncovered interest-rate parity (UIP) is altered by a forward risk premium[9] as shown in equation 2.6.

$$f_t^m = E(s_{t+m}|\Omega_t) + rp_{t,m} \tag{2.6}$$

Under the assumption of rational expectations, the realisation of future spot exchange rate is the expected future spot rate adjusted by a forecast error as follows:

$$s_{t+m} = E(s_{t+m}|\Omega_t) - \varepsilon_{t+m} \tag{2.7}$$

[9] Risk premium justification is one of the two popularly touted sources of forward bias puzzle. The other source of forward bias puzzle is the failure in rational expectations assumption.

Substituting the expected future spot exchange rate from equation 2.7 into equation 2.6, we can express the forward exchange rate as the sum of future spot exchange rate, a forward risk premium and a rational expectations forecast error.[10]

$$f_t^m = s_{t+m} + rp_{t,m} + \varepsilon_{t+m} \tag{2.8}$$

Subtracting the current spot exchange rate from both sides of equation 2.8, we have the forward premium on the left-hand side and the sum of changes in the spot exchange rate, forward risk premium and the expectations forecast error on the right-hand side as shown in equation 2.9.

$$f_t^m - s_t = (s_{t+m} - s_t) + rp_{t,m} + \varepsilon_{t+m} \tag{2.9}$$

From equation 2.9, the forward premium has been decomposed into three distinct components namely the changes in the spot exchange rates, the forward risk premium and the rational expectations forecast error. It is widely found and reported in many studies that the spot exchange rates follow a random walk and the first-difference of spot exchange rates are often stationary, I(0). Meanwhile the rational expectation forecast error has a mean value of zero and is stationary by construction. Therefore the time series property of the forward risk premium, $rp_{t,m}$ is dependent on the order of integration of the forward premium. In order for the error correction term (ECT) found in a system of cointegrated spot exchange rates series to be a proxy for the forward risk premium, their time series property must be compatible. Since the ECT is stationary by definition, the forward risk premium must also be I(0). To test whether the forward risk premium is stationary or not, we test the order of integration of the forward premium as it implies the time series property of the forward risk premium.

[10] The forecast error has a mean value of zero.

Upon establishing that a system of three exchange rates series is cointegrated, Crowder (1994) test his hypothesis that the ECT is a proxy for the risk premium by using the augmented Dickey & Fuller (1981) (ADF) and Kwiatkowski et al. (1992) (KPSS) unit root tests on the forward premium. He finds that the forward premium is nonstationary and therefore the time series properties of ECT are incompatible to be a proxy for risk premium. Crowder (1994) suggests that the market is indeed not efficient. Nevertheless, some recent studies found different results from Crowder (1994) (e.g. Barkoulas, Baum & Chakraborty, 2003; Kan & Andreosso-O'Callaghan, 2007). Barkoulas, Baum & Chakraborty, (2003) have employed a panel unit root test based on the Johansen likelihood ratio (JLR) which was further enhanced by Taylor & Sarno (1998). Barkoulas, Baum & Chakraborty, (2003) claim that the JLR test is a more powerful test which may provide a more convincing result. The null hypothesis of the JLR is, unlike the first generation of panel unit root test, that at least one of the series is nonstationary against the alternative of all the series being stationary. The rejection of the null hypothesis is strong evidence that the forward premia of various series are stationary. Barkoulas, Baum & Chakraborty, (2003) have used the daily forward premia for tenors of 1-month, 3-month, 6-month and 12-month for Canadian dollar (CAD), Deustche mark (DEM), British pound (GBP), French franc (FFR), Italian lira (ITL) and Japanese yen (JPY) with the USD as the numeraire currency. Their sample period stretched from January 2, 1980 to December 31, 1998. They have reported strong evidence of stationarity for the forward premia series for various currencies. Similarly, Kan & Andreosso-O'Callaghan (2007) who employ the augmented Dickey & Fuller (ADF) and Phillips & Perron (1988) (PP) unit root tests on the forward premium, also report that the forward premium is an I(0) process. These findings reduce support for the argument against *across-country* market efficiency as the cointegrating vector may be acting as a proxy for the risk premium.

2.2.3 Forward Unbiasedness Hypothesis as Weak-Form Efficiency Test

The use of the Fama regression and the *within-country* cointegration technique to test for the foreign exchange market efficiency are both based on the forward unbiasedness hypothesis. Meanwhile the *across-country* cointegration technique is based on the random walk hypothesis of an efficient market. From overall perspective, regression and cointegration analyses are test of weak-form market efficiency as they principally rely on past exchange rates information. The evidence thus far shows that the question of whether the market is weak-form efficient remains unanswered. When tested with the cointegration technique, the results generally support the notion of market efficiency in the foreign exchange markets but the findings through the conventional Fama regression imply otherwise. The beta of the Fama regression is not only significantly different from unity but often shows up as a negative figure. Following the popular belief at that time, this condition would be arbitraged away and the market would return to efficiency. However, this phenomenon has not disappeared and continues to these days (Frankel & Poonawala, 2010; Hochradl & Wagner, 2010). We believe our research provides incremental contributions in resolving the inconclusive results in the literature.

In the next section, we review the state of market efficiency based on the informational content of macroeconomic announcements. This type of research is usually conducted with an event-study analysis. The study of market efficiency based on the surprise elements in a particular macroeconomic announcement can be viewed as a test of semi-strong form market efficiency.

2.3 Event studies and Markets Efficiency

Another strand of market efficiency literature can be viewed through the use of event-study analysis. This approach is basically a test of semi-strong form market

efficiency as it tests for the instantaneous reaction of exchange rates to the arrival of new information in an efficient market. If the exchange rates do not react immediately to new information, there is an opportunity for excess returns and hence a violation of EMH. The first modern literature of event studies is attributed to Fama et al. (1969)[11] and since then research papers utilizing the event-study methodology have numbered thousands and still growing. Fama et al. (1969) initiate their research upon the establishment of the Centre for Research in Security Prices (CRSP). Fama et al. (1969) have basically created a new research 'industry'. They have studied the American stock prices reaction to the stock split announcement. They use the security prices which are newly collected by the CRSP to test their hypothesis regarding the behaviour of stock prices to the arrival of new information. They report that the security prices have mostly increased prior to the stock spilt announcement. They further suggest that the stock spilt announcement will usually be followed by dividend increases and thus justifying a higher stock price. Like Fama et al. (1969), most of the empirical work on markets efficiency are concentrated in the equity markets.

Table 2.1 on the following page shows the number of published papers related to informational market efficiency in five of the most influential finance journals (i.e. Journal of Finance, Journal of Financial Economics, Journal of Financial and Quantitative Analysis, Review of Financial Studies and Journal of International Money and Finance) from year 2001 to 2009. The search is done based on the keyword of '*market efficiency*' on the ISI Web of Knowledge. Upon reading the abstract and some of the contents of the selected papers, we exclude those methodological and review papers. We report the numbers of market efficiency publications in each journal under Table 2.1. With the exception of the Journal of International Money and Finance, almost

[11] Even though Fama et al. (1969) was published in 1969, it was started in the mid of 1960s. Another seminal paper in this field is Ball & Brown (1968) which was published a year earlier. MacKinlay (1997) provides a review of the development of the event-study analysis in finance.

90% of the related papers in informational market efficiency from each journal are conducted based on the empirical data in the equity markets.[12]

Table 2.1: Published Journal Articles Directly Related to Markets Efficiency, by year and journal.

Year	Journal of Finance			Journal of Fin. Econ.			Journal of Int. Money & Finance			Journal of Fin. & Quant. Analysis			Review of Fin. Studies			Total
	Eq	FX	Etc	Eq	FX	Etc	Eq	FX	Etc	Eq	FX	Etc	Eq	FX	Etc	
2001	4	0	1	2	0	0	1	2	1	2	0	0	3	0	0	16
2002	6	0	0	5	0	0	0	2	0	0	0	0	4	0	3	20
2003	6	0	0	3	0	1	0	1	0	3	1	0	0	0	0	15
2004	2	0	0	8	0	0	0	0	0	1	0	0	3	0	0	14
2005	2	1	0	2	0	1	0	1	2	0	0	0	2	0	0	11
2006	6	0	0	9	0	0	0	0	1	3	0	0	0	0	0	19
2007	5	0	0	3	0	1	1	1	1	1	0	0	1	0	0	14
2008	8	0	0	6	0	0	0	1	0	2	0	0	2	0	0	19
2009	5	0	0	4	0	0	0	1	0	2	0	1	4	0	0	17
Total	44	1	1	42	0	3	2	9	5	14	1	1	19	0	3	145

Eq. denotes equity markets, FX is foreign exchange markets and Etc. represents all other markets which include bonds, credits, commodities and combinations of several markets. The search is conducted on the ISI Web of Knowledge with the keyword of '*market efficiency*' for the period of 2001 – 2009.

The strong interest in the equity markets could be due to the fact that this market has the largest retail participation as compared to the other financial markets (e.g. bonds, credits, commodities and foreign exchange markets). The data from the equity markets are also widely available and usually of highly reliable quality. In recent time, the foreign exchange markets are fast gaining popularity among the investors; institutional and retail alike. Many big fund management companies have created a foreign exchange management unit to monitor and participate in the foreign exchange markets. Retail investors in developed as well as developing countries are also flocking into the foreign exchange markets. One of the impetuses in the popularity of the foreign exchange markets among global investors is due to the gradual liberalisation of the foreign exchange markets in emerging countries. In the past, prior to the collapse of the Bretton Woods regime, most foreign exchange rates are tied to the value of USD which

[12] We acknowledge that these numbers could be biased as there are other high-tier, specialized journals for the other financial markets such as bonds, commodities and foreign exchange. Journal of International Money and Finance is one of those specialized journals with specific interest in foreign exchange markets and hence the higher proportion of foreign exchange related research publications.

in turn pegged to the value of gold. After the abandonment of the Bretton Woods regime by the U.S. government in 1973, more and more countries are moving towards the adoption of a floating-rate regime. Based on the relatively small number of published papers in the area of foreign exchange market efficiency as compared to the equity markets, we believe there is substantial gap to be filled in this area. Hence, it would be fruitful and economical for us to further narrow down our research focus to the foreign exchange markets.

The standard test for the efficient market hypothesis (EMH) is usually a joint test with the pricing model (Fama, 1998). Therefore the rejection of an efficiency hypothesis is not necessarily due to the failure of market efficiency as it could also be due to a wrong asset pricing model or both. It is difficult to identify the root cause for the rejection of such test. For the foreign exchange market, unfortunately, there is no universally accepted pricing model. Unlike the equity market, the foreign exchange market is not centrally traded and therefore there is no proxy for an overall market return. The equity market is usually priced as a function of the market returns as featured by the capital asset pricing model (CAPM). The determination of the foreign exchange rate is mainly based on some of the established economic theories. Among the popular theories are the Purchasing Power Parity (PPP), Interest Rate Parity (covered and uncovered) and International Fisher relation. Therefore the relevant variables in the determination of the foreign exchange rates should be as stipulated by those theories.

The PPP dictates that the exchange rate of one country should be equivalent to another country's exchange rate in terms of price level. For example, if the price of a McDonald's Big Mac is selling at SGD3 in Singapore and MYR6 in Malaysia, the exchange rate between the SGD and MYR is supposed to be MYR2 per SGD. Assuming there is no transportation and transaction costs, and the exchange rate is

lower than MYR2 per SGD, Malaysians will not buy any Big Mac in Malaysia and would rather exchange their currency to SGD to buy the Big Mac in Singapore. This is exactly what *The Economist* has used to compute the Big Mac Index to gauge for the PPP in their annual publication since 1986. Therefore the main variable that matters in the determination of exchange rate under the PPP is the price level which is usually measured by a particular index number (e.g. Consumer Price Index or Producer Price Index). Meanwhile, under the interest rate-parity theory and the International Fisher relation, the main input to the determination of the foreign exchange rate is the interest rates differential among nations. Despite all these economic theories, it is widely found that the foreign exchange rates are best described by the random walk hypothesis (Meese & Rogoff, 1983; Cheung, Chinn & Pascual, 2005) and therefore a zero return is a good approximation of the normal returns for the exchange rates.[13]

Back to the semi-strong form market efficiency, testing the instantaneity of the reaction of the foreign exchange rate changes to the surprise elements in the relevant macroeconomic announcements is therefore a direct test of the semi-strong-form efficiency. If a particular macroeconomic announcement contains information, the exchange rates should adjust promptly right after the announcement. Any significant reaction prior to the macroeconomic announcement represents a leakage of information. The measurement of the reaction is determined by the time-to-the-announcement or the time-post-announcement. The period between the measurement time and the announcement time is known as the event window (MacKinlay, 1997). The maiden modern paper in the event-study analysis has utilised an event window of one-month. As mentioned, there is an inherent weakness in the use of event-study analysis to test for market efficiency because the methodology tests for not only the hypothesis of market efficiency but also a correct pricing model. If the pricing model used is not true, any

[13] This is equivalent to the constant return model used in the event studies of the equity markets.

inference about market efficiency from the results will be unconvincing. Fama (1998) suggests that the bad model problem arises from two possibilities. First, the pricing model may not be able to describe the expected returns of all the securities adequately. For instance, Fama (1998) gives the example that the CAPM is unable to explain the expected returns from small stocks. Second, even if the model is adequately comprehensive, the selected sample period may be biased and churn out anomalous results.

According to Fama (1991, 1998), the event-study methodology which employs short horizon data (i.e. high frequency data) is able to circumvent the joint hypothesis complication. Kothari, Warner & Eckbo (2007) have further confirmed the advantage of using short-horizon observations (i.e. lesser than one month observations).[14] If the foreign exchange market is efficient, the foreign exchange rates should have impounded all current relevant information. Therefore only the surprise elements of the fundamental news could affect the returns of the foreign exchange rates. The surprise elements are defined as the difference between the actual announcement and the expected value of the announcement. One of the many models to test the semi-strong form efficiency in the foreign exchange market is given as follows:

$$\Delta s_t = \alpha + \beta N_t + \varepsilon_t \tag{2.10}$$

where Δ represents the returns on the exchange rates at time *t* from one-period ago, *N* is the surprise element of a macroeconomic announcement at time *t* while the α and ε are the regression intercept and residual respectively. The surprise element is obtained by taking the difference between the expected and the actual announcement. For example, if the expected Consumer Price Index (CPI) is 110 while the actual number released is

[14] Besides Fama (1991, 1998) and Khotari, Warner & Eckbo (2007), other studies such as MacKinlay (1997) and Campbell, Lo & MacKinlay (1997) have also provided useful guides and review on the application of event-study methodology.

120, the difference of 10 between the two numbers is the surprise element. If the market is efficient, the coefficient α should be insignificantly different from zero.

Almeida, Goodhart & Payne (1998) have used a slightly different model from equation 2.10 to test for the impact of the surprises in the macroeconomic announcements, both from the United States (U.S.) as well as Germany, on the Deutsche mark (DEM)/ US dollar (USD) exchange rate for the period of January 1, 1992 to December 31, 1994. They have explicitly included the expected element of the macroeconomic announcement into equation 2.10. The estimated coefficient related to the expected announcement is termed as β_1 while the coefficient related to the surprise element β_2. They have utilised high frequency exchange rate data at five-minute interval to identify the impact of the selected macroeconomic news. The expected value of the macroeconomic announcements is obtained from the International Money Market Services (MMS) surveys.[15] First of all, they have generally found that the deviation from the efficient markets hypothesis (EMH) is very small for most of the fundamental announcements and they move on to test for the impact of the fundamental variables by restricting both the coefficients α and β_1 to be zero. They have found that most of the U.S. macroeconomic surprises significantly affect the DEM/USD returns very quickly, generally within the first two hours post-announcement. Meanwhile the significance of the German macroeconomics surprises are dependent on the proximity of the announcement date to the Bundesbank council meeting; the closer an announcement is to the council meeting, the more significant is the impact of the surprises. They report that most of the effects from the German macroeconomic surprises are only felt after three hours. They attribute this observation to the timing of the macroeconomic announcements. All of the U.S. macroeconomic announcements are released according

[15] Bloomberg is also providing similar service in collecting and broadcasting the market expectation information. We choose Bloomberg as the source of market expectation in because Bloomberg terminal is widely used by the finance professionals who are directly involved in making investment decisions.

to schedule (right to the minute of the hour) while the German announcements are mostly unscheduled. This characteristic of the U.S. macroeconomic announcement prepares market participants to react promptly to any surprises while it takes longer for the same participants to digest and react to the surprises in the German announcements.

In addition, they have observed that the impacts of the macroeconomic surprises are in accordance to the 'reaction response function' and not as predicted by some of the popular economic theories. Market participants seem to be more concerned about the reaction of the central banks than to the adjustments as dictated by economic theories as a result of the macroeconomic surprises. For example, if there is a substantial increase in the price level (CPI or PPI) in the U.S., market participants would likely buy the USD according to the reaction response function because they anticipate the U.S. Federal Reserve will increase interest rates to contain the current inflation. This is in direct contrast to the impact as predicted by the purchasing power parity (PPP) theory which suggests a depreciation as inflation would erode the value of a currency.

The findings of Almeida, Goodhart & Payne (1998) are vindicated in a recent study by Pearce & Solakoglu (2007) that also uses exchange rate data measured at high frequency of five-minute intervals. They have shown that the surprises of several U.S. macroeconomic announcements cause instantaneous significant movement in the USD/DEM and USD/JPY exchange rates during the period from December 1, 1986 to December 1, 1996. The responses of the exchange rates are completed within the first five minutes after the announcements and usually become insignificant after six hours. Pearce & Solakoglu (2007) have further found that the response of the USD/DEM to the announcement surprises is more elastic in terms of mean and volatility of returns as compared to the USD/JPY. This implies that USD/DEM is more tightly watched during the release of U.S. macroeconomic announcements. This finding generally supports the

notion of market efficiency in both the foreign exchange markets. Pearce & Solakoglu (2007) also report that the reaction of exchange rates to U.S. macroeconomic surprises are generally consistent with the monetary and portfolio balance models of exchange rates as well as the reaction function response mentioned in Almeida, Goodhart & Payne (1998). From their results, they suggest that the surprises in macroeconomic announcements would more likely change the expectations of the market participants on real interest rates rather than on the inflation rate. This is evidenced by the appreciation of the USD following a positive surprise in the real economy activities.[16] Next, they have directly tested the reaction of the exchange rates to macroeconomic surprises in different states of the economy. By dividing the economy into 'high' and 'low' states using the long-term growth trend; high state being the condition above the trend line and low being below the trend line, they show that certain macroeconomic announcements are state-dependent. For example, the surprises in the U.S. durable goods order and non-farm payroll induce stronger response in the USD/DEM during the 'low' state than in the 'high' state. Despite the state-dependent response of the exchange rates to the surprises, the reactions to positive and negative surprises are found to be symmetrical. This finding is in contrast to the finding of Andersen et al. (2003).

In Andersen et al. (2003), they have found that the 'bad' surprises carry more weight than 'good' surprises. This result is more pronounced in 'good' times. They have found that this result is generally consistent with the currencies that they have tested namely the Swiss franc (CHF), DEM, British pound (GBP), Euro dollar (EUR) and Japanese yen (JPY), all quoted against the USD. They argue that when the economy is doing well, market participants would likely expect the economic indicators to project positive situation. Hence when an announcement falls short of expectation in good times, the market is said to be caught by a real surprise and thus the stronger reaction.

[16] As contrast, if a positive surprise in US real activity alters the expectation of the agents on inflation rate, the USD should depreciate as a strong growth economy would likely fuel inflation and hence depreciation in the value of currency.

Andersen et al. (2003), who also use 5-minute intervals in the observation of the exchange rate changes, find that the reactions to the surprise elements of an announcement occur within the first five minutes post-announcement, consistent with the finding of Pearce & Solakoglu (2007). This is again an indication of market efficiency. However, they caution that the timing of the announcement is crucial in determining the significance of a particular macroeconomic indicator. They have grouped all the 41 macroeconomic announcements in their study into seven distinct categories and arrange the announcements in each category in a chronological order. They show that the announcements announced earlier in each category are more significant and resulted in a higher R^2 than the announcements announced later. They infer that the macroeconomic indicators announced later could be redundant and hence the reduced impact on the exchange rates. Andersen et al. (2003) also show that the exchange rates respond only to the unexpected component of an announcement. The announcement itself would not affect the exchange rate changes if there are no surprises but the mere announcement (even without surprises) would increase the volatility of exchange rates.

Fatum & Scholnick (2008) have specifically tested for the significance of the expected and unexpected components of U.S. monetary policy changes on the exchange rate changes. They have found that the exchange rates of DEM/USD, JPY/USD and GBP/USD respond only to the surprise element of an actual U.S. monetary policy change. They have further shown that the failure to disentangle the expected and unexpected components of the monetary policy change could obscure the significance of the announcement. The impact of the surprises usually occurs on the same day as the announcement which is consistent with most other studies in the literature. The distinctive feature of Fatum & Scholnick (2008) is their use of the Federal Fund Futures (FFF) in extracting the market expectations of the monetary policy change prior to the

actual announcement. They claim that this method provides a direct measure of the expectations of the market participants.

Further on the impact of macroeconomic surprises on the exchange rate responses, Simpson, Ramchander & Chaudhry (2005) have analysed this issue and interpret their findings along the established macroeconomic theories. They claim that the reaction of the exchange rates is unknown *a priori*. The reaction depends on the dominating theories at the time of the announcement. They have grouped 23 U.S. macroeconomic indicators into four categories based on the information conveyed by the indicators. The four categories are consumer demand, inflation, interest rate and economic growth. They report that the responses of the exchange rates of DEM, JPY, CHF, GBP and Canadian dollar (CAD) to the surprises in the consumer demand are consistent with the Mundell-Fleming balance of payment framework; a decrease in the domestic demand increases net export and drives up domestic currency. They have also shown that the purchasing power parity (PPP) theory cannot explain the changes in the exchange rates as a result of the macroeconomic surprises. The Portfolio Balance (PB) model is found to be more useful in describing the reaction of exchange rates on those surprises. They have found support for the covered interest rate parity (CIP) hypothesis where the forward premium reacts as anticipated to the macroeconomic surprises. Spot and forward exchange rates are found to be cointegrated and subsequently a vector error correction model (VECM) is estimated with spot and forward exchange rates as endogenous variables and macroeconomic surprises as the exogenous variables. The exchange rates are found to respond mainly to the surprises in consumer demand, inflation and interest rate indicators but not to the announcements directly related to the general strength of the economy. They have further found that forward exchange rates are the one that would react to the shocks in order to maintain the long-run cointegrating relationship with spot exchange rates. However, the short-run dynamic of the VECM

shows that there are significant feedback effects between the spot and forward exchange rates.

Unlike the papers reviewed thus far, Cai, Joo & Huang (2009) provides evidence of emerging market currencies reactions to the macroeconomic surprises from both the USA and the domestic countries. They have adopted currencies from nine (9) emerging markets (i.e. Czech Republic, Hungary, Poland, South Africa, Korea, Indonesia, Thailand, Turkey and Mexico) for the period of January 2, 2000 to December 31, 2006. Similar to Andersen et al. (2003) and Almeida, Goodhart & Payne (1998), Cai, Joo & Huang (2009) have also used observations at five-minute intervals to run the event-study analysis. They report that U.S. macroeconomic news carry more significant impact as compared to domestic macroeconomic news. In addition, they show that the emerging markets exchange rates become more responsive in the later part of their sample period. They attribute this finding to the gradual liberalisation of the foreign exchange markets among emerging economies. Cai, Joo & Huang (2009) have also shown that the response to the macroeconomic surprises is affected by investor sentiment regarding the future exchange rate direction. This finding complements the result reported by Andersen et al. (2003) regarding the asymmetric response of the exchange rate to bad and good surprises. It seems that there is more evidence in support of asymmetry in the exchange rate responses to macroeconomic surprises.

Hitherto, our review shows that all studies use only macroeconomic indicators as the key variables in the event studies analysis of the foreign exchange markets. Dominguez & Panthaki (2006) have broadened the definition of news to include non-fundamentals-related news[17] (i.e. technical analysis, options market, market characteristics, market sentiment, private sector and political news) and order flow (i.e.

[17] The non-fundamental related news are measured as a binary variable with the values of 0 and 1; 0 being no news and 1 denotes existence of news at the time.

the difference between the cumulative numbers of buyer-initiated trades and seller-initiated trades) in their research. They report that both of these variables are significant in affecting exchange rates and therefore should be included in the model of exchange rate determination.[18] However, the overall regression is not much improved, as evidenced by the small increase in R^2, with the inclusion of the broader definition of news.

2.4 Literature Links and Gaps

After such an elaborate review on the foreign exchange market efficiency, how is our research related to the literature? Firstly, we have adopted the Fama regression as the basic test of market efficiency. Secondly, we have also pooled our sample of currencies a-la Bansal & Dahlquist (2000). One innovation in our study is that we group our sample of currencies not only based on income level but also based on the extent of liberalisation of the foreign exchange market which is measured by the existence of a non-deliverable forward (NDF) market.[19] Currencies in our sample which are traded in the NDF market are considered less liberalised and these currencies are not limited to low income nations but also include some of the high income economies. Through this approach, we are able to provide further insight on whether the forward bias puzzle is contingent upon the foreign exchange regime or the national income level. Thirdly, our study may also be seen as an expansion of Kan & Andreosso-O'Callaghan (2007) in the way we break up the whole sample period into several sub-sample periods according to the dominant economic conditions underlying the particular period. However, our full sample period is extended by more than seven years from the ending date of the Kan & Andreosso-O'Callaghan (2007) study. This additional period represents an increase of more than 100% of the time series data from the ones used in their paper. By the

[18] Most of the current models in the determination of exchange rates (e.g. monetary model) include only the fundamental variables (e.g. money supply and inflation rate).
[19] Interested readers can refer to the review articles from Ma, Ho & McCauley (2004) and Tsuyuguchi & Wooldridge (2008) on the details of NDF market in Asia-Pacific.

extension of the sample period, we have the opportunity to look at not one but two important financial crises in modern history (i.e. AFC and GFC). Fourthly, we have adopted the Pilbeam & Olmo (2011) models in accounting for the forward bias puzzle. As far as we are concerned, this is the first study which uses the Pilbeam & Olmo (2011) models on the Asia-Pacific currencies. In a way, we are able to test the robustness of this proposed resolution on a wider selection of currencies.

Fifth, the adoption of the event-study methodology to test for market efficiency is based upon the simple model used in most of the literature reviewed above (e.g. Almeida, Goodhart & Payne, 1998; Andersen et al., 2003; Pearce & Solakoglu, 2007). However, their results are mostly derived from developed countries' currencies whereas we use the Asia-Pacific currencies which are more heterogeneous in nature. In the sense of event-study methodology, our study resembles most closely the paper by Cai, Joo & Huang (2009). However, our approach is different and moreover there are only four sample currencies which are shared between this thesis and Cai, Joo & Huang (2009). Unlike Cai, Joo & Huang (2009), we do not discuss much about the direction of the exchange rates reaction to the macroeconomic surprises but we focus on the measure of the importance of each selected macroeconomic shock by providing a ranking based on the extent of significance of each shock. Sixthly, we have taken cognisance of the findings of Fatum & Scholnick (2008) about the importance of decomposing the macroeconomic announcements into the expected and unexpected components. The test for market efficiency should only deploy the unexpected components as these are new information which has not been impounded into the exchange rates. Finally, the macroeconomic shocks used in our study are comparable with the existing literature. This would enable us to draw meaningful comparison between our results and the findings in the literature. We must stress that the number of countries and the

corresponding macroeconomic shocks used in this thesis are substantially higher than most of the studies reviewed thus far.

The review of past studies has brought to light some literature gaps in the field of foreign exchange market efficiency. First, the test of foreign exchange market efficiency is usually conducted either with Fama regression or Johansen cointegration technique independently. These two techniques are seldom used together in a single study. We believe by employing these two well-established techniques in a single study, a more comprehensive and coherent picture regarding the state of foreign exchange market efficiency will emerge. However, the results from these two techniques are expected to be conflicting with each other as indicated in the findings from the extant literature. Hence we have adopted a reconciliatory measure by utilizing the Pilbeam & Olmo (2011) models. These models are adopted mainly because they have not been utilized in any studies on emerging market currencies.

Secondly, many of the Asia-Pacific currencies are highly neglected relative to the developed countries' currencies. This study contributes to tilt the balance between these two sets of currencies. If the results are consistent, this may imply the foreign exchange markets are relatively homogenous in terms of market efficiency. Thirdly, the responses of the Asia-Pacific exchange rates to domestic as well as foreign macroeconomic shocks have not been widely studied. Most of the past studies focus only on the impact of U.S. or other advanced countries macroeconomic shocks on the exchange rates. It would be interesting and useful if we could identify which of the Asia-Pacific macroeconomic shocks have the most significant effect in the foreign exchange markets.

2.5 Chapter Summary

We have reviewed the literature related to the efficient markets hypothesis specifically in the foreign exchange markets. We have approached the literature from the weak- and semi-strong-form of efficiency. The weak-form efficiency is viewed through the forward unbiasedness hypothesis. Two of the popular techniques used to test for the unbiasedness hypothesis are the Fama regression and Johansen cointegration technique. These two techniques usually give conflicting results and therefore tests of the market efficiency condition are inconclusive. However, various proposals have been provided to reconcile the results from the Fama regression rather than the results from the Johansen cointegration technique. Meanwhile semi-strong-form efficiency is usually tested using an event-study analysis. Most research papers using this technique provide an even deeper level of analysis which is to identify the impact of the macroeconomic news on the exchange rates. From the literature review, we have identified some gaps which our current research intends to fill. We provide a more comprehensive study on the foreign exchange market efficiency. The focus on the Asia-Pacific foreign exchange markets is also important to the literature as it is a timely study which is consistent with the growing economic importance of this region. The relative significance of the macroeconomic shocks to the exchange rates movements has also been investigated in this thesis. Finally, the summary of some of the key past research papers reviewed in this chapter is provided in Tables 2.2. to 2.4

Table 2.2: Summary of Seminal Research Papers in Efficient Markets Hypothesis

The table summarises some of the important research papers which are related to the general concept of efficient markets hypothesis (EMH).

No.	Authors (Year)	Type	Main Findings
1	Fama (1970, 1991, 1998)	Review Article	a. There is strong evidence, theoretically and empirically, in support of the efficient markets hypothesis in the capital markets. b. Anomalies or puzzles identified in recent research works could be atributed to chance results and the concept of EMH withstood the test of time.
2	Malkiel (2003)	Review Article	a. The experience of market collapses and the burst of speculative bubbles do not imply a rejection of market efficiency. b. It is important to understand the unfolding of such events because the collapses of the markets are usually preceded by news which are significant enough to alter the rational expectation of investors. c. It is acknowledged that the markets are unlikely to be perfectly efficient all the time and anomalies will likely persist for a certain period of time. This, however, does not prove the failure of efficient markets hypothesis as corrections will usually follow.
3	Brown (2011)	Review Article	a. Market commentators and some academic researchers like to attribute the collapse of the financial markets to the blind faith in a flawed efficient market hypothesis. It is the failure to comprehend the actual concept of efficient markets hypothesis that prompted this group of people to attack the efficient markets hypothesis. b. In contrast, it is the failure to believe in the EMH which leads to the collapse of the financial markets.
4	Shiller (2003)	Review Article	a. The efficient market model is flawed and could not be used to explain the many anomalies identified in the financial markets. b. The combination of finance theories with other social sciences will greatly help us to understand the financial markets much better. c. While efficient markets hypothesis is useful in characterizing the behaviour of certain financial models, we cannot use them in their pure form as precise tools in describing the actual markets.
5	Grossman & Stiglitz (1980)	Theoretical paper	a. If the markets are perfectly efficient all the time and the security prices always reflect all available information, there is no incentive for traders and analysts to gather information to earn an excess returns. b. When markets are not being watched by this group of key players, market efficiency will break down and prices become incorrect. Hence it is impossible to have a perfectly efficient market continuously. c. The theoretical models suggested in this paper are not meant to dismantle the efficient markets hypothesis but to redefine its explanation. The market will continue to be efficient as long as the marginal cost of collecting information is equal to the marginal benefits of having such information.

Table 2.3: Summary of Key Research Papers in Forward Unbiasedness Hypothesis

The table summarises some of the key research papers related to the forward unbiasedness hypothesis which adopted the Fama regression and cointegration techniques in the testing of market efficiency.

No.	Authors (Year)	Data	Main Findings
1	Fama (1984)	Spot and 30-day forward rates Frequency: Weekly Period: 31 Aug 1973 - 10 Dec 1982 Countries: Belgium, Canada, France, Italy, Japan, Netherlands, Switzerland, United Kingdom & West Germany	a. Decomposed the uncovered interest rate parity regression and hence it is now called Fama regression. b. The stylised fact of negative beta in the UIP regression is explainable by the larger variance in the forward premium than the variance in the expected changes in the spot exchange rate. c. The forward bias puzzle could be atributed to (i) inefficient foreign exchange market, (ii) givernment intervention, (iii) doomsday theory or (iv) stochastic deviations from the purchasing power parity.
2	Bansal & Dahlquist (2000)	Spot and 1-month forward rates, Interest rates Frequency: Daily Period: Jan-1976 - May-1998 Countries:Switzerland, HK, Singapore, Japan, Belgium, Austria, Denmark, Canada, France, Germany, Netherlands, Italy, UK, Australia, Sweden, Spain, Portugal, Poland, Greece, Czech Republic, Malaysia, Argentina, Venezuela, Thailand, Mexico, Turkey, Philippines & India	a. Forward premium puzzle is not as pervasive as previously claimed. This puzzle is only restricted to the developed currency markets and when domestic interest rate is lower than US interest rate. b. Individual country's charateristics are more significant in explaining the occurence of the forward bias puzzle. It is therefore hard to justify the risk premium in the foreign exchange market as compensation for systematic risk.
3	Frankel & Poonawala (2010)	Spot & 1-month forward rates Frequency: Monthly Period:Dec-1996 - Apr-2004 Countries: Australia, Canada, Denmark, EU, Japan, NZ, Norway, Sweden, Switzerland, UK, Czech, HK, Hungary, India, Kuwait, Mexico, Philippines, Saudi, Singapore, South Africa, Taiwan, Thailand & Turkey	a. Forward bias puzzle is less prominent in emerging contries than the developed countries. b. It is counterintuitive to suggest that the existence of risk premia as the cause of deviation from the uncovered interest rate parity condition.

Table 2.3: Summary of Key Research Papers in Forward Unbiasedness Hypothesis (continued...)

No.	Authors (Year)	Data	Main Findings
4	Pilbeam & Olmo (2011)	Spot exchange rate and 1-month interest rate Frequency: Monthly Period: Nov-1978 - Jan-2006 Countries: Switzerland, Japan, Eurozone, UK	a. The conventional Fama regression conatins a negative bias given by the variance of the ratio of future spot rate to the forward exchange rate. b. Two modified-Fama-regression models are proposed to overcome the weaknesses of the conventional Fama regression and results are very supportive of the uncovered interest-rate parity condition.
5	Lothian & Wu (2011)	Spot exchange rate Interest rate - short term and long term Frequency: Annual Period: 1791 - 1999 Country: UK, US and France	a. Forward bias puzzle is a recent phenomenon which emerged in 1980's. When tested over 200 years of data, no such puzzle is found. b. Large interest rate differential (implying bigger forward premium) contains stronger forecasting power of currency movements. c. Uncovered interest rate parity works better (1) at long horizon, (2) over long time period, (3) in the presence of large deviations and (4) in terms of holding-period returns.
6	Clarida, Davis & Pedersen (2009)	Carry trade returns from Bloomberg Frequency: Daily, weekly & monthly Period: 1991 - 2009 Country: Australia, Canada, Switzerland, EU, UK, Japan, Norway, New Zealand and Sweden	a. Carry trade returns are strongly and systematically inversely related to both the realised and implied FX option volatility. b. Forward bias puzzle is an artifact of volatility regime. The puzzle disappears during period of high volatility. c. S&P 500 volatility index (VIX) is an important risk factor in determining carry trade returns. d. There is diversification benefit in using more currencies in a carry trade portfolio.
7	Baillie & Bollerslev (1989)	Spot and 30-day forward rates Frequency: Daily Period: 1 Mar 1980 - 28 Jan 1985 Countries: UK, West Germany, France, Italy, Switzerland, Japan and Canada	a. Spot and forward exchange rates show strong evidence of cointegration and hence support *within-country* efficiency. b. Spot exchange rates of different currencies are found to be cointegrated and hence imply a violation in *across-country* market efficiency.
8	Jeon & Seo (2003)	Spot and 3-month forward rates Frequency: Daily Period: 1-Jan-1996 - 28-Feb-2001 Countries: Thailand, Indonesia, Malaysia and South Korea	a. The foreign exchange market is generally efficient across-country as there is hardly any cointegration among a system of spot exchange rates. b. Inefficiency is detected during the Asian financial crisis but the phenomenon did not last long. c. Markets efficiency within-country are found to be weaker post Asian financial crisis as evidenced by weaker cointegration between the spot and forward exchange rates.

Table 2.3: Summary of Key Research Papers in Forward Unbiasedness Hypothesis (continued...)

No.	Authors (Year)	Data	Main Findings
9	Kan & Andreosso-O'Callaghan (2007)	Spot and 1-month forward rates Frequency: Daily Period: 31-Dec-1996 - 15-May-2003 Countries: South Korea, Taiwan, Thailand, Indonesia, Malaysia, Philippines, Japan, Australia and New Zealand	a. Spot and forward exchange rates are cointegrated and hence support the notion of *within-country* market efficiency. b. Bivariate cointegration test results between two pairs of spot/forward exchange rates show some signs of cointegration. This finding suggests mild *across-country* inefficiency. c. Multivariate cointegration test results among a group of spot/forward exchange rates of different currencies show more than one cointegrating vector and this finding indicates significant violation of *across-country* market efficiency. d. Forward premium is found to be stationary and hence this finding reduces the argument for violation in *across-country* market efficiency.
10	Barkoulas, Baum & Chakraborty (2003)	Spot and 1 to 12-month forward rates Fequency: Daily Period: 2-Jan-1980 - 31-Dec-1998 Countries: Canada, West Germany, UK, France, Italy and Japan	a. Spot exchange rates of various currencies are cointegrated and this finding indicates a violation of market efficiency. b. Forward premium is found to be stationary and hence the cointegrating vector identified in the system of spot exchange rates could be instruments for currency risk premium. Hence the market could still be efficient. c. Interest rate differentials are also identified as stationary processes and this finding is consistent with stationary forward premium.
11	Crowder (1994)	Spot and 30-day forward rates Frequency: Monthly Period: Jan-1974 - Dec-1991 Countries: UK, West Germany, Canada	a. Spot exchange rates of various currencies are cointegrated and this finding indicates a violation of market efficiency. b. Forward premium is found to be non-stationary and hence the cointegrating vector identified in the system of spot exchange rates cannot be proxy for risk premium. This finding confirms the condition for market inefficiency.
12	Hochradl & Wagner (2010)	Spot and 1-month forward rates 1-month deposit rate 1-month implied volatilities Frequency: Monthly Period: Jan-1990 - Dec-2005 Countries: Australia, Canada, Switzerland, Denmark, UK, Japan and Eurozone	a. Forward bias puzzle is exploited and traded in the foreign exchange markets. This finding contradicts the limit-to-speculation hypothesis. b. Forward bias trading strategies provide superior risk-adjusted returns while not containing any systematic risk component. c. Forward bias trading strategies are recommended as promising extension to portfolio managers in enhancing their funds performance.

Table 2.3: Summary of Key Research Papers in Forward Unbiasedness Hypothesis (continued...)

No.	Authors (Year)	Data	Main Findings
13	Chinn (2006)	Review Article	a. Recent development in the study of the forward premium puzzle point towards a less pervasive phenomenon as previously thought. b. The use of survey data and returns measured at long horizon provide support for the uncovered interest-rate parity condition. c. The existence of risk premium in justifying the forward bias puzzle is less than promising.
14	Sarno (2005)	Review Article	a. The paper updates on the development towards the resolution of three ket exchange rate economics puzzles namely the forward premium puzzle, the purchasing power parity puzzle and the fundamental disconnect puzzle. b. The evidence against the uncovered interest rate parity condition has become weaker and the forward premium puzzle is not as pervasive as before. c. The interest rate term structure still provides good information regarding the future exchange rate changes.
15	Engel (1996)	Review Article	a. There are four directions suggested towards the resolution of the forward bias puzzle: (i) foreign exchange risk premium analysis, (ii) peso problem, (iii) survey data and (iv) frictions in the international financial markets. b. Small progress has been made but no convincing resolution yet. More research effort in the right directions is encouraged.

Table 2.4: Summary of Key Research Papers in Event-study and Foreign Exchange Markets Efficiency

The table summarises some of the key research papers which study the macroeconomic announcements in the context of foreign exchange markets.

No.	Authors (Year)	Data	Main Findings
1	Meese & Rogoff (1983)	Spot exchange rates and various macroeconomic variables Frequency: Monthly Period: Mar-1973 - Jun-1981 Countries: UK, West Germany, Japan and Trade-weighted USD	a. The structural exchange rate models fail to beat a naïve random walk model in forecasting the exchange rate changes out-of-sample.
2	Cheung, Chinn & Pascual (2005)	Spot exchange rates and various macroeconomic variables Frequency: Quarterly Period: Q2-1973 - Q4-2004 Countries: US, Canada, UK, Japan, Germany and Switzerland	a. The forecasting performance of various exchange rate models differ across currency. There is no one model which is clearly superior to the others. b. The forecasting performance of the exchange rate models also differ for varying time-horizon. c. The random walk model is proven to be superior in certain time horizon for certain currencies. Hence this finding support the robustness of results from Meese and Rogoff (1983).
3	Almeida, Goodhart & Payne (1998)	Exchange rates and macroeconomic announcements from the US and Germany Period: 1-Jan-1992 - 31-Dec-1994 Currencies: Deustche mark against USD Frequency: 5-minute	a. The reactions of the exchange rates to the surprises in the maceoeconomic announcements are mostly as predicted by the reaction response function. b. Most of the US macroeconomic surprises are significant in affecting the exchange rates. The most significant shock is the news in the US Non-farm payroll. c. The impact of the US macroeconomic shocks is usually short-lived with only up to two hours after the announcements. d. The full impact of the Germany macroeconomic shocks is only felt three hours after the announcements.
4	Pearce & Solakoglu (2007)	Exchange rates and various US macroeconomic announcements Period: 1-Dec-1986 - 1-Dec-1996 Currencies: Deutsche mark and Japanese yen (against USD) Frequency: 5-, 15-, 30-, 60-minute; 2-, 6- and 12-hour	a. The surprises in the US macroeconomic announcements which are related to the real economy significantly affect the exchange rates. b. The surprises in the US Non-farm payroll is the most significant event to the exchange rates. c. The responses of exchange rates to macroeconomic shocks are usually completed within the first 5 minutes. d. The exchange rates react symmetrically to positive and negative surprises. e. Deutsche mark is more elastic than Japanese yen in responding to US macroeconomic shocks.

Table 2.4: Summary of Key Papers in Event-study and Foreign Exchange Markets Efficiency (continued...)

No.	Authors (Year)	Data	Main Findings
5	Andersen, Bollerslev, Diebold & Vega (2003)	Exchange rates and various US macroeconomic announcements Period: 3-Jan-1992 - 30-Dec-1998 Currencies: Swiss franc, Deutsche mark, British pound, Japanese yen (against USD) Frequency: 5-minute	a. Only the unanticipated portions of a macroeconomic announcement affect the exchange rates. b. Most of the US macroeconomic shocks significantly affect the exchange rates. c. Only two shocks from Germany annoucements significantly affect the exchange rate. d. US Non-farm payroll shocks is the most significant news among all the others. e. The timing of the announcements matter in which related news which are released earlier have larger significant impact. f. Announcement effects are aymmetric in which negative news carry larger impact than positive shocks.
6	Fatum & Scholnick (2008)	Exchange rates and various US monetary-related announcements Period: 1989 - 2000 Currencies: Deutsche mark, British pound and Japanese yen (against USD) Frequency: Daily	a. Exchange rates respond only to the surprise component of an actual US monetary policy change. b. Failure to disentangle the surprise component from an actual announcement obscure the significance of the news. c. Exchange rates respond to the surprises on the same day of the announcements.
7	Simpson, Ramchander & Chaudhry (2005)	Exchange rates and various US macroeconomic announcements Period: 1-Jan-1990 - 7-Sep-2000 Currencies: Canadian dollar, Deutsche mark, Japanese yen, Swiss franc and British pound (against USD) Frequency: Daily	a. Findings support the Mundell-Fleming balance of payment model and covered interest rate parity condition in explaining the movement of exchange rates. b. Purchasing Power Parity (PPP) is, however, rejected in favour of Portfolio Balance model in determining the direction of the exchange rates. c. Exchange rates respond to shocks related to consumer demand, inflation and interest rate but not to shocks related to the general strength of the economies. d. News related to Treasury budget, trade balance and capacity utilization have the strongest impact to the exchange rates.
8	Cai, Joo & Huang (2009)	Exchange rates and macroeconomic announcements from US, Czech, Hungary, Indonesia, South Korea, Mexico, Poland, South Africa, Thailand and Turkey Period: 2-Jan-2001 - 31-Dec-2006 Currencies: Korean won, Turkish lira, Czech koruna, Hungarian forint, Indonesian rupiah, Mexican peso, Polish zloty, South African rand and Thai baht	a. Domestic macroeconomic news do not have significant effect on exchange rates except for Czech koruna. b. US macroeconomic news significantly affect the exchange rates. c. Emerging market currencies become more sensitive to macroeconomic news in the later period. d. Macroeconomic news have stronger impact on emerging market currencies when market sentiment is strong.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGIES

3.0 Introduction

There are various techniques which have been applied in the testing of the efficient market hypothesis (EMH). The methodology described in this chapter is devised to specifically test all the research hypotheses as set forth in Chapter 1. We have approached this thesis, which investigates the EMH in the context of foreign exchange markets, from two perspectives. These two perspectives help us to comprehensively test for the first research hypothesis as to whether the foreign exchange market is efficient. First of all, the state of foreign exchange market efficiency is examined from the forward unbiasedness hypothesis perspective. The forward unbiasedness hypothesis, which is derived from the uncovered interest-rate parity (UIP), is a cornerstone theory used to test the efficiency condition in the foreign exchange markets. As the forward unbiasedness hypothesis relies on the historical exchange rate series to determine the relationship between the spot and forward exchange rates, we may loosely look at this perspective as a test of weak-form market efficiency. The second research hypothesis on whether there is any evidence of forward bias puzzle in the Asia-Pacific foreign exchange market is tested under the forward unbiasedness hypothesis perspective. The third research hypothesis on whether the market efficiency is constant under different economic conditions is tested with the forward unbiasedness hypothesis. We test this hypothesis by breaking up the whole sample period into several sub-sample periods.

Meanwhile, the second perspective employed is the event-study analysis. This perspective is often viewed as a test of the semi-strong form of market efficiency because the event-study analysis investigates the instantaneous reaction of security prices to the release of new information. The event-study analysis is a well established technique which has been widely used in the testing of EMH for various types of markets, for example the equity and credit markets. Research hypotheses four and five which look at the reactions of the spot exchange rates to macroeconomic surprises are tested using the event-study analysis perspective. Hence all of the research hypotheses are able to be tested with these two perspectives. By adopting both of these perspectives in the investigation of foreign exchange market efficiency, we provide a more comprehensive view on this subject. We are not aware of any prior study which has similarly adopted both of these perspectives in a single research paper. By doing this, we broaden the view with regards to the EMH in the foreign exchange markets. While one may argue that conducting separate research based on each individual perspective may also yield similar results. However, we disagree because the scope of the test is definitely limited if only one approach is adopted and the other left out. In this thesis, we provide more coherent evidence regarding the EMH in the context of foreign exchange markets because our research combines these two perspectives.

There are seven subsections in this chapter. In the following subsection, we describe the selection of data. We provide some descriptive statistics of the exchange rates series chosen in this thesis. We also discuss the sample period used in this study and how we compartmentalise the whole sample period into several subsample periods. As the whole period comprises some interesting events, in particular the Asian financial crisis (AFC) of 1997/98 and the global financial crisis (GFC) of 2008/09, the compartmentalisation of the whole period provides valuable insights into the efficiency condition under different economic climates. The breaking-up of the whole sample

period applies to the test of the forward unbiasedness hypothesis due to the availability of a large number of exchange rate data series. However, we only look at the event-study analysis under the whole period because studying smaller samples will seriously reduce the observations and may jeopardise the eventual results. We have carefully selected a huge number of macroeconomic news as the events for our second approach. As the Asia-Pacific currencies are managed under different regimes, it is useful to have some understanding of this diversity. In the subsequent section, we offer a brief development of the 12 Asia-Pacific currency markets examined in this thesis. After the brief background information about the Asia-Pacific currency markets, we move on to deliberate about the macroeconomic announcements used as the events. There are a total of 107 announcements selected from all the 12 Asia-Pacific countries plus the U.S. In the next two subsections, we elaborate on the respective techniques employed to test for all of the research hypotheses. Finally, we conclude this chapter with a recap of our explanations.

3.1 Data Description

We have employed twelve of the most active and significant Asia-Pacific currencies for this study. The currencies chosen are the Australian dollar (AUD), Chinese yuan (CNY), Japanese yen (JPY), South Korean won (KRW), Indonesian rupiah (IDR), Indian rupee (INR), Malaysian ringgit (MYR), New Zealand dollar (NZD), Philippines peso (PHP), Singapore dollar (SGD), Thai baht (THB) and Taiwanese dollar (TWD). The data used are daily spot and one-month forward exchange rates which are obtained from Datastream. The U.S. dollar (USD) is used as the numeraire currency. The prime motivation for the currencies choice is due to the fact that this group of currencies is not as well researched as the major currencies. These countries are collectively gaining more prominence in the global markets. Their combined economic significance is now the focus of the world. Besides that, at at 2012

they are the main engine of growth of the world economy. As presented in Figure 1.1, the combined trade contribution from these 12 Asia-Pacific economies to the total world trade grows from 14% in 1980 to 27% in 2010.

Table 3.1 on the following page illustrates the key demographic characteristics of these countries. The statistics from Table 3.1 are obtained from various sources such as the Central Intelligence Agency (CIA) World Factbook 2010, the U.S. Census Bureau and the World Trade Organisation (WTO) databases. Besides the 12 Asia-Pacific countries, we also present data related to the global average for comparisons. The first column shows the name of the countries followed by the population information in the second column. In the next two columns, we present the total GDP and the GDP per capita for each nation and followed by the GDP growth rate in subsequent column. The sixth column reports the unemployment rate, the seventh reports the inflation rate as measured by the changes in the Consumer Price Index (CPI) and the benchmark interest rate is in the eighth column. The total trade is shown under column ninth and the last two columns exhibit the total holding of foreign reserves and the spot exchange rate at the end of year 2010. Under column two, we notice that these 12 Asia-Pacific countries made up about 46% of the world population. Therefore the empirical evidence reported in this thesis is socially important in a global context. Even though the number of countries may be small in relative to the total sovereigns recognised by the United Nations, the number of people is almost half of the world population. From this representation, a researcher making any recommendation on global initiatives or policies must take into account the market conditions and structure of countries from this part of the world.

Table 3.1: Key Economic Demography of the 12 Asia-Pacific Countries and the World, 2010

The Asia-Pacific region is inhabited by almost half of the world population. The region contributed to about one-third of global output in 2010. The Asia-Pacific region is also growing above the global growth rate and the region is often dubbed as the global growth engine of the 21st century. The region has become an important area for global socio-economic growth.

Country	Total Population (mil)	GDP (USD bil)	GDP per capita (USD)	GDP growth (%)	Unemployment Rate (%)	CPI (%)	1-month Interest Rate	Total Trade (USD bil)	Total Reserves (USD bil)	Exchange Rate (per USD)
Australia	22	890	41,300	3.30%	5.10%	2.90%	4.80%	512	39	1.0902
China	1,330	9,872	7,400	10.30%	4.15%	5.00%	5.50%	3,335	2,662	6.7852
India	1,173	4,046	3,400	8.30%	10.80%	11.70%	4.75%	765	284	46.16
Indonesia	243	1,033	4,300	6.00%	7.10%	5.10%	6.27%	339	96	9,170
Japan	127	4,338	34,200	3.00%	5.10%	-0.70%	0.18%	1,755	1,096	87.78
South Korea	49	1,467	30,200	6.10%	3.30%	3.00%	2.64%	1,066	275	1154
Malaysia	28	417	14,700	7.20%	3.50%	1.70%	2.82%	428	107	3.0400
New Zealand	4	119	28,000	2.10%	6.50%	2.60%	3.13%	80	18	1.3874
Philippines	100	353	3,500	7.30%	7.30%	3.80%	0.75%	133	62	45.11
Singapore	5	292	57,200	14.70%	2.10%	2.80%	0.19%	870	226	1.3702
Taiwan	23	824	35,800	10.50%	5.20%	1.00%	0.66%	604	387	31.64
Thailand	66	580	8,700	7.60%	1.20%	3.30%	2.05%	457	176	31.66
World	6,900	74,480	11,200	4.70%	8.80%	4.00%	-	37,781	-	-

Sources: CIA World Factbook 2010, U.S. Census Bureau and World Trade Organization (WTO)

In addition, the combined GDP from these 12 countries contributes to about 33% of global output. Despite the social and economic significance of this region, these countries are a diverse lot. There is a huge disparity in terms of GDP per capita. Under column four (4), we notice that, on average, people from Singapore are the richest with earnings of USD57,200 per capita while the poorest group of people are from India with only USD3,400 per capita or only 6% of their Singapore counterpart. Five of the 12 Asia-Pacific countries register a lower per capita income than the global average of USD11,200 (i.e. India, Philippines, Indonesia, China and Thailand). According to the World Bank database of 2010, these five nations are categorised as medium income nations. Malaysia, despite having a GDP per capita higher than the global average, is also categorised in the medium income group. The other six countries (i.e. Singapore, Australia, Taiwan, Japan, South Korea and New Zealand) are categorised as high income nations according to the same database.

Moving on to the fifth column of Table 3.1, we notice that there are nine (9) countries in the sample which register higher growth in GDP than the global average growth rate of 4.7% in 2010. Out of these above-average growth nations, three (3) of them even record double digit growth rate (i.e. Singapore-14.7%, Taiwan-10.5% and China-10.3%). Only three (3) advanced economies (i.e. Japan, Australia and New Zealand) report a growth rate lower than the global average. The exceptional growth rates for 2010 in the Asia-Pacific region are mainly due to the contraction registered in 2009 globally. With the exception of India which registers an unemployment rate of 10.8%, all of the other Asia-Pacific countries in the sample show a lower unemployment rate than the global average of 8.8%. The inflation rates of this region are also commendable as most countries record a lower rate than the global average of 4%. The Japan economy shows some sign of deflation as evidenced by a slightly

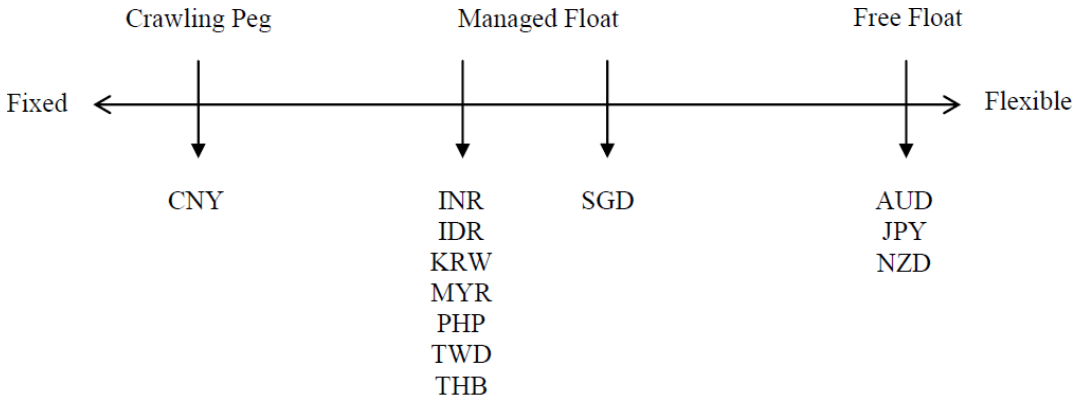
negative growth in the CPI. Meanwhile, India, Indonesia and China register inflation rates of 11.7%, 5.1% and 5.0% respectively. With this diversity in the inflation outlook, the benchmark interest rates from these countries are also very different. From the one-month interest rate structure, Indonesia offers the highest rate of 6.27% and Japan the lowest at 0.18%. The robust growth accompanied by low unemployment and moderate inflation in the Asia-Pacific countries are testimonies to the strong economic fundamental displayed by this region. We may still comfortably count on these economies to drive growth globally despite the economic calamities in the U.S. and the Eurozone (i.e. U.S. subprime collapse and Eurozone sovereign meltdown).

As the trade figures have been discussed earlier in Chapter 1: Introduction, we move on the second last column of Table 3.1 which shows the foreign exchange reserves held by each country. The central banks in the Asia-Pacific have been accumulating vast foreign exchange reserves especially after the AFC of 1997/98. As a matter of fact, China and Japan have each accumulated a reserve in excess of a trillion USD. This high level of foreign exchange reserves among the Asia-Pacific countries has created a strong fortress against any possible speculative attacks. However, this phenomenon has also caused huge global imbalances which may spell trouble for future economic prospects if the reserves are not channelled into productive economic sectors.

In view of the social and economic importance of this region, researchers must generate more studies which utilise data from this set of countries as the main focus instead of treating them as a secondary focus. The research output using these countries data must aggressively play catch-up to the vast literature which has traditionally used developed countries' records. This region also provides a unique situation in which the countries are undergoing different development stages. There are some countries in the

advanced status while most are in the developing stage. Perhaps for this reason, there is a wide variety of foreign exchange regimes adopted by countries in this region.

Figure 3.1: Scale of Foreign Exchange Regimes Flexibility



CNY-Chinese yuan, INR-Indian rupee, IDR-Indonesian rupiah, KRW-Korean won, MYR-Malaysian ringgit, PHP-Philippines peso, TWD-Taiwanese dollar, THB-Thai baht, SGD-Singapore dollar, AUD-Australian dollar, JPY-Japanese yen, NZD-New Zealand dollar.

On a scale of foreign exchange flexibility, the selected currencies spread evenly across this spectrum as shown in Figure 3.1. On the extreme left of the scale, we have fixed exchange rate regime while the flexible regime is situated on the extreme right. In the strictest sense, currencies which fall under the fixed exchange rate regime do not change in value in relation to the chosen benchmark or anchor. For example, the value of the MYR was set at 3.80 to a unit of USD from September 1, 1998 to July 21, 2005. The exchange rate of MYR was maintained at this level by the monetary authority through active intervention in the market. However, the value of the currencies under the fixed exchange rate regime still fluctuates against other currencies depending on the fluctuation of the benchmarked currency. Using the same example, the value of MYR was still changing against all other currencies which varied in value against the USD during the fixed regime period. On the other hand, in the independently floating regime, the values of currencies are determined freely by market forces. The supply and demand of one currency will determine the equilibrium value of this particular currency against

other currencies. In between these two extreme poles, there lies a wide variety of exchange rate regimes.

The classification of our sample currencies is based on the IMF *de facto* classification of the exchange rate regimes of member countries. We do not use the official pronouncement of exchange rate regime by the respective monetary authority because the actual practice may be different from the pronouncement. Levy-Yeyati & Sturzenegger (2005) have provided evidence about the differences between the words and deeds of the monetary authority in managing a country's exchange rate. While one country may claim that its currency is managed under a free-float regime, the active intervention by the monetary authority of this country in the foreign exchange markets provide contrary evidence to the official pronouncement. Therefore the *de facto* classification is always preferred to the *de jure* classification. Three (3) currencies in our sample are classified under the free-float regime namely the AUD, JPY and NZD. These currencies are not entirely free-float because their central banks still intervene in the markets in very rare circumstances for a variety of reasons. Sometimes the interventions are made public but most of the time, the actions are carried out discretely. Most of the sample currencies are classified under the managed-float regime. The SGD is slightly skewed to the right of the scale because its currency is managed within a band of its nominal effective exchange rate (NEER) and it is traded in the international market with few restrictions. On the other hand, most of the other managed-float currencies (i.e. IDR, INR, KRW, MYR, PHP, THB and TWD) are discretely managed by the authority and are traded in a very restrictive manner. For example, the MYR and IDR are not traded outside of their respective countries. Their values are determined by local market forces and with active interventions from the authority. Lastly, CNY is categorised under the crawling peg regime. The People's Bank of China (PBOC) will determine the middle point of the CNY against USD at the start of each trading day and

subsequently its value is allowed to fluctuate within a limited band. The detailed description of each of the sample currencies is provided in the following sub-section.

This thesis covers the period from January 1, 1997 to December 31, 2010 for an approximately total number of 3,653 spot and forward exchange rate daily observations respectively for each currency.[20] The exchange rates data are obtained from *Datastream*. The full period is further broken down into six subsample periods according to the respective underlying economic conditions. The compartmentalization of the full period into the sub-periods is only applicable for the testing of the forward unbiasedness hypothesis. We do not apply the sub-period analysis for the event-study approach because of the constraints in the data. The number of observations for most macroeconomic surprises will be greatly reduced to a meaningless level if the sub-period analysis is adopted in the event-study approach. The first sub-period is from January 1, 1997 to June 30, 1997. This period is a prelude to the full-blown Asian financial crisis (AFC) which hit the region in the second half of 1997. Even though there were signs of instability in the financial markets in the first half of 1997, the currency markets were still steady and seemed to be absolved from the upcoming crisis. We call the first sub-period the pre-AFC period.

The second sub-period is framed from July 1, 1997 to December 31, 1998. The start of the AFC is widely agreed to be marked by the flotation of THB by the Bank of Thailand on July 2, 1997 (Gong, Lee & Chen, 2004). The crisis spread like wildfire among the neighbouring nations once the floatation of THB occurred in July 1997. Hence the name of "*tom-yum effect*" was coined by the popular press. The AFC did not only affect emerging market economies but also some industrialised nations. Countries with high leverage and borrowings in foreign currencies suffered the most during this

[20] The analysis period for CNY starts only after the shift from fixed exchange rate regime to crawling-pegged regime on 22 July 2005. Likewise, the 'temporary' fixed exchange rate period for MYR (i.e. from September 1, 1998 to July 21, 2005) is excluded from the analysis. The forward exchange rates data for INR and KRW start from 27 October 1997 and 11 February 2002 respectively.

period. Besides Thailand, Indonesia, Malaysia and South Korea have become nearly insolvent. Many big businesses in these countries were bankrupted by the constant depreciation of the local currencies against the USD during this period. The AFC had spelt trouble not only to the investment community and businesses but also the ruling regimes of these countries. We witnessed the authoritarian regime of President Suharto in Indonesia being overthrown by the masses. There were also leadership transition in the Philippines, South Korea and Thailand. In Malaysia, the Prime Minister Mahathir Mohamad had a fall-out with his then Deputy Prime Minister Anwar Ibrahim over the handling of the AFC. The AFC leaves its mark in the region as a watershed event which altered the structure of the affected nations politically, socially and economically. The financial and social landscapes of these countries were changed for good. Nevertheless, countries with deep national coffers (e.g. Singapore and Japan) were able to withstand the onslaught of the AFC. Countries which practiced a largely closed-door economy were also relieved from the full effect of the AFC. The severely affected countries such as Indonesia, Thailand and South Korea had resorted to aid packages made available by the International Monetary Fund (IMF). The aid package came with several controversial conditions with the objective to strengthen the fundamentals of the economy. The Malaysian government, however, disagreed with the set of conditions determined by IMF and as a result, unilaterally embraced some unorthodox measures to address the AFC. Soon after the release of the IMF aid packages to the affected countries and the introduction of some unorthodox measures in Malaysia, calmness gradually returned to the financial markets. While there were still plenty of restructuring exercises to be conducted, businesses were able to continue to operate with greater certainty. By the end of 1998, the depreciation spree of the Asian currencies had almost ended and stability was restored.

We date the beginning of the third sub-period from January 1, 1999 until July 20, 2005. The economies of these countries rebounded strongly and growth returned on the right path. Throughout this sub-period, the affected countries were progressively rebuilding their economic fundamentals. Financial structures were reformed and solidified to a higher level so that the economy is better equipped to handle future shocks. We term the third sub-period as the post-AFC period. The fourth sub-period begins from July 21, 2005 until December 31, 2007. The beginning of this period coincides with the shift in the foreign exchange regime in China and Malaysia. The People's Bank of China (PBOC) had made a surprise announcement on July 21, 2005 after the close of the markets to abandon the fixed exchange rate regime and move to a crawling peg regime. The CNY was pegged at 8.28 to a unit of USD at the time of the announcement. Soon after the PBOC's announcement, the Malaysian central bank, Bank Negara Malaysia (BNM), held an emergency press conference in late evening on the same day to announce its intention to replace the fixed peg of MYR to USD to a managed-float regime. The MYR was pegged at 3.80 to a unit of USD as a measure to stop the speculative attack at the height of the AFC. The growing reserves at the PBOC and BNM were seen as evidence of the undervaluation of these two currencies against the USD. Financial economists have often accused these countries of manipulating their currencies in order to increase the competitiveness of their products. The appreciation of Asian currencies has continued for an extended period of time. Despite the consistent appreciation during this sub-period, most Asian currencies have still not recovered to the pre-AFC levels. This is also a period immediately prior to the global financial crisis (GFC) of 2008/2009. We shall call this fourth sub-period the pre-GFC period.

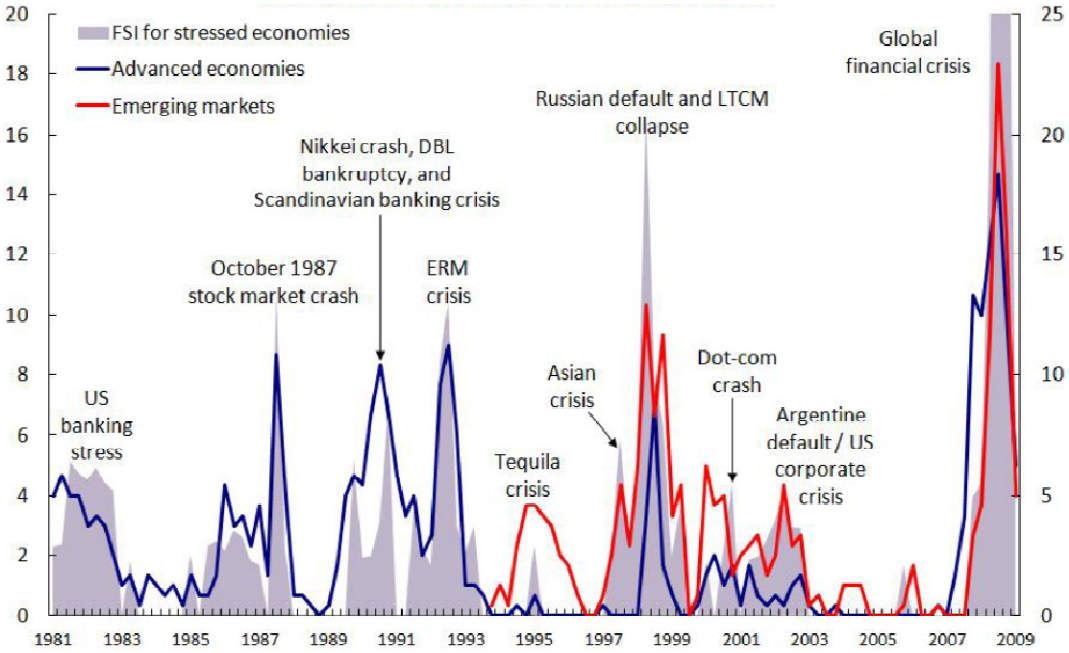
The next sub-period coincides with the declaration of the beginning of recession in the U.S. by the National Bureau of Economic Research (NBER) in December 2007. The period from January 1, 2008 to December 31, 2009 is termed as GFC period. In

fact, as early as 2007, there were already some signs of a slowdown in the U.S. property market. Prior to that, interest rates in the U.S. had been left at a very accommodative level for a considerably long period of time. This environment had fuelled speculative activities especially in the property market as cheap funding was easy to come by. However, the low interest rate environment did not last long as the inflationary pressure reared its ugly head and the Federal Reserve Bank of the U.S. started a series of interest rate hikes. As interest rates were increasing, the bursting of the property bubble seemed inevitable. Following this development, the subprime mortgage market was the first one to get hit in the U.S. financial markets. A subprime mortgage refers to a loan granted to a borrower with low credit worthiness. These borrowers usually took up the loan with the expectation that the value of the property would only go up and they would be able to reap a quick capital gain. This situation held true until the Federal Reserve started to hike interest rates. Subprime borrowers who have no steady source of income eventually defaulted on the loans and the banks had to foreclose on those properties. As more properties were put up for sale in the auction markets, the property sector finally collapsed. Furthermore, the situation was aggravated by some new financial innovations such as collateralised debt obligations (CDO) and credit derivatives swap (CDS). Basically, a CDO is a collection of mortgages sold by the originating banks to the investment community such as mutual funds, pension funds and the like. The CDO is usually sold in tranches to increase its appeal to different segments of investor. Some CDOs which were backed by subprime mortgages could even be innovatively packaged into a type of security with a AAA rating.

Banks and funds which were holding large amounts of CDO were forced to recognise a huge write-down in their accounting books following the collapse in the subprime market. Two notable financial institutions were wiped out due to GFC. Bear Stearns filed for bankruptcy in early 2008, followed by the collapse of Lehman Brothers

in late 2008. According to data from Fortune 500 in 2007, Lehman Brothers was the fourth largest investment bank in the U.S. and the 47th largest company in the world. The bankruptcy of these large financial institutions sparked off serious systemic risk in the global financial markets. Banks, even those with strong balance sheets, became reluctant to lend funds due to the heightened level of risks. This phenomenon caused market liquidity to dry up globally and the world economy spiralled into a deep recession. Some economists have termed this incident as the 'Great Recession' in relation to the Great Depression recorded from 1929 to 1932. Dooley & Hutchison (2009) and Melvin & Taylor (2009) have provided an insightful chronicle of the GFC.

Figure 3.2: Number of Countries under Financial Stress



The graph shows the number of countries under financial distress from 1981 to 2009. The Financial Stress Index (FSI) is used as the measure of whether the countries fall into the stressed economies category. The y-axis on the left indicates the number for advanced economies while the y-axis on the right for emerging markets. The number of countries under financial stress decreased dramatically in 2009 and this indication supports our conjecture that the global financial crisis (GFC) ends in 2009.
Source: IMF report entitled "Global Safety Nets: Crisis Prevention in an Age of Uncertainty".

Calmness gradually returned to the market in early 2009 and by the end of the year, the signs of recovery became more obvious. The job markets in the U.S. started to record growth and the GDP of many nations have recovered to positive territory. We consider the end of 2009 as the closure to the GFC. This cut-off for the GFC is arbitrary

and we acknowledge that it could be a point of contention. Therefore in order to support our conjecture, we borrow a graph from an IMF's report entitled *Global Safety Nets: Crisis Prevention in an Age of Uncertainty* and put it under Figure 3.2. From Figure 3.2, we notice that among all the crises which occurred between 1981 and 2009, the 2008/09 crisis is the largest of all in terms of impact to the world. It is, therefore, justified to call this event as the GFC. The number of countries under financial stress peaked between 2008 and 2009 and it quickly receded towards the end of 2009. Hence we consider the end of 2009 as the closure for the GFC. Finally, the full year of 2010 is used at the post-GFC sub-period. This is the final sub-period in our whole sample. The summary of our sub-periods is shown in Table 3.2 below.

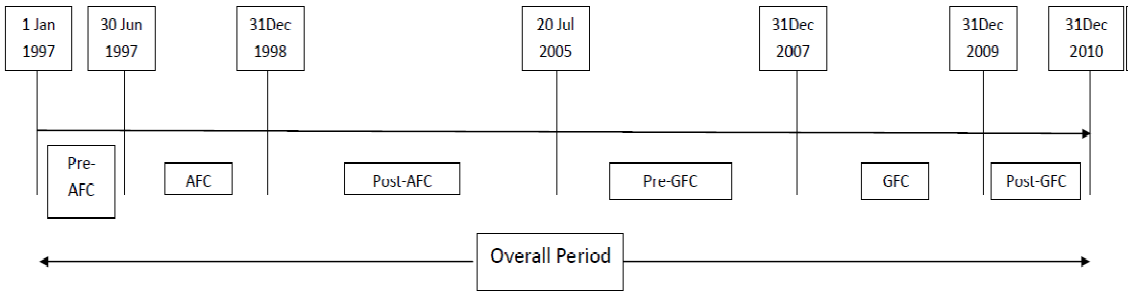
Table 3.2: Sub-period Summary

Name	Period	Description
Overall	1 Jan 1997 – 31 Dec 2010	The overall period covers two major financial crises in modern history. It covers a sample of 3,656 spot and forward exchange rates respectively.
Pre- Asian Financial Crisis	1 Jan 1997 – 30 June 1997	This is the period which precedes the full-blown Asian financial crisis. However, some instability and turbulences in the financial markets were already evidenced.
Asian Financial Crisis	1 Jul 1997 – 31 Dec 1998	This is the period which covers the full-blown turmoil of the Asian financial crisis. Local currencies depreciated substantially during this period as a result of speculative attacks and capital flights.
Post-Asian Financial Crisis	1 Jan 1999 – 20 Jul 2005	This period signifies the return of market stability after some of the affected nations accepted the IMF's aids while some others subscribed to unorthodox measure.
Pre-Global Financial Crisis	21 Jul 2005 – 31 Dec 2007	The beginning of this period is to coincide with the major shift in the foreign exchange regime in China and Malaysia. The Asian currencies experienced a period of appreciation following this episode.
Global Financial Crisis	1 Jan 2008 – 31 Dec 2009	This period covers the collapse of the US subprime mortgage markets and liquidity squeeze which eventually spread global. Volatility in the foreign exchange market was as high as the Asian financial crisis period.

Table 3.2: Sub-period Summary (continued...)

Post-Global Financial Crisis	1 Jan 2010 – 31 Dec 2010	This period witnesses the implementation of some unconventional measures to tackle the global financial crisis. The financial markets were still highly uncertain but with better calmness.

Graphical representation:



3.2 Foreign Exchange Markets in Asia-Pacific

According to the Bank for International Settlement (BIS)'s Triennial Central Bank Survey 2010, the Asia-Pacific foreign exchange markets have gained strong dominance in the global markets. Japan, Singapore, Hong Kong and Australia have emerged as leading financial centres in the trading of foreign currencies, accounting for a global trading volume of 20%. Among our sample currencies, the JPY, AUD and NZD are categorised as the top 10 most traded currencies in the world. Collectively, the 12 selected currencies in our sample constitute 17.4% of the total global foreign exchange market turnover. The distribution of the global turnover for the 12 currencies in our sample is as depicted in Table 3.3 on the following page.

The Asia-Pacific foreign exchange markets consist of various regimes. The choice of the foreign exchange regime is closely related to the depth of the financial markets and the stage of development of the particular country. As our sample currencies are made up of nations at different junctures of economic growth, it is only natural that we have different foreign exchange regimes. This diversity definitely enriches our empirical research. An understanding of the development of the individual

foreign exchange market for each country in our sample is helpful when we interpret of the data and results. We shall present some historical information and recent development of the sample currencies in the order as per Table 3.3 below.

Table 3.3: Asia-Pacific Currency Distribution of Global Foreign Exchange Market Turnover: 2001 – 2010

The original value reported in the BIS' report is against a world total of 200% due to the fact that the trading of currency always involves two currencies. The original figures are converted by a factor of half in order to report a base of 100% with the intention to make the explanation and interpretation easier to follow.

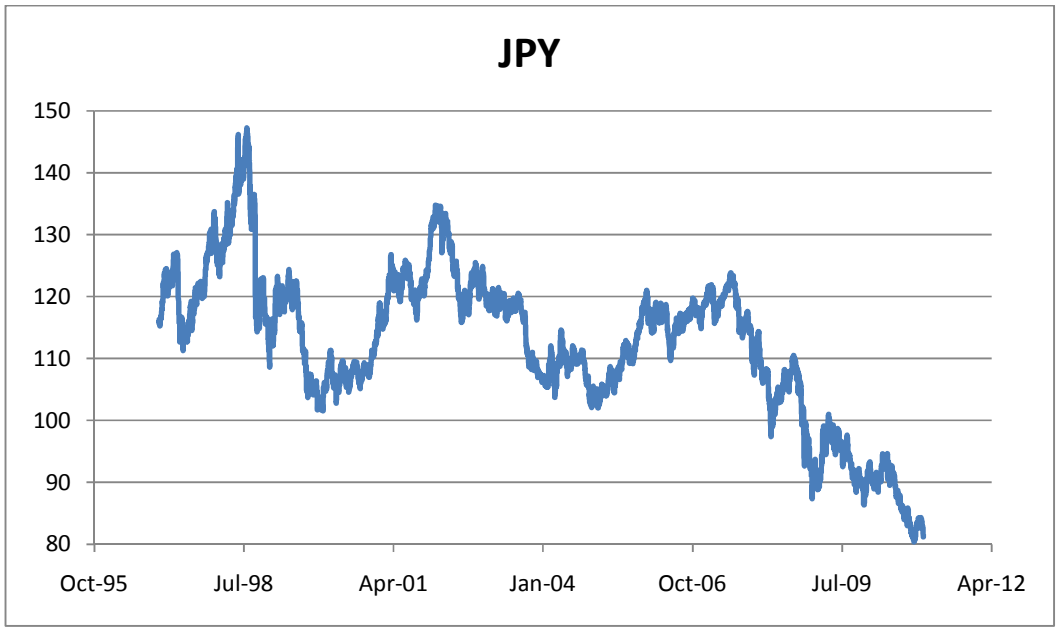
Country	Currency	2010 (%)	2007 (%)	2004 (%)	2001 (%)
	JPY	9.5	8.6	10.4	11.8
	AUD	3.8	3.3	3.0	2.2
	NZD	0.8	0.9	0.6	0.3
	KRW	0.8	0.6	0.6	0.4
	SGD	0.7	0.6	0.5	0.6
	INR	0.5	0.4	0.2	0.1
	CNY	0.5	0.3	0.1	0.0
	TWD	0.3	0.2	0.2	0.2
	MYR	0.2	0.1	0.1	0.1
	THB	0.1	0.1	0.1	0.1
	PHP	0.1	0.1	0.0	0.0
	IDR	0.1	0.1	0.1	0.0
TOTAL A-P		**17.4**	**15.3**	**15.9**	**15.8**
	USD	42.5	42.8	44.0	45.0
Others		40.1	41.9	40.1	39.2
WORLD TOTAL		100	100	100	100

Source: BIS Triennial Central Bank Survey: Report on Foreign Exchange Market Activity in 2010

Japanese yen (JPY)

Japan is among the first industrialised Asian countries. The ancient versions of the Japanese currencies were mostly sourced from China. It is only after the Meiji Restoration in 1868 that the currency system in Japan was revamped. Following a rapid modernisation in Japan during the Meiji Restoration, New Currency Act 1871 was passed to introduce Japanese yen (JPY) as the sole legal tender. About a decade later, the Bank of Japan was established in 1882 to function as the institution which controls the money supply in Japan. In emulating the advanced economies, the Japan Imperial Government adopted a gold exchange standard in 1898. This monetary system was maintained until the end of World War Two. After a devastating defeat in the war, the Japanese economy was thrown into an upheaval. In an effort to reorganise the economy, the Japanese government joined the Bretton Woods system and the value of JPY was pegged to the USD at JPY360 to one unit of USD. In 1971, the U.S. government abandoned the Bretton Woods system in view of the depleting gold reserves in its coffer.

Figure 3.3: JPY per USD – January 1, 1997 to December 31, 2010



Source: Datastream

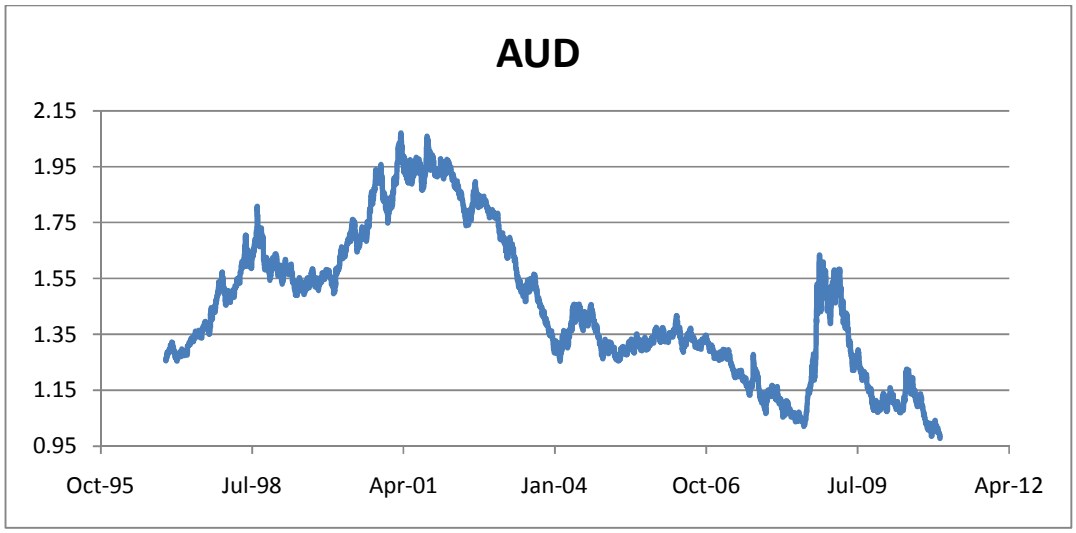
Since then, the USD has become a fiat currency fully backed by only the promise of the U.S. government. In the same year, the Group of 10 signed the Smithsonian Agreement to adjust the fixed peg against the USD. The JPY was then revalued against the USD to JPY301 to JPY315. As the USD continued to lose its value, most of the advanced countries' currencies were floated. The JPY was floated in 1973 at JPY263 per USD and has since been on this free-float regime. Even though under a free-float regime, the Bank of Japan still intervened in the foreign exchange markets to influence the value of JPY. Over the past four decades under the free-float regime, the JPY has always been a major currency and widely traded in the global markets. It is also one of the more popular reserve currencies among the central banks around the world. For most of 2000s, the JPY has been a favourite funding currency due to its low interest rate (Galati, Heath & McGuire, 2007). In a currency carry trade, investors borrow funds in JPY and use the funds to invest in higher yielding currencies. The massive unwinding of the JPY carry trade was reported during the GFC in 2007/08 (Melvin & Taylor, 2009). As a result, the JPY registered a strong depreciation in early part of 2000s and reversed the trend towards the end of 2000s. Figure 3.3 shows the movement of JPY during our sample period.

Australian dollar (AUD)

Australia has a very deep linkage with the United Kingdom and these two countries still share a common monarch. The first banknote of Australia was printed upon the establishment of the Bank of New South Wales in 1817 and the British Government introduced the sterling standard throughout its empire in 1825. Following the establishment of the Commonwealth of Australia in 1901, the locally issued Australian currency surfaced for the first time alongside the existing pound sterling. These Australian currencies were issued by various state banks across Australia. A

standardized unit of Australian currency known as the Australian pound was only introduced in 1912 after the passing of the Notes Act in 1910 and Commonwealth Bank Act in 1911. The Commonwealth Bank of Australia was converted to the Reserve Bank of Australia (RBA) in 1959 to play the role as the central bank of Australia upon the passing of the Central Bank Act 1959. Similar to most of the British colonies, the value of the Australian pound was pegged to the British pound (GBP). The Australian pound stayed within the Sterling Area throughout the interwar years as well as the early part of the Bretton Woods regime. The Australian pound left the Sterling Area after the devaluation of GBP against the USD in 1967 and the currency was thus renamed to the current name of the Australian dollar (AUD). The AUD is also affectionately known as "Aussie" or in short "OZ".

Figure 3.4: AUD per USD – January 1, 1997 to December 31, 2010



Source: Datastream

The AUD was subsequently pegged to the USD from 1967 to 1983. Even though the U.S. government abandoned the Bretton Woods regime in 1973, the AUD still remained pegged to the USD. The AUD was only effectively floated in 1983 and its value is subsequently determined by market forces. However, there were still occasional reports on intervention activities by the RBA in the foreign exchange market.

Conventionally, the AUD is still being quoted as the amount of USD per unit of AUD. Post-floating era, the lowest value of AUD against the USD was recorded in April 2001 at USD0.4775 per unit of AUD. At the time of writing, the highest point for AUD against the USD was traded at USD1.1080 per AUD on July 27, 2011. Figure 3.4 illustrates the movement of the AUD within our whole sample period from January 1, 1997 to December 31, 2010.

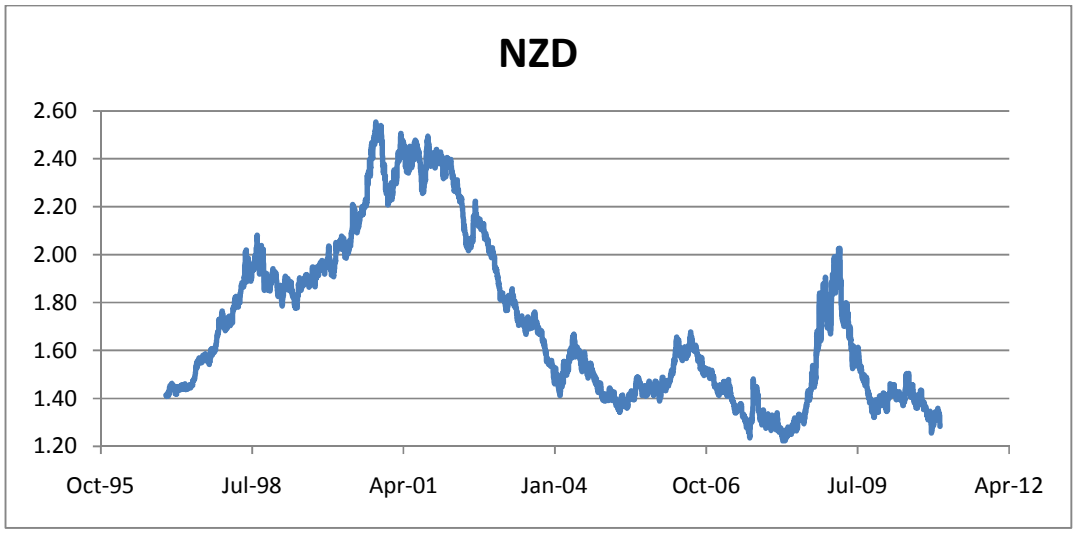
New Zealand dollar (NZD)

Similar to Australia, New Zealand is also closely linked to the U.K. and these countries also share a common monarch. New Zealand was a colony of the British Empire since 1840 with the signing of the Treaty of Waitangi between the British Crown and the local chieftains. Following this event, the British currency became the legal tender in New Zealand accompanied by some other form of currencies issued by the trading banks. The local reserve bank, the Reserve Bank of New Zealand (RBNZ) was established in 1934 upon the passing of the Reserve Bank Act 1934. With this establishment, the New Zealand pound was given birth and became the sole legal tender in New Zealand. Naturally, the value of the New Zealand pound was pegged to the GBP. The New Zealand pound remained the official currency for New Zealand until the adoption of a decimalization system in 1967.

The currency was officially renamed as the New Zealand dollar (NZD) in 1967 following the passing of the Decimal Currency Act 1964. The NZD is also affectionately known as the "Kiwi" after the unique flightless bird found only in New Zealand. The NZD remained pegged to the GBP even after the decimalisation exercise. Only after the collapse of the Bretton Woods system in 1973, the value of NZD was determined by a trade-weighted basket of currencies. This trade-weighted basket was maintained until 1985 when the RBNZ floated the NZD. The value of the currency is

now freely determined by market forces. Similar to the AUD, there are still reports about the suspected intervention activities of the RBNZ in the foreign exchange markets. At the time of writing, the highest value of NZD post-float was recorded on July 22, 2011 at USD0.8666 to a unit of NZD. While its lowest value post-floating was traded at USD0.3922 on November 22, 2000. Figure 3.5 shows the movement of the NZD against USD for our sample period.

Figure 3.5: NZD per USD – January 1, 1997 to December 31, 2010



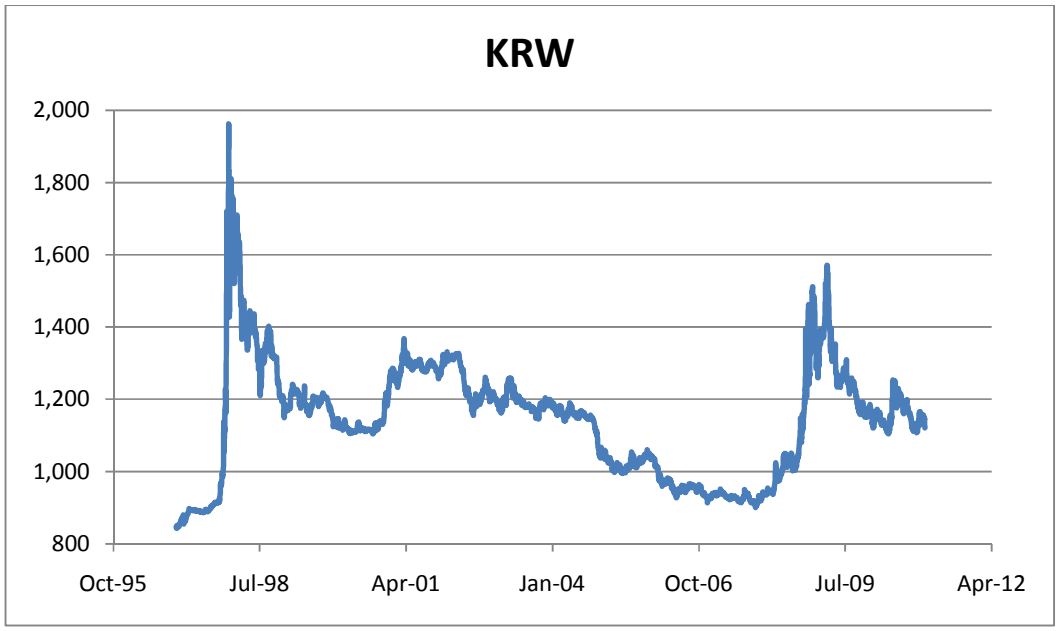
Source: Datastream

South Korean won (KRW)

For the first half of the 20th century, the Korean Peninsula was under the Japanese Occupation. The official currency for Korea was the Korean yen during the period of colonisation. Upon the defeat of the Japanese army in 1945, the Korean Peninsula was split into two parts – South Korea under the influence of the U.S. while North Korea was under the U.S.S.R. The Korean won (KRW) emerged to replace the Korean yen as the official currency in Korea. Its value was initially fixed at 15 won per unit of USD in 1945 and subsequently devalued heavily to 50 won and 450 won per USD in 1947 and 1948 respectively. After a failed effort to unify both the north and

south of Korea, separate sovereigns were established. The South Korea was officially recognised as a sovereign in 1948. The passing of the Bank of Korea Act 1950 gave birth to the central bank of South Korea called the Bank of Korea (BOK).

Figure 3.6: KRW per USD – January 1, 1997 to December 31, 2010



Source: Datastream

As the economy of South Korea was in a quagmire and the threat of war with its north counterpart was escalating in the 1950s, the value of KRW was greatly affected and it dropped to KRW6,000 to a USD. The Korean government undertook a reorganisation of the KRW in 1962 and repegged its value to KRW125 to one USD. A series of devaluation of KRW occurred from 1962 to 1980 when it reached KRW500 per USD. At the height of the AFC, the BOK abandoned the fixed exchange rate regime and moved to float its currency in the market. Even though the KRW is fully convertible, the currency is only tradable on a non-deliverable basis outside of the country. The foreign exchange market of KRW is still highly regulated and the BOK keeps a close watch on the currency volatility. The BOK is reportedly intervening in the market to smooth the excessive volatility of the currency movements. The value of the

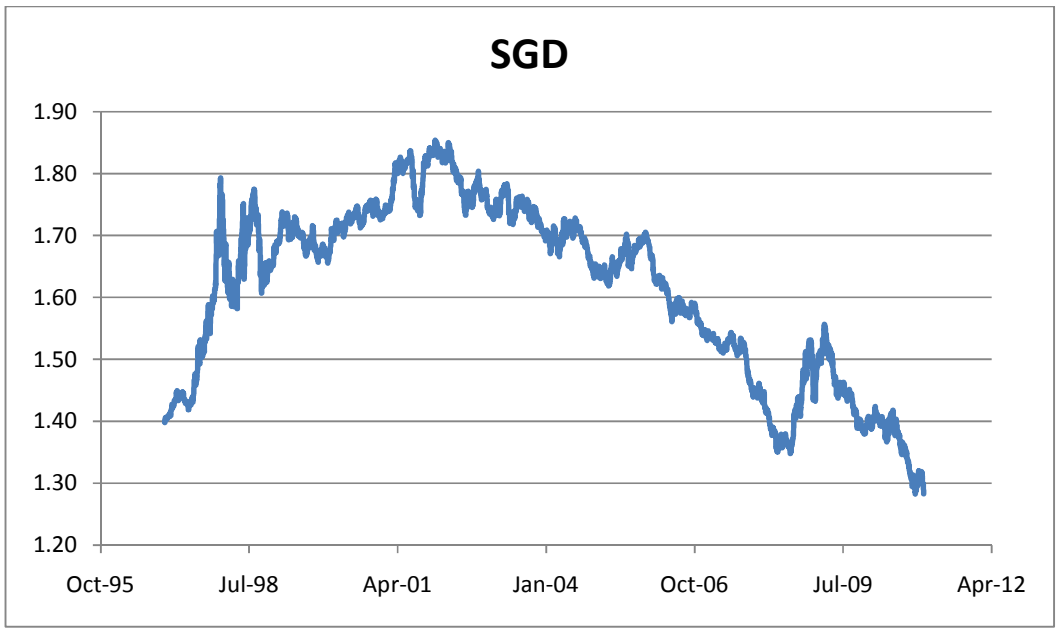
KRW against the USD from January 1, 1997 to December 31, 2010 is shown in Figure 3.6.

Singapore dollar (SGD)

Singapore is a unique country as it is a Chinese-dominated country which is situated in the heart of Malay Archipelago. It shares a common history with Malaysia and was indeed part of the country from 1963 to 1965. The modern history of Singapore starts from the arrival of Sir Thomas Stamford Raffles in 1819. It became part of the British colony in 1826 with its absorption into the Straits Settlement along with Penang and Malacca in the Peninsular of Malaya. As the Straits Settlement grew in economic significance, the British officially declared the conversion of the Settlement into a Crown Colony and administered it directly from the Colony Office in London in 1867. The Straits dollar was the legal tender in Singapore from 1826 until 1939 when the official currency was replaced with the Malayan dollar. In 1942, Singapore fell into the hand of the Japanese Imperial government and it followed with the introduction of the Japanese currency known as 'banana money'. Upon the return of the British government after the surrender of the Japanese army, the Malayan dollar was reintroduced and businesses resumed as usual. The Board of Commissioners of Currency, Malaya and British Borneo was set up in 1953 as the sole issuer of currency for Malaya, Singapore and British Borneo. The currency was renamed to Malaya and British Borneo dollar. This currency continued to be used as the legal tender even after the establishment of Malaysia in 1963. Singapore was later expelled from Malaysia in 1965 due to some irreconcilable differences between the ruling parties in Malaysia and Singapore. However, the currency union through the Board of Commissioners of Currency, Malaya and British Borneo still continued until 1967 when Malaysia, Singapore and Brunei decided to issue their own currencies. This year marked the birth

of the modern Singapore dollar (SGD). The Singapore government created the Board of Commissioners of Currency to manage the SGD. The currencies of Singapore, Malaysia and Brunei remain interchangeable at par until 1973 after the Malaysian government opted to terminate the Interchangeability Agreement. Singapore and Brunei continue the agreement until today.

Figure 3.7: SGD per USD – January 1, 1997 to December 31, 2010



Source: Datastream

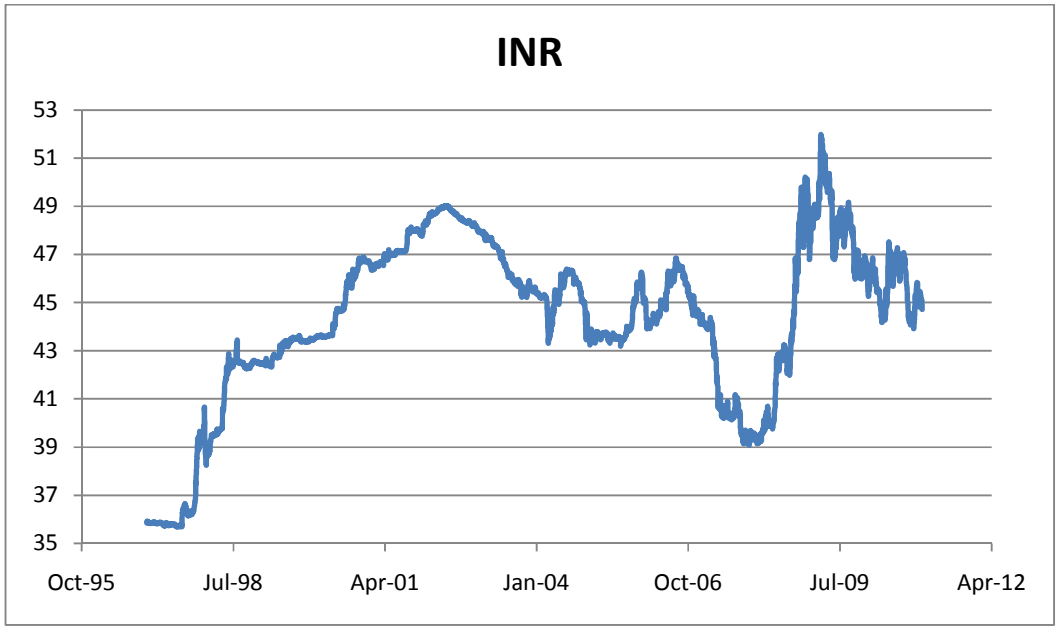
After the collapse of the Bretton Woods system, the SGD was managed under a fixed peg against a basket of trade-weighted currencies until 1985. The SGD was floated in 1985 within a monitoring band decided by the Board of Commissioners of Currency. The SGD withstood well in the face of the AFC onslaught as the country had strong and solid international reserves. The Board of Commissioners of Currency was dissolved in 2002 and replaced by the Monetary Authority of Singapore (MAS). The monetary policy in Singapore is unique in comparison to most of the other countries as it targets its currency value instead of price stability. The Singapore government believes that it is more effective to target the currency as Singapore is largely a trading

nation. The SGD is freely traded in the international market with few restrictions. The value of the SGD against the USD within our sample period is depicted under Figure 3.7.

Indian rupee (INR)

India, being a country with a long history of civilisation, is one of the pioneer issuers of coins. The modern financial system in India traced its root back to 1858 when the British government took over the reign of India and declared it as a Crown Colony. The Reserve Bank of India (RBI) was officially set up in 1935 to manage the issuance of the Indian rupee (INR). The INR was one of the currencies within the Sterling Area and RBI shifted the peg to a basket of commodities and currencies in 1973 upon the full breakdown of the Bretton Woods system.

Figure 3.8: INR per USD – January 1, 1997 to December 31, 2010



Source: Datastream

The INR remained a highly regulated currency until 1993 when the INR became fully convertible. The value of the INR is freely determined by the registered interbank dealers depending on the market forces. The RBI, however, remains active in

intervening in the foreign exchange market to influence the value of the INR. Despite the relaxation of some foreign exchange rules, the INR remains only tradable within India during official hours. As the Indian economy has grown in term of economic significance, an offshore non-deliverable forward market was developed for the INR. The historical price of the INR against USD from January 1, 1997 to December 31, 2010 is shown in Figure 3.8.

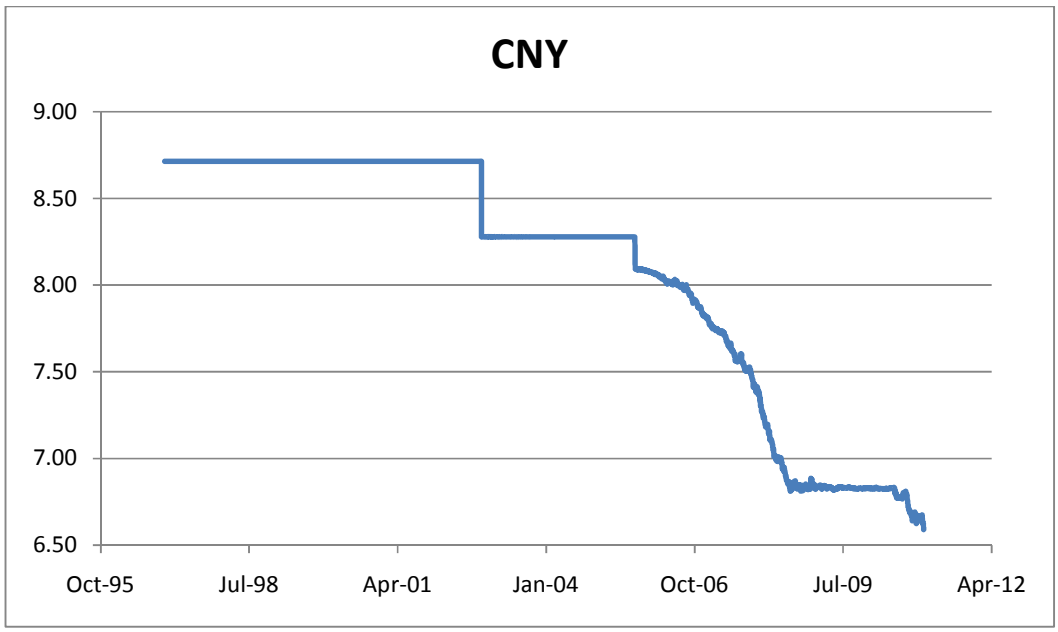
Chinese yuan (CNY)

The Chinese yuan (CNY), also popularly known as the renminbi, is the official legal tender in China. Similar to India, China is an old civilisation and among the first issuers of currency in the world. The new face of the CNY was first issued in 1948 by the People's Bank of China (PBOC) which was established the same year. The PBOC remained as the only bank in China until 1979 when the financial market was slightly liberalised. Some state-owned banks were set up in the 1980s to undertake commercial banking activities from the PBOC. On July 21, 2005, the PBOC made a surprise announcement to revalue the CNY against the USD by 2.1% from CNY8.72 to CNY8.21 and at the same time shifted the fixed exchange rate regime to a managed-float regime known as the crawling peg.

Under the crawling peg regime, the PBOC will fix the middle rate of the CNY against the USD in the morning of every trading day and the exchange rate is subsequently allowed to be traded within a predetermined band. The PBOC will intervene in the market to ensure the supply of CNY is met by buying up the foreign currencies. The PBOC has built up the largest international reserves in the world with a holding in excess of USD3 trillion by 2011 and still growing. The value of the CNY has been under tremendous pressure from the international financial community, especially the U.S. government, to accelerate the pace of appreciation. There are growing interests

among central banks around the world to hold the CNY as one of their reserve currencies in view of the deterioration in the economic fundamentals of many advanced nations like the U.S. and Eurozone. The value of the CNY has been on a steady rise due to its lustre among international community and Figure 3.9 depicts its value during our sample period.

Figure 3.9: CNY per USD – January 1, 1997 to December 31, 2010



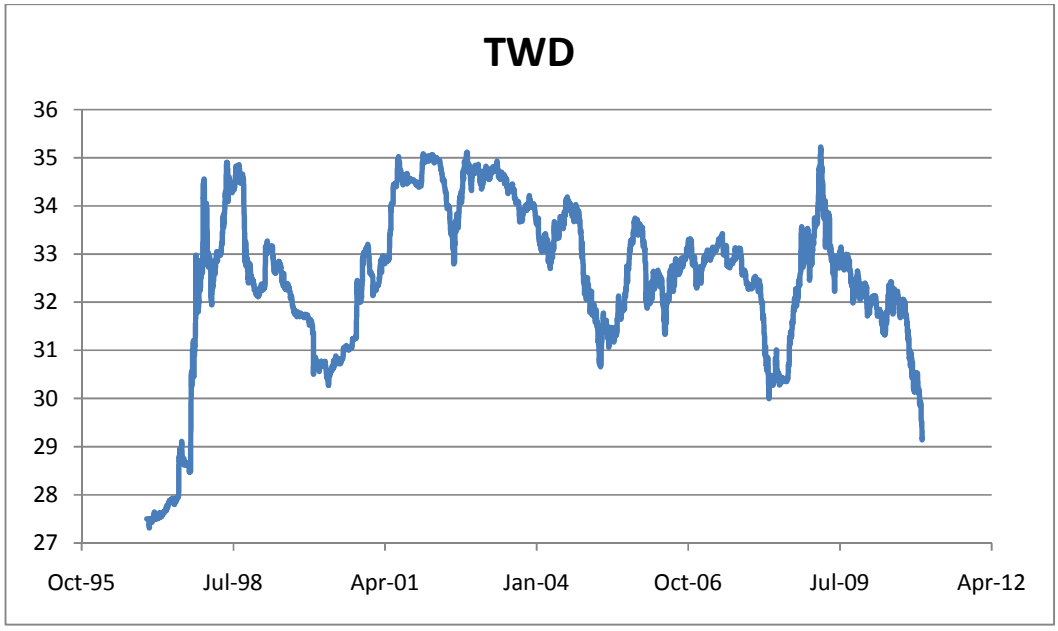
Source: Datastream

New Taiwan dollar (TWD)

Taiwan, also known as the Republic of China, was established in 1949 after the migration of the Kuomintang Party from Mainland China to Taiwan following its defeat to the Communist Party in the Chinese civil war. The New Taiwan dollar (TWD) was introduced the same year to replace the Old Taiwan dollar at a ratio of 40,000 Old Taiwan dollars to one TWD in an effort to restructure the currency due to the hyperinflation which plagued the country. The TWD had been issued and managed by the Bank of Taiwan until the functions were transferred to the Central Bank of the Republic of China (CBC) in 2000. Prior to 1979, the value of the TWD was pegged to

the USD managed through a central clearing and settlement system. The value of the TWD was subsequently determined by market forces through the introduction of the Taipei Foreign Exchange Market but with explicit intervention from the CBC to smooth out excessive volatility. The trading of the TWD is still restricted within Taiwan and does not carry full convertibility. The trading activities involving foreign currencies with TWD must be cleared through the CBC. However, there is an active offshore non-deliverable market for the trading of TWD. The TWD against USD reached its lowest value in the 1960s to above TWD40 to one USD. In the 1990s the TWD was *de facto* pegged at TWD25 to a USD until the AFC hit in 1997. The value of the TWD from January 1, 1997 to December 31, 2010 is captured in Figure 3.10.

Figure 3.10: TWD per USD – January 1, 1997 to December 31, 2010



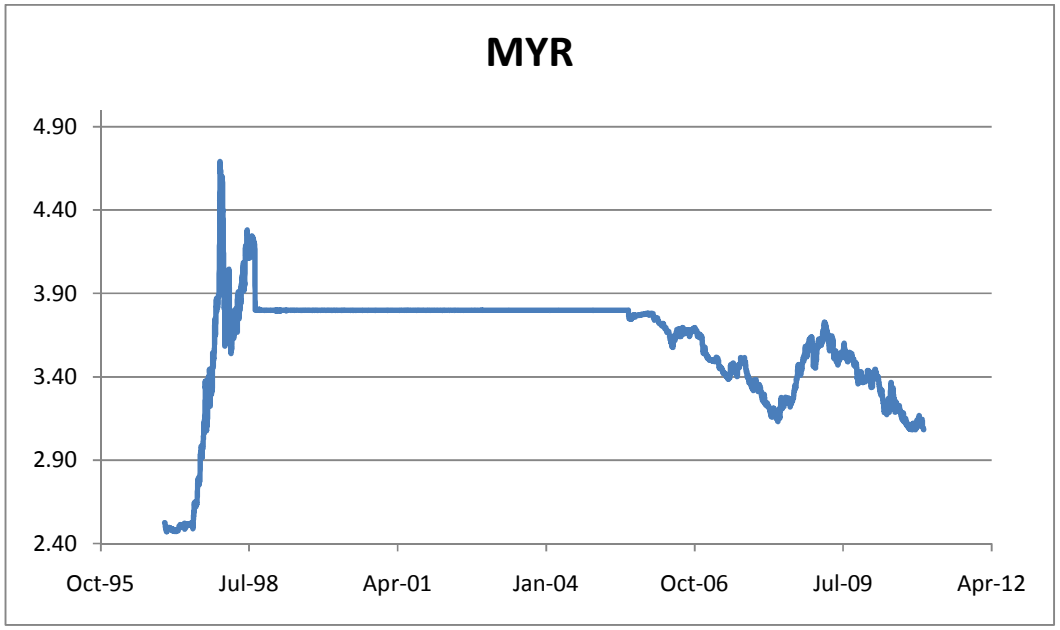
Source: Datastream

Malaysian ringgit (MYR)

Similar to Singapore, Malaysia was under the British rule in the late 19th century to the middle of 20th century when it gained Independence in 1957. The Malaysian ringgit (MYR) was first issued by the central bank, Bank Negara Malaysia (BNM) in

1967 to replace the Malaya and British Borneo dollar at par. In the same year, the Singapore and Brunei governments also abandoned the common currency to issue their own currencies. However, these three splinter currencies remain interchangeable at par with each other through the Interchangeability Agreement established in 1967. Upon the collapse of the Bretton Woods system, the Malaysian government chose to rescind the Interchageability Agreement and the value of MYR is no longer interchangeable at par to SGD and Brunei dollar (BND).

Figure 3.11: MYR per USD – January 1, 1997 to December 31, 2010



Source: Datastream

The MYR was under the *de jure* free-float regime in 1980's until 1997. However, the BNM intervened in the foreign exchange markets actively to influence the value of its currency. Besides that, the BNM was also reckoned as one of the aggressive speculators in the global foreign exchange market until it suffered a huge loss from the devaluation of British pound (GBP) in 1990. Prior to the AFC, the MYR was trading around MYR2.50 to the USD. At the height of the AFC, the MYR was under heavy pressure and climbed to about MYR4.80 to the USD. On September 1, 1998, the

Malaysian government made a surprise announcement to peg the MYR at MYR3.80 to a USD in order to curb further speculative attacks. The MYR also lost convertibility overseas and all trading related to MYR must be cleared through the central bank. The BNM abandoned the 7-year-old fixed peg in July 2005 after the PBOC shifted its exchange rate regime from fixed peg to crawling peg. Since then, the MYR is put under the managed-float regime with occasional intervention from the BNM to smooth out excessive volatility. The MYR remains non-tradable outside of Malaysia and all foreign exchange transactions related to MYR must be cleared through the BNM at the end of each trading day. However, there is an active offshore non-deliverable MYR market offered by large international banks. The value of MYR against USD throughout our sample period is shown in Figure 3.11.

Thai baht (THB)

Thailand has a long and glorious history for being a sovereign which has never been colonised. The use of Thai baht (THB) can be traced back to the era of Sukhotai (1238 – 1438). The modern THB takes its root in 1897 when the decimal system was introduced by King Chulalongkorn. During World War II, the value of THB was pegged at par to the Japanese yen. The Bank of Thailand Act was passed in 1942 and the Bank of Thailand (BOT) has been vested with the role of a central bank since then. Upon the defeat of the Japanese Imperial Army at the end of World War II, the THB reverted to a USD peg. During the Bretton Woods era, the THB was pegged at THB20.8 to a unit of USD and was revised to THB20 from 1973 to 1978. After the spike in oil prices in 1978/79, the world economy slumped and the USD appreciated strongly. The THB was devalued to THB25 per USD. This rate was maintained until July 1, 1997. The THB was floated in July 1997 after the BOT failed to maintain the peg at THB25 per USD. The flotation of THB is often cited as the beginning of the AFC (Jeon & Seo,

2003; Gong, Lee & Chen, 2004). The THB was rapidly losing its value until it reached its lowest point in January 1998 to THB56 per USD. The economy of Thailand gradually recovered after the injection of the IMF rescue package. Following the recent coup d'état in 2006, several restrictions were further imposed on the trading of THB. These restrictions have been slowly removed. The THB is now fully convertible but still subject to close scrutiny from the BOT. There is an active offshore non-deliverable forward market for THB due to the restrictions. Figure 3.12 shows the value of THB against USD from January 1, 1997 to December 31, 2010.

Figure 3.12: THB per USD – January 1, 1997 to December 31, 2010

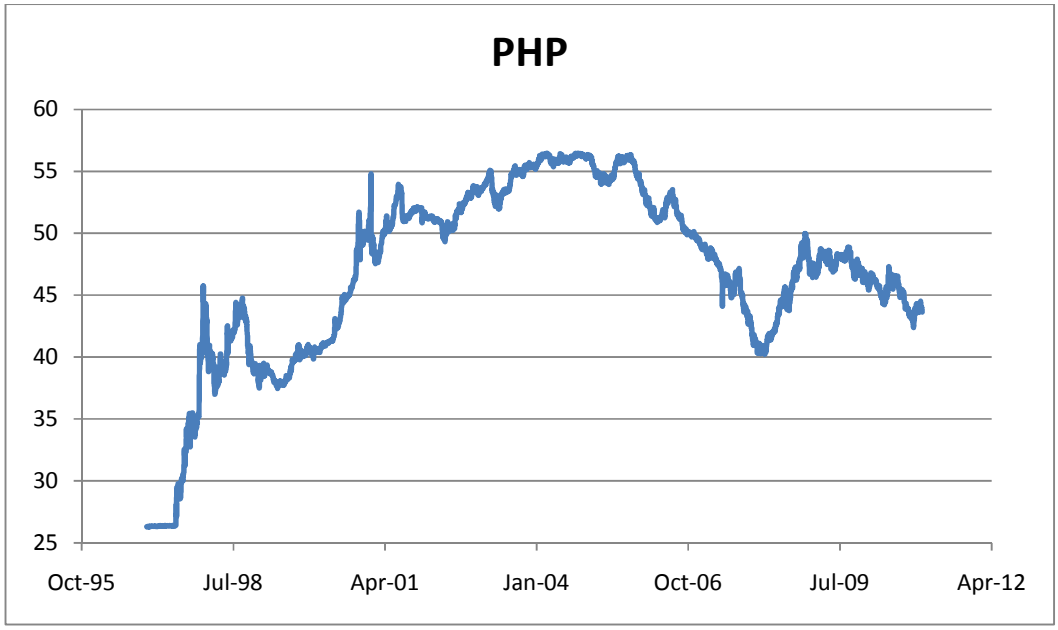
Source: Datastream

Philippines peso (PHP)

The Philippines peso (PHP) is administered by the Bangko Sentral ng Pilipinas (BSP), the successor to Central Bank of the Philippines (CBP). Prior to the establishment of CBP in 1949, the PHP was issued by big national banks such as Bank of the Philippine Islands and the Philippine National Bank. The passing of the Central Bank Act 1948 facilitated the birth of the CBP as the central bank. The value of the PHP

has been subject to complicated arrangements due to changes in its political landscape. Upon the ousting of President Ferdinand Marcos in 1986, a New Central Bank Act 1993 was passed with the aim to establish an independent central bank and this Act gave birth to BSP. The value of PHP has been on a managed-float regime since 1992 with active intervention from the BSP. The PHP is not fully convertible and its dealing is subject to strict regulations from the BSP. Not long after the reform of the PHP, the AFC struck and the value of PHP depreciated sharply against the USD and other major currencies. There is a moderate non-deliverable market for the PHP outside of the country. We depict the value of PHP during our sample period in Figure 3.13.

Figure 3.13: PHP per USD – January 1, 1997 to December 31, 2010



Source: Datastream

Indonesian rupiah (IDR)

The Archipelago of Indonesia was under the rule of the Netherlands government from 1815 to 1945. The official medium of exchange was determined by the Dutch government in the Netherlands. Upon the surrender of the Japanese Imperial Army at the end of World War II, Indonesia announced its Independence on August 17, 1945.

But this announcement was disputed by the Dutch government and they swiftly returned to Indonesia with large battalions of army. The Netherlands acceded to the Independence of Indonesia in 1949 after a bitter struggle with the newly-formed government. The value of the Indonesian rupiah (IDR) was set at IDR3.8 to one USD in 1949. In 1953, the Indonesian government nationalised the De Javasche Bank, which had been acting as the central bank since the Dutch colonial era, and renamed it to Bank Indonesia (BI). The BI is entrusted with the management of the IDR but the central government still retained the power to issue currency. The value of the IDR was pegged at IDR11.4 to one USD when the BI was formed. Without the power to control money supply, the BI could not function effectively and the Indonesian economy suffered hyperinflation. The value of the IDR went into a spiral of devaluation until 1968 when the power to issue currency was transferred solely to the BI.

Figure 3.14: IDR per USD – January 1, 1997 to December 31, 2010

Source: Datastream

The inflationary problem was under control by the 1970s and the environment supported a stable growth in the country. The IDR was pegged at IDR415 per USD until

1978 when the global oil shock hit the markets. The Indonesian government abandoned the fixed peg to the USD in 1978 and adopted a crawling regime to administer its foreign exchange value. The devaluation of the IDR continued at a steady pace since the shift to the crawling peg regime in order to support its export oriented economy. Prior to the AFC, the IDR was traded around IDR2,500 to a USD. When the THB was floated in July 1997, the IDR lost its value rapidly. Global investors realised that the international reserves of BI were weak and there was a stampede to rush out from the holding of IDR. The BI was forced to abandon the crawling peg due to the exhaustion of its reserves and floated the IDR in 1997. The value of IDR depreciated massively to IDR15,500 per USD at the height of AFC. Even after the AFC subsided, the value of IDR remained above IDR10,000 per USD. In 2001, the BI introduced a rule to prohibit the transfer of IDR to an offshore account and this ruling has effectively stopped the trading of IDR in the international market. The value of IDR appreciated to below IDR10,000 in 2002. The IDR remains tradable only in the Indonesian market with active interventions from the BI to curb excessive volatilities. The value of IDR from January 1, 1997 to December 31, 2010 is illustrated in Figure 3.14.

3.3 Descriptive Statistics of Asia-Pacific Exchange Rates

After a brief introduction to the foreign exchange regime of each individual currency market, we present the descriptive statistics of the spot and forward exchange rates for all the 12 sample currencies in this subsection. Table 3.4 (Page 115) shows the basic statistics for the spot exchange rates while Table 3.5 (Page 116) the forward exchange rates. All the exchange rates are quoted in terms of domestic value per unit of USD. As the forward exchange rates are derived from the spot exchange rate by taking into account the interest-rate differential between the domestic and U.S. interest rate, we only discuss the descriptive statistics related the spot exchange rates.

Table 3.4: Descriptive Statistics of Asia-Pacific Spot Exchange Rates: January 1, 1997 to December 31, 2010

The table shows the basic statistics of the Asia-Pacific spot exchange rates for January 1, 1997 to December 31, 2010 – AUD: Australian dollar, CNY: Chinese yuan, IDR: Indonesian rupiah, INR: Indian rupee, JPY: Japanese yen, KRW: South Korean won, MYR: Malaysian ringgit, NZD: New Zealand dollar, PHP: Philippines peso, SGD: Singapore dollar, THB: Thai baht, TWD: Taiwan dollar. The exchange rates are quoted in terms of domestic currency against one unit of U.S. dollar (USD). The weakest point and date denote the lowest value of the particular currency against the USD and the accompanying date when it happened. Meanwhile the strongest point and date show the opposite. The weakest points for most of the Southeast Asian (i.e. IDR, MYR, THB) and East Asian (i.e. JPY and KRW) currencies were recorded during the height of the Asian Financial Crisis (AFC) 1997/98. The burst of the dot.com bubble in 2000-2001 seem to have cause currencies like AUD, NZD and SGD to depreciate to their lowest level against the USD. The INR and TWD depreciated to their lowest point during the global financial crisis (GFC) 2007/08. As CNY was on a fixed peg against the USD prior to July 2005, its lowest value was recorded during the fixed exchange rate regime. The lowest point of PHP, which was recorded in March 2004, was largely driven by domestic political event. Next, the strongest level for currencies like AUD, CNY, JPY and SGD were recorded in the tail-end of 2010 while the NZD touched its strongest level in 2008. For the rest of the other currencies (i.e. IDR, INR, KRW, MYR, PHP, THB and TWD), they have never recovered to the pre-AFC levels. According to the Jarque-Bera test, the spot exchange rate series are normally distributed.

	AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Mean	1.4493	8.0787	8,827	44.35	112.35	1,142	3.6072	1.7124	46.87	1.6129	37.79	32.52
Median	1.3923	8.2771	9,110	44.90	114.45	1,159	3.8000	1.5991	47.92	1.6560	38.50	32.70
Weakest Point	2.0708	8.7130	15,500	51.97	147.27	1,960	4.6853	2.5530	56.46	1.8540	56.00	35.22
Weakest Date	2-Apr-01	Pre-Nov-2002	17-Jun-98	3-Mar-09	11-Aug-98	23-Dec-97	1-Aug-98	18-Oct-00	22-Mar-04	27-Dec-01	12-Jan-98	2-Mar-09
Strongest Point	0.9775	6.5906	2,362	35.69	80.39	844	2.4715	1.2234	26.28	1.2827	22.70	27.31
Strongest Date	31-Dec-10	31-Dec-10	2-Jan-97	25-Jul-97	29-Oct-10	3-Jan-97	15-Jan-97	27-Feb-08	2-Jan-97	4-Nov-10	17-Jun-97	16-Jan-97
Std. Dev.	0.2613	0.7220	1,987	3.41	12.33	159	0.3306	0.3427	7.213827	0.143598	4.95	1.66
Skewness	0.3933	-0.8244	-1.5456	-0.8093	-0.3323	0.4857	-1.6442	0.7183	-0.9161	-0.4347	-0.3335	-0.9973
Kurtosis	2.2452	2.1621	7.3040	3.2809	3.0646	3.8193	6.2013	2.4037	3.6647	1.9857	2.9439	4.2567
Jarque-Bera	180.95	520.74	4,275.18	410.91	67.88	245.88	3,206.68	368.34	578.40	271.72	68.20	846.14
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	3653	3653	3653	3653	3653	3653	3653	3653	3653	3653	3653	3653

Table 3.5: Descriptive Statistics of Asia-Pacific Forward Exchange Rates: January 1, 1997 to December 31, 2010

The table shows the basic statistics of the Asia-Pacific forward exchange rates for January 1, 1997 to December 31, 2010 – AUD: Australian dollar, CNY: Chinese yuan, IDR: Indonesian rupiah, INR: Indian rupee, JPY: Japanese yen, KRW: South Korean won, MYR: Malaysian ringgit, NZD: New Zealand dollar, PHP: Philippines peso, SGD: Singapore dollar, THB: Thai baht, TWD: Taiwan dollar. The exchange rates are quoted in terms of domestic currency against one unit of U.S. dollar (USD). The forward exchange rates are derivation from spot exchange rates by taking into account the interest-rate differential between the domestic and U.S. interest rate. The interpretation follows Table 3.4 which describes the spot exchange rates.

	AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Mean	1.4516	7.6613	8,866	45.05	112.03	1,113	3.6769	1.7163	47.08	1.6115	38.06	32.50
Median	1.3946	7.9642	9,173	45.27	113.98	1,148	3.8000	1.6032	48.05	1.6544	38.55	32.68
Weakest Point	2.0648	8.2841	17,345	52.14	146.48	1,570	5.4300	2.5397	56.84	1.8532	57.60	35.54
Weakest Date	3-Apr-01	37323	17-Jun-98	3-Mar-09	11-Aug-98	2-Mar-09	28-Oct-98	19-Oct-00	22-Mar-04	27-Dec-01	12-Jan-98	16-Jun-98
Strongest Point	0.9796	6.5937	2,374	36.28	80.53	899	2.4745	1.2303	26.39	1.2810	25.15	27.33
Strongest Date	31-Dec-10	31-Dec-10	3-Jan-97	28-Oct-97	29-Oct-10	31-Oct-07	13-Jan-97	27-Feb-08	14-Jan-97	31-Dec-10	11-Jun-97	16-Jan-97
Std. Dev.	0.2610	0.6248	1,983	2.80	12.21	135	0.4739	0.3424	7.222854	0.143299	4.80	1.68
Skewness	0.4006	-0.4131	-1.4892	-0.4050	-0.3212	0.2973	0.9304	0.7201	-0.9121	-0.4297	-0.2519	-0.9066
Kurtosis	2.2519	1.4245	7.7124	2.8392	3.0553	2.5578	7.8166	2.4084	3.6765	1.9841	3.2735	4.0531
Jarque-Bera	182.92	305.94	4,730.24	97.75	63.28	53.07	4,058.28	368.98	576.17	269.48	50.03	669.19
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	3653	2320	3653	3440	3653	2320	3653	3653	3653	3653	3653	3653

In Table 3.4, we show the average, median, weakest and strongest level of the Asia-Pacific currencies vis-à-vis the USD. The weakest point refers to the lowest value recorded during the sample period and the date indicates when the value was traded. Those countries which were severely hit by the AFC recorded the lowest point in the value of their currencies during the height of the AFC. The IDR, MYR, THB, KRW and JPY were traded to their lowest value around 1998. During the AFC, the IDR depreciated to only 15% of its original value prior to the AFC. The THB and KRW dropped to about 40% and MYR to approximately 50% of their highest values shortly before the AFC. The drastic depreciation in the currency values underscored the brutality of the AFC impact on these countries. Next, the bursting of the dot.com bubble in 2000-2001 brought the value of AUD, NZD and SGD to their lowest points. It seems that the economies of these nations are largely driven by high-technology industries. Finally, the global financial crisis (GFC) 2007-2008 caused the INR and TWD to trade to their lowest value. The CNY recorded its lowest value during the fixed peg regime at CNY8.713 to a USD while the PHP touched its lowest point in March 2004 due to domestic political unrest. As for the strongest levels, there are basically only two clusters; one pre-AFC and another post-GFC. Most of the Asia-Pacific currencies never recover to pre-AFC levels and hence their strongest points were recorded during the pre-AFC period. The IDR, INR, KRW, MYR, PHP, THB and TWD were at their strongest in the beginning of our sample period. Meanwhile, the strongest levels for the AUD, JPY, SGD and CNY were traded at the end of 2010. The NZD is the odd one out with its strongest point touched in 2008. The Jarque-Bera test results show that the spot and forward exchange rates series are not normally distributed. Finally, we have also conducted a cross-correlation test on the spot exchange rates series and the results are tabulated in Table 3.6 on the following page.

Table 3.6: Cross-correlation of Asia-Pacific Spot Exchange Rates: January 1, 1997 to December 31, 2010

The table shows the coefficients correlation between the sample currencies. The correlation between the AUD-NZD is the strongest at 0.96. The other strongly correlated currencies with coefficient above 0.80 are AUD-SGD, MYR-THB and SGD-THB. Meanwhile, the IDR and INR are negatively correlated with both CNY and JPY.

	AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
AUD	1.00											
CNY	0.71	1.00										
IDR	0.16	-0.29	1.00									
INR	0.37	-0.21	0.64	1.00								
JPY	0.55	0.73	-0.07	-0.26	1.00							
KRW	0.53	0.12	0.45	0.46	0.10	1.00						
MYR	0.56	0.38	0.62	0.52	0.30	0.54	1.00					
NZD	0.96	0.60	0.20	0.42	0.41	0.55	0.51	1.00				
PHP	0.16	-0.10	0.63	0.73	-0.09	0.16	0.61	0.09	1.00			
SGD	0.85	0.79	0.21	0.34	0.61	0.39	0.78	0.74	0.42	1.00		
THB	0.75	0.57	0.41	0.47	0.46	0.56	0.85	0.67	0.57	0.88	1.00	
TWD	0.45	0.07	0.69	0.67	0.29	0.56	0.74	0.38	0.69	0.57	0.66	1.00

Since the fall of the Bretton Woods system, most of the currencies in the world are now quoted against the USD. Unless those currencies are managed under the fixed peg regime, the changes in the foreign exchange rates should record some sorts of co-movement as they are commonly quoted against the USD. From our sample currencies, the AUD and NZD have the strongest correlation at 0.96. The correlation between AUD-SGD, MYR-THB and SGD-THB are also strong with a coefficient above 0.80. These currencies with strong correlation are usually viewed as proxies to one another. Meanwhile, the IDR and INR are negatively correlated with both CNY and JPY respectively.

3.4 Macroeconomic Events in Asia-Pacific

We have adopted a wide range of macroeconomic announcements in this thesis for the purpose of testing the informational efficiency of the Asia-Pacific foreign exchange markets. In total, we have employed 107 macroeconomic announcements from this region in our thesis. The macroeconomic announcements are collected from the Bloomberg database. The main criterion for the selection of these 107 macroeconomic announcements

is the availability of the prior market consensus information related to the actual announcements. For example, the monthly inflation number which is set to be announced by the relevant authority must have a corresponding market expectation before it is selected. This criterion is important because it filters out only vital macroeconomic announcements. Only key indicators will attract interest among economists and the investment community to issue an expectation. The availability of market expectations is also important to help us in extracting an exogenous announcement surprises. Unlike most of the previous studies in the literature (e.g. Almeida, Goodhart & Payne, 1998, Andersen et al., 2003), we have adopted not only the macroeconomic announcements from the advanced economies but also the macroeconomic announcements throughout the Asia-Pacific region. From a geographical perspective, this study is the most comprehensive in covering the macroeconomic announcements of each selected country in the sample to date. Besides the 12 Asia-Pacific countries, we have also included the U.S. in the selection of macroeconomic announcements. The breakdown of the macroeconomic events from each individual country is shown in Table 3.7 on the next page.

The macroeconomic announcements from the U.S. and Japan make up about 50% of our total announcements. The rest of the countries contribute less than 10% each to the total number of macroeconomic announcements used in this thesis. The selection bias can be justified on two grounds. First, the U.S. and Japan are the world's largest and second largest economy. Therefore the macroeconomic announcements emanating from these two countries carry more clout than the others. Second, macroeconomic announcements from the advanced economies are much more structured and consistent as compared to those from the developing nations. Some of the newly industrialised countries may only establish

macroeconomic indicators recently. Therefore the numbers of macroeconomic indicators which consist of sufficient observations are limited from the developing nations.

Table 3.7: Number of Macroeconomic Events Selected from the Asia-Pacific Economies: January 1, 1997 to December 31, 2010

The table shows the number of macroeconomic events employed from each of the Asia-Pacific economy from January 1, 1997 to December 31, 2010. We employ the highest number of macroeconomic indicators from the U.S. (31%) followed by Japan (19%). The rest of the countries contribute less than 10% of the total number of macroeconomic announcements. The selection bias is due to the wide availability of the advanced countries' announcements as compare to the developing nations.

Countries	**Number of Indicators**	%
United States	33	31%
Japan	20	19%
Australia	9	8%
Singapore	7	7%
Taiwan	7	7%
New Zealand	6	6%
Malaysia	5	5%
Thailand	5	5%
China	4	4%
Indonesia	3	3%
Korea, South	3	3%
Philippines	3	3%
India	2	2%
TOTAL	**107**	100%

With such a vast number of macroeconomic announcements, we have to group them into some common categories for meaningful comparison and analyses. While there are various ways to classify macroeconomic indicators, two of the more popular methods are (i) time-content of the information and (ii) nature of the indicators. The time-content information refers to whether the announcements are leading, lagging or coincident. The leading indicators give hints on the future direction of the state of the economy while the lagging indicators describe the past economic condition. The coincident indicators, on the

other hand, show the current state of economy. Even though this method of classification sounds logical, it is debatable whether a particular economic indicator does really fall into one of the three time-content classification. This type of classification remains arbitrary. We have adopted the second method in which we classify the macroeconomic indicators based on the nature of the information they convey. We have chosen three categories namely (i) Interest rates, prices and money, (ii) Production and business activity and (iii) Total output, international trade and employment.

As the name suggests, the first category (i) Interest rates, prices and money refers to those indicators which are related to monetary announcements. The examples include announcements of benchmark interest rates, inflation and money supply. This is an important category because most of the assets in the financial markets derive their value from the prevailing discount rate. The announcements related to Interest rates, prices and money play a crucial role in determining the value of the discount rate. Next, the (ii) Production and business activity category include announcements such as industrial production, factory orders, retail sales and consumer confidence. This category encompasses macroeconomic indicators which are directly related to the underlying real economy. These indicators describe the pulse of the economy and its future direction. Finally, the third category (iii) Total output, international trade and employment comprise those macroeconomic indicators which point to the bigger scale of the economy such as the gross domestic product (GDP), balance of trade and employment levels. We believe these three categories are sufficient to represent all the macroeconomic indicators selected for this thesis. The first category [(i) rates, prices and money] makes up of 28% of the total selected macroeconomic indicators while the second [(ii) Production and business activity]

and third [(iii) Total output, international trade and employment] categories constitute 36% each. We present the full set of the selected macroeconomic events in Table 3.8 below.

Table 3.8: Asia-Pacific Macroeconomic Events

The table shows the selected 107 macroeconomic events from the Asia-Pacific region. These macroeconomic events come from the 13 countries in this region. The main criterion of this selection is the availability of the market expectation data related to the particular macroeconomic announcements. The existence of market expectation information implies that the particular macroeconomic announcement is important – i.e. economists will not be bothered to forecast a non-important announcement. The macroeconomic events are broadly categorised into three groups based on the nature of the information content. These groups are (i) Interest rate, prices and money (IPM), (ii) Production and business activity (PBA) and (iii) Total output, international trade and employment. The data are collected from Bloomberg database.

Country	Macroeconomic Indicators	Category	From	To	# Obs
Australia	Consumer Prices (QoQ)	IPM	Jan-97	Oct-10	56
Australia	Current Account Balance	TOITE	Jan-97	Nov-10	53
Australia	Employment Change	TOITE	Mar-98	Dec-10	153
Australia	Gross Domestic Product (QoQ)	TOITE	Mar-97	Dec-10	55
Australia	Producer Price Index (QoQ)	IPM	Apr-02	Oct-10	36
Australia	RBA CASH TARGET	IPM	Feb-00	Dec-10	117
Australia	Retail Sales s.a. (MoM)	PBA	Feb-97	Dec-10	129
Australia	Trade Balance	TOITE	Jan-00	Dec-10	112
Australia	Unemployment Rate	TOITE	Jan-97	Dec-10	166
China	Consumer Price Index (YoY)	IPM	Jan-00	Dec-10	131
China	Industrial Production (YoY)	PBA	Apr-06	Dec-10	51
China	Producer Price Index (YoY)	IPM	Jul-02	Dec-10	100
China	Trade Balance (USD)	TOITE	Mar-06	Dec-10	58
India	Industrial Production YoY	PBA	Oct-03	Dec-10	87
India	Qtrly GDP YoY%	TOITE	Mar-02	Nov-10	36
Indonesia	Bank Indonesia Reference Rate	IPM	Nov-05	Dec-10	61
Indonesia	Inflation NSA (MoM)	IPM	Feb-99	Dec-10	138
Indonesia	Total Trade Balance	TOITE	Feb-99	Dec-10	142
Japan	Adjusted Current Account Total	TOITE	Dec-99	Dec-10	133
Japan	All Industry Activity Index (MoM)	PBA	Jan-03	Dec-10	93
Japan	Coincident Index CI	PBA	Sep-01	Dec-10	211
Japan	Consumer Confidence	PBA	04-May	Dec-10	80
Japan	Current Account Total	TOITE	Mar-97	Dec-10	150
Japan	Gross Domestic Product (QoQ)	TOITE	Dec-97	Dec-10	89
Japan	Housing Starts (YoY)	PBA	May-00	Dec-10	129
Japan	Industrial Production (MoM)	PBA	Apr-00	Dec-10	239
Japan	Japan Money Stock M2 YoY	IPM	Feb-00	Dec-10	131
Japan	Jobless Rate	TOITE	Feb-00	Dec-10	132
Japan	Large Retailers' Sales	PBA	Feb-00	Dec-10	130
Japan	Leading Index CI	PBA	Sep-01	Dec-10	220
Japan	Machine Orders (MoM)	PBA	Feb-00	Dec-10	131
Japan	Machine Orders YOY%	PBA	Apr-02	Dec-10	88
Japan	Merchnds Trade Balance Total	TOITE	Feb-00	Dec-10	131
Japan	Natl CPI YoY	IPM	Sep-01	Dec-10	111
Japan	Tankan Lge Manufacturers Index	PBA	Oct-98	Dec-10	50

Table 3.8: Asia-Pacific Macroeconomic Events (continued...)

Country	Macroeconomic Indicators	Category	From	To	# Obs
Japan	Tertiary Industry Index (MoM)	PBA	Mar-00	Dec-10	128
Japan	Tokyo CPI YoY	IPM	Sep-01	Dec-10	112
Japan	Trade Balance - BOP Basis	TOITE	Sep-02	Dec-10	100
Korea, South	Consumer Price Index (MoM)	IPM	May-00	Dec-10	128
Korea, South	GDP at Constant Price (YoY)	TOITE	Mar-00	Dec-10	62
Korea, South	Industrial Production (MoM)	PBA	Aug-02	Dec-10	102
Malaysia	CPI YoY	IPM	Dec-01	Dec-10	109
Malaysia	GDP YoY%	TOITE	Nov-99	Nov-10	43
Malaysia	Industrial Production YoY	PBA	Apr-01	Dec-10	117
Malaysia	Overnight Rate	IPM	Nov-05	Nov-10	39
Malaysia	Trade Balance	TOITE	Apr-04	Dec-10	81
New Zealand	Consumer Prices (QoQ)	IPM	Apr-97	Oct-10	54
New Zealand	GDP QoQ	TOITE	Mar-99	Dec-10	48
New Zealand	RBNZ Official Cash Rate	IPM	Apr-99	Dec-10	89
New Zealand	Retail Sales (MoM)	PBA	Jan-98	Dec-10	152
New Zealand	Trade Balance	TOITE	May-97	10-Nov	177
New Zealand	Unemployment Rate	TOITE	Aug-97	Nov-10	53
Philippines	Consumer Price Index NSA (MoM)	IPM	May-05	Dec-10	68
Philippines	Gross Domestic Product (YoY)	TOITE	Jan-00	Nov-10	44
Philippines	Overnight Borrowing Rate	IPM	Sep-05	Dec-10	51
Singapore	Advance GDP Estimate (QoQ)	TOITE	Oct-03	Oct-10	29
Singapore	CPI (YoY)	IPM	Apr-99	Dec-10	141
Singapore	GDP (YoY)	TOITE	Nov-98	Nov-10	49
Singapore	Industrial Production YoY	PBA	Mar-99	Dec-10	144
Singapore	Non-oil Domestic Exports (YoY)	TOITE	Jun-99	Dec-10	139
Singapore	Retail Sales (YoY)	PBA	Feb-99	Dec-10	143
Singapore	Unemployment Rate (sa)	TOITE	Feb-99	Oct-10	47
Taiwan	Benchmark Interest Rate	IPM	Mar-06	Dec-10	25
Taiwan	CPI YoY%	IPM	Feb-00	Dec-10	131
Taiwan	Current Account Balance (USD)	TOITE	Feb-00	Nov-10	43
Taiwan	GDP - Constant Prices (YoY)	TOITE	Feb-00	Nov-10	44
Taiwan	Industrial Production (YoY)	PBA	Jan-00	Dec-10	130
Taiwan	Total Trade Bal in US$ Billion	TOITE	Feb-00	Dec-10	131
Taiwan	Unemployment Rate - sa	TOITE	Apr-01	Dec-10	115
Thailand	Benchmark Interest Rate	IPM	Oct-05	Dec-10	42
Thailand	Consumer Price Index (YoY)	IPM	Jan-04	Dec-10	84
Thailand	Current Account Balance (USD)	TOITE	Feb-00	Dec-10	130
Thailand	Gross Domestic Product (YoY)	TOITE	Mar-00	Nov-10	42
Thailand	Manufacturing Production (YoY)	PBA	Feb-00	Aug-10	127
United States	Advance Retail Sales	PBA	Jan-97	Dec-10	167
United States	Avg Hourly Earning MOM Prod	IPM	Jul-98	Dec-10	140
United States	Building Permits	PBA	Aug-02	Dec-10	101
United States	Business Inventories	PBA	Jul-97	Dec-10	161
United States	Capacity Utilization	PBA	Jan-97	Dec-10	166
United States	Change in Manufact. Payrolls	TOITE	Jan-99	Dec-10	144
United States	Change in Nonfarm Payrolls	TOITE	Jan-97	Dec-10	167
United States	Chicago Purchasing Manager	PBA	Jan-97	Dec-10	168
United States	Consumer Confidence	PBA	Feb-97	Dec-10	166
United States	Consumer Price Index (MoM)	IPM	Jan-97	Dec-10	168

Table 3.8: Asia-Pacific Macroeconomic Events (continued...)

Country	Macroeconomic Indicators	Category	From	To	# Obs
United States	Current Account Balance	TOITE	Mar-98	Dec-10	52
United States	Durable Goods Orders	PBA	Nov-97	Dec-10	158
United States	Empire Manufacturing	PBA	Nov-02	Dec-10	98
United States	Factory Orders	PBA	Jan-97	Dec-10	168
United States	FOMC Rate Decision	IPM	May-97	Dec-10	116
United States	GDP Price Deflator	IPM	Apr-98	Dec-10	153
United States	GDP QoQ (Annualized)	TOITE	Mar-97	Dec-10	165
United States	Housing Starts	PBA	Mar-98	Dec-10	154
United States	Import Price Index (MoM)	IPM	Aug-98	Dec-10	145
United States	Industrial Production	PBA	Jan-97	Dec-10	168
United States	Initial Jobless Claims	TOITE	Jan-97	Dec-10	707
United States	ISM Manufacturing	PBA	Jan-97	Dec-10	168
United States	ISM Non-Manufacturing	PBA	Dec-98	Dec-10	146
United States	Leading Indicators	PBA	Mar-97	Dec-10	165
United States	New Home Sales	PBA	Feb-97	Dec-10	167
United States	Personal Income	IPM	Feb-97	Dec-10	168
United States	Personal Spending	IPM	Feb-97	Dec-10	167
United States	Philadelphia Fed.	PBA	Jan-97	Dec-10	167
United States	Producer Price Index (MoM)	IPM	Dec-97	Dec-10	156
United States	Trade Balance	TOITE	Jan-97	Dec-10	168
United States	U. of Michigan Confidence	PBA	May-99	Dec-10	279
United States	Unemployment Rate	TOITE	Jan-97	Dec-10	166
United States	Wholesale Inventories	PBA	Jan-97	Dec-10	168

Table 3.8 shows the list of selected macroeconomic indicators. The first column indicates the country of the macroeconomic announcements followed by the name of the indicators in column two. The third column represents the category in which the particular indicators are grouped. The fourth and fifth columns show the duration from the start to the end of the observations. The beginning observations of the macroeconomic indicators vary depending on the availability of the data but the ending observations are all collected towards the end of 2010. The last column displays the number of observations for each macroeconomic indicator. The announcement related to the Taiwan benchmark interest rate has the least number of observations at 25 due to the late beginning of the data collection point. Meanwhile, the announcement on the U.S. initial jobless claims has the highest number of observations at 707 because of its release on a weekly basis. After a thorough introduction and some analyses on the data, we move on to explain the two particular

approaches (i.e. forward unbiasedness hypothesis and event-study analysis) adopted in the testing of the research hypotheses in the following subsections. The research hypotheses have been described at length in the first chapter of the thesis.

3.5 Forward Unbiasedness Hypothesis and Markets Efficiency

The uncovered interest-rate parity (UIP) is a cornerstone theory in the literature of foreign exchange market efficiency. The UIP postulates that the interest-rate differential between two countries should be offset by the corresponding changes in the spot exchange rates. For example, assume the one-month interest rate in Malaysia is 3.0% while the similar tenor interest rate in U.S. is 0.5%. According to the UIP, the interest rate differential in favour of MYR must be offset by a depreciation of MYR against the USD by the same magnitude. In other words, the currency which carries higher interest rate (e.g. MYR) should depreciate against the currency with lower interest rate (e.g. USD). This condition gives rise to the forward unbiasedness hypothesis. Assuming covered interest-rate parity (CIP),[21] the forward exchange rate is a mathematical derivation of the spot exchange rate by taking into account the interest-rate differential between the currencies of the two countries. Hence, in an efficient market, the forward exchange rate should be an unbiased predictor of future spot exchange rate (Sarno & Taylor, 2002). The failure of the forward exchange rate to provide an unbiased prediction of future spot exchange rate implies failure of market efficiency. The unbiasedness of the forward exchange rate is tested through two popular econometric techniques. One is by regressing the changes in the spot exchange rates on the corresponding lagged forward premium. This technique is now popularly known as the Fama regression due to Fama (1984).

[21] The CIP is an arbitrage condition and its violation should attract arbitrageurs to exploit the opportunity. Therefore, by definition, the CIP must hold true. Furthermore, there is a large body of literature indicating the validity of the CIP, for example, Baillie & Chang (2011) and Pilbeam & Olmo (2011).

The second technique is through the cointegration analysis. The most commonly used cointegration test is the Johansen cointegration technique. The backgrounds of these two approaches have been introduced in the previous chapter and we explain, in details, the application of these approaches here. The determination of foreign exchange market efficiency through the study of the relationship between the forward and spot exchange rates is also called the *within-country* efficiency. We extend the cointegration analysis to cover the *across-country* efficiency which looks at the relationship among a group of exchange rates series. It must be noted that the *across-country* market efficiency is not based on the forward unbiasedness hypothesis. It is purely a natural extension of the cointegration technique which enables us to test the tenet of no-predictability of an efficient market. A finding of cointegration among a group of exchange rates series implies the breakdown of the no-predictability tenet of an efficient market and hence a violation of market efficiency. We choose to detail the *across-country* efficiency under this subsection because of the methodological link between these two concepts.

3.5.1 *Within-country* efficiency

The *within-country* efficiency investigates the essence of the forward unbiasedness hypothesis. The market is *within-country* efficient if the forward exchange rates are unbiased predictors of future spot exchange rates. We test the forward unbiasedness hypothesis with the Fama regression and the Johansen cointegration technique.

3.5.1.1 Fama Regression

The Fama regression actually precedes Fama (1984). As discussed in Chapter 2: Literature Review, the Fama regression has been widely adopted in the study of foreign exchange market efficiency since the late 1970s until today. As a result, we have an

extensive range of published articles which can be compared with our findings subsequently. There is vast empirical evidence, which employed mainly the advanced countries' currencies, showing the biasedness of the forward exchange rate as predictor of the future spot exchange rate (e.g. Fama, 1984; Hochradl & Wagner 2010) and this phenomenon has now come to be known as the forward bias puzzle. From the empirical evidence, currencies with high interest rate tend to appreciate, instead of depreciate as stipulated by the UIP, against currencies with lower interest rate. The forward bias puzzle has continued to baffle the international finance community to this day (Pilbeam & Olmo, 2011). Our second research hypothesis which intends to explore whether the forward bias puzzle exists in the Asia-Pacific foreign exchange markets is tested through the Fama regression. A finding of a negative beta coefficient indicates the existence of the forward bias puzzle and a non-negative beta estimate implies otherwise. The Fama regression is reproduced below as equation 3.1 for easy reference.

$$\Delta s_{t+m} = \alpha + \beta\left(f_{t+m,t} - s_t\right) + \varepsilon_t \tag{3.1}$$

The Δs_{t+m} denotes the changes in the spot exchange rates for t+m-period ahead, f_{t+m} is the forward rate for m-period ahead which is determined at time t and s_t is the spot exchange rate at time t. The difference between f_{t+m} and s_t is also known as the forward premium.[22] The ε_t is a white noise regression error. The forward unbiasedness hypothesis holds if the estimated α and β are jointly insignificantly different from zero and positive unity. The vindication of the forward unbiasedness hypothesis in turn implies market efficiency and vice-versa. All the exchange rates are quoted in terms of domestic currency per one unit of USD.

[22] The forward premium is also called forward discount in certain literature. To be precise, the difference between the forward and spot exchange rates is called a premium when the value is positive and a discount when it is negative. Therefore a negative forward 'premium' is essentially a forward discount. We use the term forward premium throughout this thesis for consistency and to avoid unnecessary confusion.

We measure the changes in the spot exchange rates using one-month horizon. This approach is consistent with most of the papers in the literature (e.g. Jeon & Seo, 2003; Frankel & Poonawala, 2010). We regress daily one-month changes in the spot exchange rates on the corresponding daily one-month lagged forward premium. We assume there are, on average, 22 trading days in a month. Therefore, in essence, the one-month horizon is actually only made up of 22 days. The use of daily data with one-month horizon observations creates an overlapping of observations issue. According to Baillie & Bollerslev (1989) and Barnhart, McNown & Wallace (1999), the use of least squares method in the case of overlapping data to estimate the parameters of Fama regression may give rise to the problem of endogeneity and serial correlation. Following Chinn (2006), we overcome this issue by employing the generalized-method-of-moment (GMM) to estimate the coefficients of Fama regression. The lagged dependent variable is used as the instrumental variable. The standard error of estimates are heteroscedasticity and autocorrelation consistent (HAC). The estimation is conducted via Eviews.

The hypothesis of the regression, H_0: $(\alpha,\beta) = (0,1)$ against the H_1: At least one of the conditions is violated, is tested by using the Wald test statistic, which has a chi-square distribution with *k* degrees of freedom, where *k* is the number of restrictions. The Fama regression is estimated for each individual currency for the whole sample period as well as the subsample periods. The subsample period analysis is intended to test for our third research hypothesis on whether the market is consistently efficient under different economic conditions. As the subsample periods are partitioned based on the underlying economic condition, the results will show us whether there is any observable pattern for the state of EMH under various economic conditions. Some of the subsample periods contain relatively short time series (e.g. the Pre-AFC sub-period is from January 1, 1997 to June 30,

1997) and therefore the resulting estimates of the parameters for each individual currency could be imprecise during this subsample period. We address this concern by pooling the various currencies and employ a panel estimation technique. The pooled Fama regression is estimated with a two-stage least squares method. The choice of whether to use fixed or random effects in the regression model is decided through the Hausman test. We create a total of six (6) overlapping-pooled samples. The summary of the pooled samples is shown in Table 3.9 below.

Table 3.9: Summary of Pooled Samples

There are six (6) pooled samples created from the 12 sample currencies for panel analysis. The first pool contains all currencies and the second pool excludes CNY and MYR because both of these currencies were pegged to the USD for a substantially long period of time during our full sample period. The third and fourth pools are segregated based on the income level of the respective countries. The categorisation of countries into high and medium income nations is obtained from the World Bank database for year 2010. The fifth and sixth pools, on the other hand, are grouped based on the extent of foreign exchange liberalisation. We use the existence of the NDF market as proxy for restricted currencies and the absence of it to signify non-restricted currencies.

No.	Constituent of Currencies	Criteria of Selection
1	All currencies	All
2	All but exclude CNY and MYR	Exclude currencies with fixed peg element
3	AUD, JPY, KRW, NZD, SGD and TWD	High-income nations
4	CNY, INR, IDR, MYR, PHP and THB	Medium-income nations
5	CNY, INR, IDR, KRW, MYR, PHP, THB and TWD	Currencies traded on NDF-market
6	AUD, JPY, NZD and SGD	Currencies not traded on NDF-market

The first pooled sample contains all the 12 Asia-Pacific currencies. We exclude CNY and MYR in the second pooled sample due to the fact that both currencies adopted a fixed exchange rate regime for a substantial period of time during the whole sample period. The next four pooled samples are grouped based on two criteria. The first criterion is based on the Gross National Income (GNI) per capita as at 2010. This information is available from the World Bank database. There are six countries which are categorised as high income nations namely Australia, Japan, South Korea, New Zealand, Singapore and Taiwan (third pooled sample). The rest of the countries are categorised as medium income

nations (fourth pooled sample). Bansal & Dahlquist (2000) have conducted a panel data analysis based on the first criterion for their samples of currencies and found that the estimates of the slope coefficients for both samples are significantly different. Hence this criterion could be a real differentiating factor for the existence of the forward bias puzzle. The second criterion used is the extent of foreign exchange market liberalization of the particular country. This attribute is proxied by the existence of offshore non-deliverable currency forwards (NDFs). The NDF markets were developed after the AFC outside the jurisdiction of countries with varying degrees of foreign exchange convertibility restrictions because the access to onshore forward markets was limited to non-resident investors (Tsuyuguchi & Wooldridge, 2008). Asian monetary authorities regard the NDF markets with suspicion because of their concern about cross-border spillovers and speculative activities even though NDFs are useful for hedging currency risk exposure (Ma, Ho & McCauley, 2004). Naturally, the presence of NDF markets implies a less-liberalized regulatory regime whereas its absence indicates a liberalized regime. We find that the degree of market liberalization is another important attribute in explaining the existence of the forward bias puzzle. This finding is informative because our study period goes beyond Bansal & Dahlquist's (2000) study period of 1976-1998 and covers additional Asia-Pacific currencies. The CNY, IDR, INR, KRW, MYR, PHP, THB and TWD are traded in the NDF markets (fifth pooled sample) while the rest are not (sixth pooled sample). Technically, the fourth pooled sample is a subset of the fifth pooled sample while the sixth pooled sample is a subset of the third pooled sample.

3.5.1.2 Johansen Cointegration

The second approach adopted is the Johansen (1991; 1995) cointegration technique. A similar approach has been used by Kan & Andreosso-O'Callaghan (2007), Aroskar,

Sarkar & Swanson, (2004) and Jeon & Seo (2003). Before we can apply this technique, we must determine the order of integration of the spot and forward exchange rates series. A time series is considered stationary if it has a constant mean, constant variance and the covariance between two observations depends only on the length of time separating the two values. The most easily observable condition of a stationary time series is the constant mean. A stationary time series has the property of mean reversion due to the constant mean condition. From looking at the exchange rates series depicted from Figures 3.3 to 3.14, we have a fairly good hint on the stationarity property of the spot exchange rates. The random wandering of the exchange rates series suggests that they are non-stationary. However, we must still conduct some formal stationarity tests to verify our suspicion. The stationarity tests are conducted on each individual exchange rate series for the whole sample period as well as the subsample periods. We have employed the augmented Dickey & Fuller (1979) (ADF), Phillips & Perron (1988) (PP) and Kwiatkwoski et al. (1992) (KPSS) unit root tests on the exchange rates series. The ADF and PP tests have the null hypothesis of nonstationarity while the KPSS test has a null hypothesis of stationarity. A trend and intercept are included in all the unit root tests. In order to ensure the error terms are not serially correlated, lags are integrated into the ADF test equation. The lag length in the ADF test is chosen based on the Akaike Information Criterion (AIC). The theoretical model of an ADF test is as follows:

$$\Delta Y_t = \mu + \beta t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \varepsilon_t \qquad (3.2)$$

with H_0: $\delta=0$ and H_1: $\delta\neq0$. The PP unit root test shares a similar model with the ADF model. The differentiating point of the PP test is specifically devised to cater for serial correlation when testing for a unit root and therefore no dependent lag variable is needed in its equation. The residual spectrum at frequency zero in the PP test is estimated through the

Bartlett kernel approach. The critical values for the ADF and PP tests are as tabulated by MacKinnon, Haug & Michelis (1999). As for the KPSS test, the residual spectrum at frequency zero is estimated through the Bartlett kernel approach similar to the PP test. The Langrange-Multiplier test statistic computed is compared against the critical values as tabulated by Kwiatkowski et al. (1992). If there are conflicting results on the stationarity property of the exchange rates series, we follow the majority results. This is also the rationale of using three different unit root tests in this exercise.

As mentioned, only the I(1) series are tested for cointegration. When the linear combination of the non-stationary spot and forward exchange rates series is stationary, we conclude that both of the series are cointegrated. The finding of cointegration between the spot and forward exchange rates series implies the unbiasedness of the forward rates as predictor of future spot exchange rates and hence supports the notion of market efficiency. The trace statistics (λ-trace) and maximum eigenvalue (λ-max) tests are used as the test statistics with critical values tabulated by MacKinnon, Haug & Michelis (1999). Lags of the dependent variable are included to eliminate the serial correlation in the residuals. The lag length chosen for this cointegration test is 22 given the overlapping nature of the data (Baillie & Bollerslev, 1989). To ensure robustness in our results, two options are selected for the cointegration test; one is the assumption of intercept but no trend and two is with intercept and trend in the cointegrating relations.

The number of cointegrating rank, *r*, is tested with trace statistic, λ-trace, and maximum eigenvalue, λ-max, tests. These two tests start with the first null hypothesis of no cointegrating rank (i.e. $r = 0$) against alternative of one (or at least one) (i.e. $r \geq 1$) cointegrating rank. If the first null hypothesis is rejected, we move on to test for the second null hypothesis of H_0: $r = 1$ against H_1: $r \geq 2$. We repeat the same process until we fail to

reject the null hypothesis. The variables are cointegrated if *r* is more than zero and less than the number of variables, k (i.e. $0 \leq r \leq k$). If *r* is equal to the number of variables, (i.e. r=k), the variables are independent and this case is called trivial cointegration in which the relationship is useless. We deem trivial cointegration as equivalent to no cointegration. In our case, spot and forward exchange rates are cointegrated if there is one and only one cointegrating rank. Similar to Fama regression, we run the Johansen cointegration test on each exchange rate series for the whole period and all the subsample periods. We only report the number of cointegrating vectors indentified in the tests. If they are found to be cointegrated, we infer that the forward rate is an unbiased predictor of future spot rate (Jeon & Seo, 2003) and this finding, in turn, supports markets efficiency.

3.5.1.3 Reconciliation of Potential Conflicting Results

As reviewed in the previous chapter, previous research results reported with the Fama regression usually indicate market inefficiency while the results from the Johansen cointegration technique supports market efficiency. The conflicting results provide a gap for this thesis to fill. We have not come across any published papers which directly compare and contrast the results from the Fama regression with those obtained from the Johansen cointegration test. This thesis represents a major contribution to the literature by filling this research gap. In order to resolve any potential conflict of results, we have adopted the models suggested by Pilbeam & Olmo (2011) in addressing the weaknesses of the Fama regression. While there are a plethora of studies which propose resolutions to the forward bias puzzle such as Frankel & Poonawala (2010), Clarida, Davis & Pedersen (2009), Chakraborty & Evans (2008) and Baillie & Bollerslev (2000), we have chosen to use Pilbeam & Olmo (2011) models as a reconciliatory measure to the potential conflicting results from our analyses. The choice of the Pilbeam & Olmo (2011) is mainly driven by its

unexplored robustness. The sample currencies used by Pilbeam & Olmo (2011) are all from advanced economies. This thesis is the first study to apply the Pilbeam & Olmo (2011) models to the Asia-Pacific currencies.

By using a Taylor expansion, Pilbeam & Olmo (2011) show that the estimates from the conventional Fama regression contains a negative bias due to the substantial difference in volatilities between the log exchange rates changes and the forward premium. They have enhanced the Fama regression model by introducing some extra variables to address the negative bias concern. They claim that the additional variables introduced into the models prevent the conventional Fama regression from holding even if the market is efficient with the exception when the ratio between the spot and the lagged forward exchange rates are systematically very close to one. Two models are proposed by Pilbeam & Olmo (2011). One is a direct test of market efficiency while the other tests for the degree of market inefficiency if the efficiency condition is violated. The two models are given in equations 3.3 and 3.4.

$$\left[\left(\frac{S_{t,i}}{F_{t-1,i}} - 1\right)\right] = \alpha_i + \varepsilon_{t,i} \tag{3.3}$$

$$\left[\left(\frac{S_{t,i}}{F_{t-1,i}} - 1\right)\right] = \alpha_i + \rho_i \frac{1}{F_{t-1,i}} \varepsilon_{t,i} \tag{3.4}$$

S and *F* are the spot and forward exchange rates for currency *i* at levels and *t* denotes the time. α and ρ are the regression estimates. The uppercase for both S and F indicate that the observations are measured at level-form instead of the usual logarithm-form. Equation 3.3 tests for the foreign exchange market efficiency while equation 3.4 provides an estimation of the degree of market inefficiency. Equations 3.3 and 3.4 are called Pilbeam & Olmo (2011) model 1 and model 2 respectively. Under equation 3.3, the

market is efficient if the estimated α is not significantly different from zero. Hence the null hypothesis for equation 3.3 is that the market is efficient (i.e. H_0: $\alpha = 0$) against the alternative of market inefficiency (i.e. H_0: $\alpha \neq 0$). However, if the market is inefficient or contains a risk premium, equation 3.3 suffers from misspecification. Pilbeam & Olmo (2011) introduced another model in the form of equation 3.4 to cater for the existence of a risk premium or market inefficiency. The market is efficient if α and ρ are insignificantly different from zero. The significance of these estimated coefficients measure the degree of market inefficiency. Similar to Fama regression, we run both Pilbeam & Olmo (2011) models on each individual currency as well as the pooled samples as described in Table 3.9. We also conduct parallel analysis for the whole and subsample periods with Pilbeam & Olmo (2011) models.

3.5.1.4 Robustness Tests for *Within-country* Efficiency

We conduct a robustness test for each of the techniques adopted in the *within-country* efficiency analysis to ensure that the interpretations of the results are robust. We have conjectured that the market efficiency condition may not be constant over time due to differences in underlying economic conditions. For this purpose, we have broken the whole sample period into several subsample periods. Instead of breaking up the whole sample period intermittently and conducting separate regression analysis for each subsample period, we conduct a dummy variables regression by segregating the observations into AFC, GFC and non-crisis period before running one single regression. The observations which occurred between July 1, 1997 and December 31, 1998 are considered as AFC observations, while observations which fall between January 1, 2008 and December 31, 2009 are categorised as GFC observations. All the other observations which are not within the stipulated timeframe are grouped as non-crisis observations.

$$\Delta s_{t+1,i} = \beta_{i,1} D_1 (f_{t+m,t} - s_t) + \beta_{i,2} D_2 (f_{t+m,t} - s_t) + \beta_{i,3} D_3 (f_{t+m,t} - s_t) + \varepsilon_{t+1,i} \quad (3.5)$$

$$D_1 = \begin{cases} 1, non - crisis\ period \\ 0, \quad otherwise \end{cases}$$

$$D_2 = \begin{cases} 1, AFC\ period \\ 0, \ otherwise \end{cases}$$

$$D_2 = \begin{cases} 1, GFC\ period \\ 0, \ otherwise \end{cases}$$

Equation 3.5 shows the respecified Fama regression for robustness test purposes. We run equation 3.5 on each individual currency as well as the pooled samples as described under Table 3.9. The use of the pooled samples is to check whether institutional characteristics are important in influencing the forward bias puzzle. In order to examine whether there is any significant difference in the forward unbiasedness hypothesis under different market conditions, we test for the equality of β_1, β_2 and β_3 which represent non-crisis, AFC and GFC periods respectively. The results from equation 3.1 are robust if they are qualitatively similar to those obtained from equation 3.5. The robustness test is also extended, in the same spirit, to one of the models proposed by Pilbeam & Olmo (2011). We choose only to test the robustness of equation 3.3 and not equation 3.4 because of its potential complex interpretation. The robustness test on Pilbeam & Olmo (2011) model 1 is given in equation 3.6.

$$\left[\left(\frac{S_{i,t+1}}{F_{i,t}}\right) - 1\right] = \alpha_{i,1} D_1 + \alpha_{i,2} D_2 + \alpha_{i,3} D_3 + \varepsilon_{i,t+1} \quad (3.6)$$

The results from equation 3.3 are compared to results obtained from equation 3.6 for robustness purposes. The results from our main analysis are considered robust if they are consistent with those results obtained from this approach.

3.5.2 *Across-country* efficiency

The *across-country* market efficiency studies the relationship among currencies from different countries. One of the main tenets of the efficient markets hypothesis (EMH) is the no-predictability condition. When one country's currency becomes predictable from another country's currency, this situation constitutes a violation of *across-country* market efficiency. We test for the *across-country* efficiency through the Johansen cointegration technique. It must be noted again at this point that the *across-country* efficiency has moved away from the relationship between the spot and forward exchange rates. Hence, unlike the *within-country* market efficiency, the *across-country* market efficiency does not fall under the area of forward unbiasedness hypothesis. Both of the concepts of *within-* and *across-country* market efficiency are linked through the grand theory of EMH even though they are being studied from different angles. We include the explanation of the *across-country* market efficiency under this subsection because of the mutual use of the Johansen cointegration technique in the testing of both the *within-* and *across-country* efficiency. Although we apply the same technique, the interpretations of results are markedly different. The finding of cointegration in the *within-country* efficiency test implies market efficiency while it requires a no-cointegration result in the *across-country* efficiency test to support a market efficiency condition. Due to this difference, we present the required conditions for a market to be considered efficient under both the *within-* and *across*-country perspectives under Table 3.10 on the following page to avoid potential confusion.

Besides examining the *across-country* efficiency under different economic conditions as per Table 3.2 on page 94, we have also further divided the *across-country* efficiency test into bivariate and multivariate forms for cointegration testing. The bivariate cointegration test looks at the relationship between the spot exchange rates of two

currencies while the multivariate cointegration test studies a group of spot exchange rates from various currencies collectively. In the bivariate test, each currency spot exchange rate is tested for cointegration with another currency spot exchange rate.

Table 3.10: Markets Efficiency Conditions

From the *within-country* perspective, market is efficient if the forward rates are unbiased predictor of future spot exchange rates. This condition can be tested with both regression and cointegration techniques. Fama (1984) regresses the changes of spot rates on the lagged forward premium and the resulting coefficients α and β must be insignificantly different from 0 and 1 respectively in order to meet the efficiency condition. Meanwhile Pilbeam and Olmo (2011) have suggested a similar but different form of regression to test the efficiency condition: the ratio between spot and lagged forward rates is to be deducted by one before regressing on a constant. The market is efficient if the constant is insignificantly different from 0. The unbiasedness of forward rates as predictor of future spot rates can also be tested with the Johansen cointegration technique: the market is efficient if the spot and forward exchange rates are cointegrated. In contrast, from the *across-country* perspective, the market is efficient if there is no cointegration among different series of exchange rates.

Perspective	Type of Test	Efficiency Condition	Econometric Representation
i) Within-country	Fama (1984) Regression	Forward rates are unbiased predictor of future spot exchange rates	$\Delta s_{t+m} = \alpha + \beta(f_t^m - s_t) + \mu_t$ $H_0: (\alpha, \beta) = (0,1)$
	Pilbeam & Olmo's (2011) model	Forward rates are unbiased predictor of future spot exchange rates	$\left[\left(\frac{S_{t+1}}{F_t}\right) - 1\right] = \alpha + \varepsilon_{t+1}$ $H_0: \alpha = 0$
	Johansen Cointegration	Spot and forward exchange rates are cointegrated	$s_{i,t} \sim I(1); \quad f_{i,t-m} \sim I(1);$ $(s_{i,t} - \beta_i f_{i,t-m}) \sim I(0)$
ii) Across-country	Johansen Cointegration – Bivariate	No cointegration between two series of different spot exchange rates	$s_{i,t} \sim I(1); \quad s_{j,t} \sim I(1);$ $(s_{i,t} - \alpha_k s_{j,t}) \sim I(0)$
	Johansen Cointegration – Multivariate	No cointegration among series of different spot exchange rates	

Meanwhile in the multivariate test, we run the cointegration test on a group of currencies. Under the multivariate test, we have grouped the currencies according to their respective locality namely, the Southeast Asia (i.e. IDR, MYR, PHP, SGD & THB) and East Asia (i.e. CNY, JPY, TWD & KRW). Since we have only two currencies from Australasia, we are not able to conduct a multivariate cointegration test for this locality. If the spot exchange rates are found to be cointegrated, there is evidence to show the presence of a long-run relationship among the currencies. Any deviation of one series from the equilibrium relationship indicates that the subsequent movement of the series will return to the long-run relationship (Jeon & Seo, 2003). The governance of exchange rate movements through the long run relationship represents the predictability of one exchange rate from

another exchange rate. Hence this relationship clearly violates the tenet of no-predictability of the EMH (Baillie & Bollerslev, 1989).

3.5.2.1 Forward Premium Stationarity

The finding of cointegration between two or among a group of spot exchange rates, however, does not necessarily represent an absolute rejection of market efficiency. Crowder (1994) suggests that the cointegrating vector in a system of spot exchange rates could be a proxy for a risk premium that drives their co-movement. With the existence of a risk premium, the *across-country* market efficiency could be wrongly rejected. According to Aroskar, Sarkar & Swanson, (2004), there are three possibilities following the rejection of the *across-country* market efficiency: (i) the market could be efficient and contains a risk premium, (ii) the market could be inefficient and contains a risk premium or (iii) the market is indeed inefficient and contains no risk premium. Crowder has decomposed the forward premium into three components namely (i) the changes in spot exchange rates, (ii) a currency risk premium and (iii) a rational expectation error which resembles white noise. This relationship is represented by equation 3.7.

$$\left(f_{t+m,t} - s_t\right) = (s_{t+m} - s_t) + \delta_{t+m} + \varepsilon_{t+m} \qquad (3.7)$$

The variables *f* and *s* are the forward and spot exchange rates in logarithm form and δ denotes the risk premium while ε is the rational expectation error which is independently and identically distributed (IID). The changes in spot exchange rate, $s_{t+m} - s_t$, is widely found to be an I(0) process (Kan & Andreosso-O'Callaghan, 2007). Meanwhile ε, which follows a white noise process, is also a stationary term by construction. The stationarity property of the risk premium is therefore dependent on the forward premium, $f_{t+m,t} - s_t$. In order for the common stochastic trends to be proxy for a risk premium, the forward premium must therefore be stationary so that it is compatible with the time series property

of the error correction term (ECT) found in the cointegrated model. The stationarity behaviour of the forward premium is tested with the ADF and PP unit root tests. The presence of unit roots in the forward premium would reject the suggestion that the cointegrating vector is a proxy for the risk premium and the market is indeed inefficient but leave undetermined whether there is any risk premium. Meanwhile if the forward premium contains no evidence of unit roots, the market could possibly be efficient and the ECT is the instrument for a risk premium. In essence, a non-stationary forward premium weakens the argument against market inefficiency identified under the *across-country* market efficiency test. This approach has been employed by, among others, Kan & Andreosso-O'Callaghan (2007), Aroskar, Sarkar & Swanson, (2004) and Barkoulas, Baum & Chakraborty, (2003).

3.6 Event-study Analysis and Markets Efficiency

The essence of the EMH as pioneered by Fama (1970) emphasises the informational efficiency of security prices in which the prices react only to the arrival of new information. The prevailing prices of any asset in an efficient market have already impounded all relevant available, public and private, information and hence the prices will only move when new information arrives. The arrival of new information or news to the markets happens in a random fashion and this phenomenon explains why the behaviour of security prices is largely detected as a random walk process (Malkiel, 2003). The test of the instantaneous reaction of security prices to new information is often considered as a test of semi-strong form efficiency. In the foreign exchange markets, the best proxy for new information is macroeconomic surprises. In this section, we employ an event-study analysis to test whether exchange rates react instantaneously to the surprise elements of a macroeconomic announcement, at home or abroad. This methodology helps to provide an additional perspective to our Research Hypothesis One on whether the foreign exchange

markets are efficient. It must be noted at this point that a mere announcement of a macroeconomic indicator does not constitute news because, most likely, the large part of this piece of information has already been predicted. Therefore only the surprise elements of the macroeconomic announcement should be considered as new information.

In the context of the foreign exchange market, exchange rates are equivalent to security prices in a capital market. The equilibrium for floating exchange rates is basically determined by market forces of supply and demand. Since the collapse of the Bretton Woods regime in the early 1970s, most advanced countries have moved their exchange rate management system to a floating rate regime. In the 1990s and early 2000s, more countries, especially those from emerging markets, have started to adopt floating exchange rate regimes (Lin & Ye, 2011; Klein & Shambaugh, 2008). As a company is valued from its fundamentals such as earnings and projected growth, exchange rates are similarly valued against countries' macroeconomic fundamentals which include, among others, inflation, unemployment and economic growth. In view of this, various exchange rate models which incorporate macroeconomic variables have been introduced since the flotation of international exchange rates. Among the popular models are such as the monetary model (e.g. Frenkel, 1976; Cerra & Saxena, 2010), portfolio balance model (e.g. Dornsbusch, 1975; Breedon & Vitale, 2010), purchasing power parity model (e.g. Krugman, 1978) and balance of payments model (e.g. Horne, 1983). However, the performance of these models is not satisfactory in explaining the movement of exchange rates thus far (Sarno & Sojli, 2009). Following the poor performance of these models, researchers have termed this phenomenon as the 'fundamental disconnect puzzle' (Sarno, 2005; Obstfeld & Rogoff, 2000). Despite the criticisms, there is also evidence which provide some salvation to exchange rate models (e.g. Engel & West, 2005; Engel et al., 2007). Exchange rates are

found to be correlated with macroeconomic surprises and this situation shows that exchange rates are not entirely disconnected from macroeconomic fundamentals.

Notwithstanding the validity of the exchange rate models, our main concern in this part of the thesis is to examine the reaction of the exchange rates to macroeconomic surprises in order to determine the state of market efficiency. An efficient foreign exchange market would reveal an instantaneous reaction of exchange rates to the news elements of those important macroeconomic announcements. We acknowledge that not all macroeconomic announcements are relevant and thus the surprise elements of such announcements may not affect exchange rates. Therefore we cannot exactly reject market efficiency when we fail to find any reaction in the exchange rates to some of the macroeconomic surprises. Our main contention is to show that the exchange rates do react to the arrival of some relevant new information and nothing else. This finding will be sufficient evidence to support the semi-strong form efficiency. As a word of caution, our results on market efficiency in the foreign exchange markets which are based on the event-study analysis are only indicative and not as absolute as the results from the forward unbiasedness hypothesis. We have selected 107 key macroeconomic announcements from the United States and the Asia-Pacific countries to test for market efficiency. These indicators are broadly categorised into three (3) groups as explained earlier in this chapter.

As mentioned, the literature has shown that it is imperative for any work using event-study analysis in the field of foreign exchange rates to disentangle the unexpected components from the pure macroeconomic announcements (Fatum & Scholnick, 2008.) As new information arrives in a random fashion to the market, we cannot possibly model the news element. That leaves us with only the 'expected' component. Hence the key to determining the 'surprise' elements of a macroeconomic announcement are to discover the

'expected' component of the particular announcement. Basically, there are two ways to obtain the expected component of a macroeconomic announcement. One, it is to conduct an econometric forecasting of the macroeconomic announcement. Once we have enough observations, we are able to build a forecasting model to project the future value of the macroeconomic announcements. The second method is to extract the expected component directly from the market participants. The second method is preferred to the first because the data collected from the second method is exogenous information which does not rely purely on the historical data by itself. Most of the established financial service providers give an expectation of the key macroeconomic indicators prior to the official announcements. This data is usually collated by Bloomberg and Reuters and made available in their respective databases. Another advantage of obtaining the expected component directly from the market is the source of such information. These providers are usually market participants, such as banks and fund managers, which deal directly in the market when they get hold of new information. Any deviation of the actual announcement from the expected component is considered as a surprise or new information which may attract reactions from market participants. This relationship is captured under equation 3.8.

$$N_{i,t} = A_{i,t} - E_{i,t} \tag{3.8}$$

where all the three variables in the equation are related to the macroeconomic indicator *i*; *N* is the unexpected component, *A* is the actual value and *E* is the market expected value. The unexpected component, *N*, is also known as 'news' or market forecast error.

For the U.S. as well as some of the developed countries' macroeconomic announcements, the market expectation components are relatively easily obtained as the expected value is being willingly furnished by some institutions prior to the announcement.

However, this could be a challenge for the developing countries, which made up the majority of our sample, as the market expectations for the macroeconomic announcements are not widely available. In view of this, our macroeconomic shocks for the Asia-Pacific countries are greatly constrained by this shortcoming. Next, we acknowledge that it is becoming more desirable to employ intraday data for event-study analysis but many currencies in the Asia-Pacific region are usually not traded around-the-clock hence making it difficult to obtain continuous minute-by-minute observations for the exchange rate information. The daily exchange rates data which we used are, by any measure, still considered as short-horizon data (Fama, 1998; Kothari, Warner & Eckbo, 2007). By employing short-horizon data, we are able to circumvent the potential problem caused by the use of false pricing model (Kothari, Warner & Eckbo, 2007). We use the same-day changes in the spot exchange rate as the announcement date to test for the instantaneity of responses of exchange rates to macroeconomic news. More specifically, we employ the following regression model to test for market efficiency in the Asia-Pacific region:

$$\Delta s_{t,i} = \alpha_i + \beta_i \widehat{N_{j,t}} + \varepsilon_t \tag{3.9}$$

where $\Delta s_{t,i}$ is the changes in the log spot exchange rate for currency *i* recorded on the day of the announcement and $N_{j,t}$ is the standardized unexpected components of *j*-th macroeconomic announcement. The ε is the regression standard error and it is an independently and identically distributed (IID) process. In order to compare the significance among the macroeconomic announcements, we have standardized the unexpected elements by dividing the variable *N* by its respective standard deviation as shown in equation 3.10.

$$\widehat{N_{J,t}} = \frac{A_{i,t} - E_{i,t}}{\sigma_j} \tag{3.10}$$

With this standardization, we would be able to interpret the estimated β coefficient as the response of the exchange rate to one standard deviation shock in the macroeconomic announcements.

The event-study analysis which is used to test for the foreign exchange market efficiency is slightly different from the conventional event-study methodology used in the capital markets (i.e. equity or credit markets). The conventional event-study methodology, illustrated in Fama et al. (1969), is usually used to test for the impact of a particular event on security prices and the impact is identified through the significance of the cumulative abnormal returns. We do not use the cumulative abnormal returns in this thesis. In order to conduct a conventional event-study analysis, there must be an acceptable asset pricing model for the particular class of assets to detect the abnormal returns (Kothari, Warner & Eckbo, 2007; Corrado & Truong, 2008). Moreover, in the foreign exchange market, there is no one universally acceptable model which can be used as the benchmark to detect excess returns. In a seminal paper, Meese & Rogoff (1983) have shown that most of the exchange rate models underperformed a naive random walk model. Their conclusion is so persistent as there is still no convincing evidence to debunk their claim. Cheung, Chinn & Pascual (2005) reconfirm the superiority of the naive random walk model over some other popular exchange rate models with recent data. In the absence of a reliable exchange rate model, we subscribe to the naive random walk model as the benchmark model to determine the excess returns. According to the random walk hypothesis, the best estimate of tomorrow prices is today's prices. Hence there should not be any significant excess returns. If an event is

important and contains informational value, the β coefficient of equation 3.9 should be significantly different from zero.

In order to test for foreign exchange market efficiency using an event-study analysis, exchange rates should only react to the macroeconomic surprises and not any other variable. From the literature, we gather that the foreign exchange market efficiency test is based on the significance of the estimated α coefficient in equation 3.9. The market is efficient if the estimated α coefficient is not significantly different from zero. The estimate of β is expected to be significant for the macroeconomic indicators which are influential in the determination of foreign exchange rates. However, the sign of the β coefficient is difficult to be determined *a priori* as there are plenty of conflicting theories at force. For example, purchasing power parity (PPP) theory postulates that a higher than expected inflation number would cause the depreciation of the currency of concern. On the other hand, the portfolio balance theory dictates that the currency should appreciate instead of depreciate because a higher inflation will prompt the monetary authority to increase interest rate and hence attracts investment flow into the country. Another newly-established theory known as the reaction response function (RRF) hypothesizes that the reaction of the exchange rates to macroeconomic surprises is better explained by traders' expectations of how the monetary authority is going to respond to these surprises (Pearce & Solakoglu, 2007; Simpson, Ramchander & Chaudhry, 2005). The sign of the estimated β depends on which of the competing theories is more dominant. We run equation 3.9 for each series of the macroeconomic announcements on each, as well as the pooled version, of the exchange rate series. For the individual exchange rate series, we run a total of 1,284 regressions (i.e. 12 exchange rates series times 107 macroeconomic indicators) whereas for the pooled analysis, we conduct only 107 regressions (i.e. 107 macroeconomic indicators).

3.6.1 U.S. and Domestic Macroeconomic Shocks and Their Ranking

Research Hypothesis Four seeks to find out whether or not the Asia-Pacific exchange rates react to their own macroeconomic surprises. As our sample currencies are quoted against the USD, we treat the U.S. macroeconomic announcements separately from the other Asia-Pacific macroeconomic announcements. The relationship between U.S. macroeconomic shocks and the exchange rates are quite well researched and have been systematically documented (e.g. Pearce & Solakoglu, 2007; Almeida, Goodhart & Payne, 1998). However, the relationship between domestic macroeconomic shocks and exchange rates are not that well-researched. There is no clear evidence about the impact of domestic macroeconomic shocks on exchange rates especially for small economies. Cai, Joo & Huang (2009) is the closest literature which looks at the relationship between emerging market macroeconomic shocks and exchange rates. Our thesis is distinct from Cai, Joo & Huang, (2009) because of the vastly different set of currencies we employ. Research Hypothesis Four is tested to specifically fill the gap in this area within the literature.

Under the U.S. macroeconomic events, we measure the relative impact of their surprises and report which of these shocks are the most influential in impacting the Asia-Pacific currencies. The extent of the influence of the shocks is identified by the number of currencies that are significantly impacted. The shock which impacts the highest number of currencies is considered the most influential. We also examine which of the Asia-Pacific currencies are the most elastic in reacting to these macroeconomic surprises. The currency which reacts to the highest number of macroeconomic surprises is considered the most elastic. For domestic macroeconomic shocks, we conduct the same analyses as for the U.S. macroeconomic surprises. We identify the most influential domestic macroeconomic

shocks and also find out which of the Asia-Pacific currencies are the most responsive to the surprises of these announcements.

Finally, we combine all the U.S. and domestic macroeconomic shocks for the pooled regression analysis. We pooled all the 12 Asia-Pacific currencies and conduct a two-stage least square to estimate equation 3.9. Our focus for the pooled regression is the estimated β for each macroeconomic shock. As the macroeconomic surprises are standardized with their respective standard deviations, the estimated β is comparable to each other. The resulting β estimate is interpreted as the magnitude of change in the pooled exchange rates to one standard deviation shock in the macroeconomic surprises. We sort the estimated beta from the pooled regressions according to their t-statistics value. The impact of the macroeconomic shocks should not be naively measured based on the magnitude of the estimated β because the standard error of the estimate may distort their comparison with one another. The sorted list provides us with a ranking of the most significant macroeconomic shocks in terms of their relative impact on the Asia-Pacific exchange rates. This is a novel approach and the ranking is one of the major contributions of this thesis to the literature.

3.7 Chapter Summary

The methodologies explained in this chapter are specifically devised to test for the five research hypotheses we have identified in the beginning of the thesis. Before we proceed to describe the methodologies, we present the set of data used as the empirical input. We have selected twelve (12) Asia-Pacific countries as the focus of our research. These 12 countries are Australia, China, India, Indonesia, Japan, South Korea, Malaysia, New Zealand, the Philippines, Singapore, Taiwan and Thailand. We obtain the daily exchange rate information from January 1, 1997 to December 31, 2010 for each of these

countries from Datastream. We have also obtained 107 key macroeconomic announcements from the U.S. and all the 12 Asia-Pacific countries. The information related to the macroeconomic announcements is extracted from the Bloomberg database.

We employ two main approaches to test for our first research hypothesis. They are the forward unbiasedness hypothesis and the event-study analysis. The forward unbiasedness hypothesis which is based on the uncovered interest-rate parity (UIP) is the cornerstone theory used in the testing of the foreign exchange market efficiency (Sarno & Taylor, 2002). The forward unbiasedness hypothesis postulates that in an efficient market, the forward exchange rate should be an unbiased predictor of the future spot exchange rate. At the same time, the event-study analysis is also used to complement the forward unbiasedness hypothesis in the testing of the foreign exchange market efficiency. As a caveat, we acknowledge that the evidence obtained from the event-study analysis with regards to the state of foreign exchange market efficiency is only indicative and does not provide an absolute answer to the research hypothesis. Therefore this approach is a supplementary test to the forward unbiasedness hypothesis.

For our second and third research hypotheses, we test them through the forward unbiasedness hypothesis. We also extend the use of the event-study analysis to test for our research hypotheses four and five. As a conclusion, the techniques employed are carefully selected to support the testing of our research hypotheses and to enable our findings to be compared and contrasted with the extant literature. Along the way, we have also introduced some novel approaches, such as the grouping of the currencies based on their institutional characteristics and the ranking of the macroeconomic indicators amongst others, to further enrich the literature.

FOREIGN EXCHANGE MARKET EFFICIENCY: ASIA-PACIFIC FOCUS

CHAPTER 4

RESULTS AND DISCUSSIONS

4.0 Introduction

The results are presented from the two approaches which we have adopted in our methodology namely the forward unbiasedness hypothesis and the event-study analysis. Within each approach, there are several perspectives which we use to facilitate our discussions. Under the forward unbiasedness hypothesis, which could be viewed as a weak-form efficiency testing results, are discussed first from the perspective of *within-country* followed by the *across-country* perspective. *Within-country* efficiency refers to the state of efficiency for one currency pair and looks at the relationship between the country's spot and forward exchange rates. We employ the Fama regression (Fama, 1984) and Johansen cointegration (Johansen, 1989,1991) technique to test for the unbiasedness hypothesis.

The Johansen cointegration technique is extended to test for *across-country* market efficiency. According to one of the main tenets of the efficient markets hypothesis (EMH), assets or security prices should not be predictable by any existing information. Applying this tenet to a system of spot exchange rates, the market is *across-country* efficient if there is no cointegration among the various countries spot exchange rates (Barkoulas, Baum & Chakraborty, 2003). The existence of a cointegrating vector implies predictability of one spot exchange rate with another spot exchange rate and hence a violation of the tenet of no predictability. The *across-country* efficiency perspective provides us with a view of the

foreign exchange markets as a single intertwined market among a group of currencies. We report the relationships between and among a group of spot exchange rates.

Next, under the event-study analysis approach, we have broadly segregated the macroeconomic indicators into United States (U.S.) and domestic indicators in line with the dominant role of the U.S. economy on the rest of the world. The wide range of economic indicators which have been employed are categorised into three (3) groups namely (i) Interest rate, prices and money, (ii) Production and business activity and (iii) Total output, international trade and employment. The market is efficient if the exchange rates react only to the surprise components of a particular announcement and not to any other element. The event-study approach is also being extended to examine the relative impact of the macroeconomic surprises on the Asia-Pacific exchange rates.

The remaining sections of this chapter are arranged as follows: Section 4.1 provides the results from the forward unbiasedness hypothesis in general followed by detailed discussions in the following two (2) subsections; 4.1.1 *Within-country* efficiency and 4.1.2 *Across-country* efficiency. Section 4.2 brings us into the event-study analysis and it contains four (4) subsections which elaborate on the impact of U.S. and domestic macroeconomic indicators respectively. Section 4.3 concludes the chapter by providing a coherent view on the two (2) approaches and their findings.

4.1 Forward Unbiasedness Hypothesis and Markets Efficiency

Foreign exchange markets are efficient when the forward exchange rates are unbiased predictors of future spot exchange rates. Therefore changes in the spot exchange rate should not be significantly different from the corresponding forward premium. We have used a one-month horizon to obtain the spot exchange rate changes and as a result, we

have to obtain the corresponding forward premium (i.e. one-month) by taking the difference between the one-month forward rate and the spot exchange rate. Besides the adoption of the Fama regression, we have also conducted Johansen cointegration on the spot and forward exchange rates to test for the unbiasedness hypothesis. As we have extended the cointegration technique to test for cointegration among the spot exchange rates of our sample currencies, we are able to provide an *across-country* market efficiency perspective. With these two techniques, we are able to view the foreign exchange markets efficiency from two perspectives; *within-country* and *across-country*.

4.1.1 *Within-country* Efficiency

4.1.1.1 Fama Regression

Within-country markets efficiency emphasises the forward exchange rates as unbiased predictor of future spot exchange rates. First of all, we have regressed one-month changes of the spot exchange rates on the corresponding one-month lagged forward premium as shown in equation 4.1.

$$\Delta s_{t+1,i} = \alpha_i + \beta_i fp_{t,i} + \varepsilon_{t+1,i} \quad (4.1)$$

s and *fp* are the log spot and forward premium at time *t+1* and *t* respectively. The subscript *i* is to denote the selected currency while the ε is the estimation error. Equation 4.1 is also popularly known as Fama regression due to Fama's 1984 seminal paper in decomposing the meaning and implications of the estimated coefficients. This regression equation has been widely used to test foreign exchange market efficiency and as a result we have the opportunity to study the similarity and differences with the existing literature. The market is efficient if α and β are equal to zero and one respectively. We have tested the null hypothesis of (α,β) = (0,1) against the alternative hypothesis of at least one equation is not

true with the Wald test which has a chi-square distribution with k degrees of freedom, where k is the number of restrictions. We present the Wald F-test results and the estimates of the Fama beta coefficient for each individual currency market. The standard error of estimates is heteroscedasticity and autocorrelation consistent. The results are shown in Table 4.1 on the following page.

There is a widespread rejection of market efficiency as shown by the rejection of the null hypothesis of $(\alpha,\beta) = (0,1)$. This finding is in agreement with most of the studies reviewed in Chapter 2: Literature Review (e.g. Engel, 1996 and Sarno, 2005). In the whole sample period, we show that only the Korean won (KRW), Malaysian ringgit (MYR), Philippines peso (PHP) and Taiwanese dollar (TWD) are efficient from the perspective of the Fama regression. However, the beta estimate for KRW is slightly less than zero (i.e. -0.03) and the failure to reject the null hypothesis is due to the large standard error of the beta estimate. Therefore only the MYR, PHP and TWD produced beta estimates which are closer to the theoretical value of one as stipulated by the unbiasedness hypothesis. About half of the currency markets [i.e. Australian dollar (AUD), Indian rupee (INR), Japanese yen (JPY), KRW, New Zealand dollar (NZD) and Singaporean dollar (SGD)] show a negative beta coefficient and therefore the existence of the forward bias puzzle.[23] The negative beta coefficient implies that the currencies with higher interest rate appreciated against currencies with lower interest rate. This is a direct violation of the uncovered interest-rate parity (UIRP) condition which required the appreciation of lower interest rate currencies to avoid any profit opportunity.

[23] Forward bias puzzle is a condition when the beta estimated from the Fama regression registered a negative value. This is a widely reported phenomenon in the literature of foreign exchange market efficiency (see Froot & Thaler, 1990 and Sarno, 2005).

Table 4.1: Fama Regression Results

Acronyms for sample currencies are as follows: Australian dollar (AUD); Chinese yuan (CNY); Indonesian rupiah (IDR); Indian rupee (INR); Japanese yen (JPY); Korean won (KRW); Malaysian ringgit (MYR); New Zealand dollar (NZD); Philippines peso (PHP); Singaporean dollar (SGD); Thai baht (THB) and Taiwanese dollar (TWD). Whole period is from January 1, 1997 to December 31, 2010 and the pre-AFC, AFC, Post-AFC, Pre-GFC, GFC and Post-GFC subperiods are as described under Table (3.1). The regression estimated is Fama regression as shown in equation 4.1. The market is efficient if the α and β are jointly equal to '0' and '1'.The Wald F-statistics show the F-value from the Wald test of null hypothesis (α,β) = (0,1) against the alternative hypothesis of at least one equation is untrue. Meanwhile the beta estimate column shows the Fama beta estimated from the regression and the figures in parentheses are the corresponding standard error of the respective beta estimates. The theoretical value of the Fama beta for an efficient market is one. Forward bias puzzle is defined as the finding of negative beta coefficient. * and ** denote significance at 0.05 and 0.10 respectively. NA implies 'not available' and it is due to either data availability issue or fixed exchange rate regime as in the case for CNY and MYR. There is a widespread rejection of unbiasedness hypothesis or markets efficiency notion. Meanwhile the forward bias puzzle is not as pervasive as the literature claimed to be. Please see section 4.1.1 for discussions.

Currency	Whole Period		Pre-AFC Subperiod		AFC Subperiod		Post-AFC Subperiod		Pre-GFC Subperiod		GFC Subperiod		Post-GFC Subperiod	
	Wald F-Stat	β Estimate	Wald F-Stat	β Estimate	Wald F-Stat	β Estimate	Wald F-Stat	β Estimate	Wald F-Stat	β Estimate	Wald F-Stat	β Estimate	Wald F-Stat	β Estimate
AUD	9.62*	-0.78 (0.69)	0.55	0.97 (3.67)	0.88	1.52 (0.83)	11.13*	-1.20 (0.83)	1.89	0.59 (3.03)	0.77	0.13 (3.01)	3.40*	-1.12 (7.55)
CNY	3.95*	0.55 (0.18)	NA	NA	NA	NA	NA	NA	1.05	0.62 (0.31)	2.58*	0.63 (0.22)	0.95	-0.70 (1.42)
IDR	14.24*	0.19 (0.15)	0.29	-1.00 (3.09)	2.75**	-2.96 (2.05)	3.20*	0.26 (0.30)	0.53	2.20 (1.24)	0.29	-1.39 (8.37)	2.91**	-1.51 (13.69)
INR	9.84*	-0.75 (0.76)	NA	NA	8.32*	-2.14 (1.25)	16.53*	0.47 (1.49)	17.39*	-2.20 (0.76)	0.07	-0.05 (3.25)	2.08	0.09 (5.99)
JPY	6.34*	-0.29 (0.68)	0.00	0.51 (13.35)	1.31	-0.19 (4.64)	5.53*	-0.55 (1.11)	2.91*	-0.26 (4.07)	0.33	0.71 (0.54)	1.44	0.48 (0.33)
KRW	1.72	-0.03 (0.88)	NA	NA	NA	NA	7.22*	0.24 (1.60)	0.42	0.44 (1.78)	0.16	1.36 (1.61)	2.48**	-0.76 (1.73)
MYR	1.06	0.94 (0.40)	0.82	1.22 (0.35)	6.46*	-0.84 (0.66)	NA	NA	4.41*	1.18 (2.41)	0.94	-1.69 (1.96)	7.46*	1.40 (1.10)
NZD	5.01*	-0.31 (0.99)	0.21	0.27 (3.94)	4.36*	0.94 (1.60)	16.44*	-1.53 (0.84)	1.04	1.04 (6.00)	0.06	1.61 (3.33)	2.48**	-0.32 (3.26)
PHP	0.47	0.85 (0.66)	103.33*	0.15 (0.28)	0.36	0.47 (1.90)	3.85*	-1.44 (1.03)	20.20*	0.51 (1.27)	0.21	0.30 (2.41)	5.83*	0.36 (2.30)
SGD	3.79*	-0.52 (0.73)	7.13*	-4.53 (3.36)	2.70**	-1.42 (1.11)	12.15*	-1.29 (0.92)	1.55	-0.35 (3.18)	1.27	-0.07 (0.91)	4.26*	-0.10 (0.51)
THB	9.61*	0.30** (0.16)	18.59*	-0.56 (0.96)	1.31	2.00 (0.98)	8.76*	-1.12 (0.63)	26.55*	0.19 (0.26)	14.57*	0.16 (0.16)	13.31*	-1.56 (1.70)
TWD	1.85	0.60* (0.26)	7.85*	0.58 (4.28)	1.50	-1.18 (2.16)	0.14	0.89 (0.41)	2.08	0.16 (4.13)	0.14	1.11 (1.24)	5.01*	-1.89 (0.92)

The whole sample period results are in contrast with those studies which employed only advanced economies' currencies (e.g. Barnhart et al., 1999; Clarida, Davis & Pedersen, 2009). Those studies reported a negative beta coefficient for most, if not all, of the sample currencies. We show that the currency markets in Asia-Pacific are not homogeneous and the findings from advanced economies' currency might not be generalizable to developing countries' currency. Our results are in support of the findings from Frankel & Poonawala (2010) and Bansal & Dahlquist (2000) which claimed that the currencies from rich nations are more prone to have forward bias puzzle as compared to those developing or medium income nations' currency.

As we have apportioned the whole sample period into six subperiods, we are able to enrich the perspective of forward unbiasedness hypothesis with results under different economic conditions. There are two interesting observations from Table 4.1 under the subperiod columns. Firstly, there are fewer rejections of the forward unbiasedness hypothesis during the crisis periods [both Asian financial crisis (AFC) and global financial crisis (GFC)] than during the non-crisis periods (i.e. Pre-AFC, Post-AFC, Pre-GFC and Post-GFC). For example, there are only two currencies (i.e. CNY and THB) which reported rejection of the forward unbiasedness hypothesis during the GFC as compared to nine rejections under the Post-GFC period (i.e. all currencies except for CNY, INR and JPY). This finding implies that the forward rates predict the future spot exchange rate better during time of crisis. At the same time, this finding also implies that more currency markets are efficient during time of crisis and inefficient during non-crisis periods. Even though this finding is found to be counterintuitive as generally crisis periods should be represented by conditions of chaos and therefore inefficiency, we would like to suggest that crisis periods are time for markets to be corrected and hence less inefficiency. Clarida, Davis & Pedersen

(2009) have shown that the forward bias puzzle is an artefact of volatility regimes. In times of high volatility, the forward bias puzzle tends to disappear and forward unbiasedness hypothesis will hold true and vice versa. While our findings here are in agreement with Clarida, Davis & Pedersen (2009), our reasoning provides a different perspective to look at the phenomenon of the forward bias puzzle.

Secondly, the forward bias puzzle does not occur consistently in all of the currency markets with the exception of SGD. The SGD market has reported a negative beta coefficient for the whole and all the subperiods. Meanwhile, AUD and NZD displayed sign of forward bias puzzle only during the whole and post-AFC and post-GFC periods. In the pre-crisis and crisis periods (i.e. pre-AFC, pre-GFC, AFC and GFC periods), the beta estimates for AUD and NZD are all larger than zero and this implies that the direction of the spot exchange rates changes are at least in line with the forward premium. Meanwhile, currencies like IDR, INR and MYR reported the opposite results from those of AUD and NZD. These currencies consistently registered a negative beta coefficient for crisis periods and generally the right sign during non-crisis periods. We suspect that the forward bias puzzle is a prominent phenomenon during non-crisis period for rich countries' currencies while the same phenomenon is true for lower income countries' currencies during crisis period.

In order to verify our suspicion, we have grouped our sample currencies according to their characteristics. Firstly, we have grouped the sample currencies according to the nations' income level as indicated by the World Bank database as of 2009. We have two groups of currencies in our sample; high income (i.e. AUD, JPY, KRW, NZD, SGD and TWD) and medium income (CNY, IDR, INR, MYR, PHP and THB). The second characteristic used is the extent of foreign exchange liberalisation of the particular currency

market. We have employed the existence of non-deliverable forward (NDF) markets as the proxy for the extent of foreign exchange liberalisation; non-existence implies liberalised while existence implies otherwise. The NDF markets exist mainly out of the needs to cater for market participants who have no access to domestic foreign exchange or money markets. This accessibility issue is mainly due to the restriction imposed by local monetary authorities to combat unwanted and excessive speculation in domestic currencies. Hence those currencies with the existence of NDF markets are considered as less liberalized. Currencies with the existence of NDF markets are CNY, IDR, INR, KRW, MYR, PHP, THB and TWD.

Table 4.2: Pooled Samples

Acronyms for sample currencies are as follows: Australian dollar (AUD); Chinese yuan (CNY); Indonesian rupiah (IDR); Indian rupee (INR); Japanese yen (JPY); Korean won (KRW); Malaysian ringgit (MYR); New Zealand dollar (NZD); Philippines peso (PHP); Singaporean dollar (SGD); Thai baht (THB) and Taiwanese dollar (TWD). We have pooled our sample currencies into five groups based on two characteristics. Pooled All is the combination of all the sample currencies with some exceptions during whole period and the following subperiods: Pre-AFC, AFC and Post-AFC periods, due to data availability issue or long period of adoption of fixed exchange rate regime. The first characteristic is the country's income level as per World Bank database in 2009. We have two groups among our sample currencies: high-income and medium-income. The second characteristic we used is the extent of liberalization of the particular exchange rate market. Currencies without the existence of non-deliverable forward (NDF) market are considered liberalised and the opposite otherwise. From the pooled samples, we observed that most of the pooled high-income members are also members of pooled non-NDF (except for KRW and TWD). This is expected given rich nations usually adopt a more liberalised foreign exchange regime.

	Whole Period	Pre-AFC Subperiod	AFC Subperiod	Post-AFC Subperiod	Pre-GFC Subperiod	GFC Subperiod	Post-GFC Subperiod
Pooled Samples	Currencies	Currencies	Currencies	Currencies	Currencies	Currencies	Currencies
Pooled All	All except for MYR & CNY	All except for CNY, INR & KRW	All except for CNY & KRW	All except for CNY & MYR	ALL	ALL	ALL
Pooled High Income	AUD, JPY, KRW, NZD, SGD & TWD	AUD, JPY, NZD, SGD & TWD	AUD, JPY, NZD, SGD & TWD	AUD, JPY, KRW, NZD, SGD & TWD	AUD, JPY, KRW, NZD, SGD & TWD	AUD, JPY, KRW, NZD, SGD & TWD	AUD, JPY, KRW, NZD, SGD & TWD
Pooled Medium Income	IDR, INR, PHP & THB	IDR, MYR, PHP & THB	IDR, INR, MYR, PHP & THB	IDR, INR, PHP & THB	CNY, IDR, INR, MYR, PHP & THB	CNY, IDR, INR, MYR, PHP & THB	CNY, IDR, INR, MYR, PHP & THB
Pooled NDF	IDR, INR, KRW, PHP, THB & TWD	IDR, MYR, PHP, THB & TWD	IDR, INR, MYR, PHP, THB & TWD	IDR, INR, KRW, PHP, THB & TWD	CNY, IDR, INR, KRW, MYR, PHP, THB & TWD	CNY, IDR, INR, KRW, MYR, PHP, THB & TWD	CNY, IDR, INR, KRW, MYR, PHP, THB & TWD
Pooled Non-NDF	AUD, JPY, NZD, SGD	AUD, JPY, NZD, SGD	AUD, JPY, NZD, SGD	AUD, JPY, NZD, SGD	AUD, JPY, NZD, SGD	AUD, JPY, NZD, SGD	AUD, JPY, NZD, SGD

With this categorisation, we have pooled our sample currencies into four groups namely; i) high income, ii) medium income, iii) NDF and iv) non-NDF. We have also pooled all the eligible currency as the overall pool to function as a control group. We have excluded CNY and MYR from the pooling of the sample currencies in the whole and some subperiods due to the long time span of fixed exchange rate regime adopted by these two markets within the whole period. Table 4.2 in the previous page summarises the grouping of these pooled samples.

The Fama regression is estimated with the pooled samples using the two-stage least square method with a fixed/random effect. The Fama beta estimates and the Hausman test results are shown in Table 4.3 on the next page. Panel A of Table 4.3 shows the Fama beta estimates obtained from the pooled samples. The Fama beta is estimated with either cross-section fixed or random effect based on the results of the Hausman test shown under Panel B of the same table. The values reported under Panel B are the chi-square results accompanied by the p-values in brackets. A significant chi-square value denotes the rejection of the cross-section random effect model in favour of a cross-section fixed effect model. About half of the estimations are conducted with fixed effect and another half with random effect. Moving back to Panel A, we verify our suspicion of whether or not the forward bias puzzle is a characteristics-dependent feature in the foreign exchange markets by comparing the estimated Fama beta.

Firstly, we compare the sign of the estimated Fama betas from the pooled high income nations with those from the pooled medium income nations. We notice that the estimated beta from the two pooled samples usually show opposite sign. For example, in the whole period, the estimated beta from the pooled high income group is -0.1730 as compared to the estimated beta of 0.2252 from the pooled medium income.

Table 4.3: Pooled Fama Conventional Regression Beta Estimates

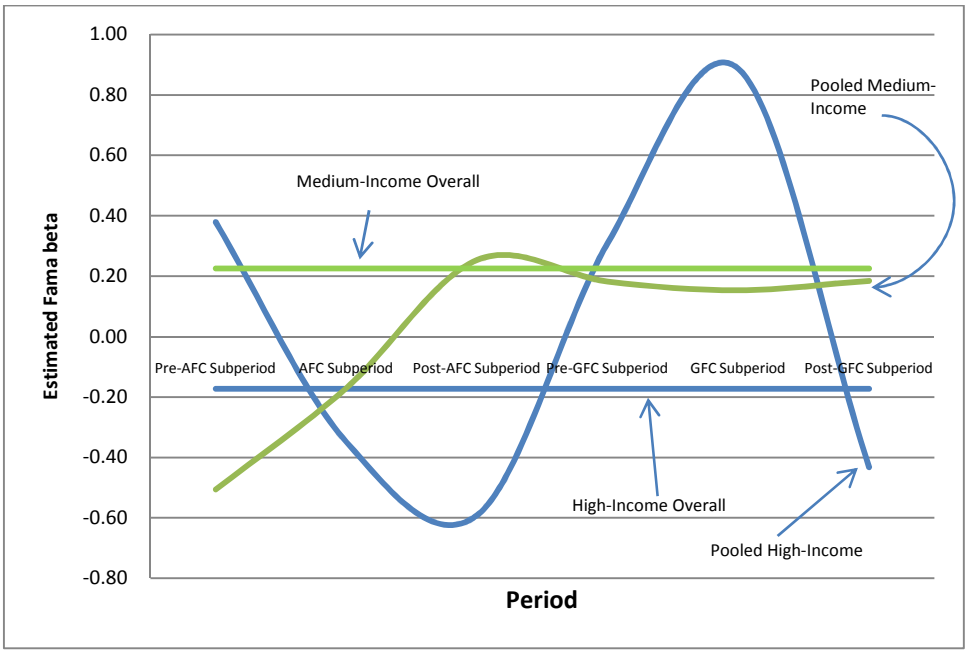
Panel A shows the beta estimates for the pooled samples from the conventional Fama regression. The numbers in parentheses are the corresponding standard error of estimates. Meanwhile Panel B shows the Hausman test results (chi-square value) which are used as guides to determine whether to estimate the pooled Fama regression with a cross-section fixed or random effect. The numbers in brackets under Panel B are p-value. * and ** denote significance at the 0.05 and 0.10 levels. Significant values under Panel B reject the cross-section random effect model in favour of a cross-section fixed effect model. The beta estimates from the pooled samples are more concentrated with relatively lower standard errors. For the whole period, both characteristics: income level (high income vs medium income) and extent of foreign exchange liberalisation (NDF vs non-NDF) show different sign for the Fama beta. As for the overall pooled sample, the sign of the beta estimates is not consistent and contains no particular pattern throughout the sample period. The Fama beta estimates from pooled high income and pooled medium income display opposite signs during non-crisis periods (except during Pre-GFC subperiod) and same sign during both AFC and GFC subperiods. For pooled NDF and pooled non-NDF, the signs of Fama beta are initially different but converge to same sign towards the later part of the subsample periods (from Pre-GFC onwards).

	Whole Period	Pre-AFC Subperiod	AFC Subperiod	Post-AFC Subperiod	Pre-GFC Subperiod	GFC Subperiod	Post-GFC Subperiod
Panel A: Beta Estimates	β Estimate	β Estimate	β Estimate	β Estimate	β Estimate	β Estimate	β Estimate
Pooled All	0.2126* (0.0174)	-0.2198 (0.2592)	-0.1789* (0.0506)	0.2373* (0.0147)	0.1842* (0.0249)	0.2239* (0.0556)	-0.1675 (0.1629)
Pooled High Income	-0.1730* (0.0689)	0.3792 (0.6063)	-0.3490 (0.2350)	-0.5914* (0.0908)	0.3099 (0.2295)	0.8868* (0.2235)	-0.4325** (0.2548)
Pooled Medium Income	0.2252* (0.0226)	-0.5061* (0.2372)	-0.1699* (0.0698)	0.2536* (0.0164)	0.1823* (0.0213)	0.1534* (0.0419)	0.1846 (0.2132)
Pooled NDF	0.2268* (0.0198)	-0.5113* (0.2117)	-0.1787* (0.0639)	0.2560* (0.0147)	0.1826* (0.0204)	0.1846* (0.0496)	-0.4106** (0.2100)
Pooled Non-NDF	-0.4494* (0.0922)	0.3782 (0.6787)	-0.2005 (0.2635)	-1.1151* (0.1264)	0.3167 (0.2948)	0.8092* (0.2667)	-0.2113 (0.3217)
Panel B: Hausman Tests (Chi-square)	Hausman (Chi-Sq)	Hausman (Chi-Sq)	Hausman (Chi-Sq)	Hausman (Chi-Sq)	Hausman (Chi-Sq)	Hausman (Chi-Sq)	Hausman (Chi-Sq)
Pooled All	1.3647 [0.2427]	0.0468 [0.8287]	15.3177* [0.0001]	0.1533 [0.6954]	18.7566* [0.0000]	0.6137 [0.4334]	2.0424 [0.1530]
Pooled High Income	1.5791 [0.2089]	3.5769** [0.0586]	6.1684* [0.0130]	0.7984 [0.3716]	5.3866* [0.0203]	0.0612 [0.8046]	0.5975 [0.4395]
Pooled Medium Income	0.4662 [0.4947]	0.0690 [0.7928]	2.2915 [0.1301]	0.0195 [0.8889]	8.2723* [0.0040]	0.8376 [0.3601]	0.1634 [0.6860]
Pooled NDF	0.1221 [0.7267]	0.1913 [0.6619]	4.6016* [0.0319]	0.0466 [0.8290]	11.8517* [0.0006]	0.0112 [0.9158]	2.7311** [0.0984]
Pooled Non-NDF	8.2335* [0.0041]	3.0938** [0.0786]	6.6139* [0.0101]	2.9996** [0.0833]	2.7128** [0.0995]	1.1208 [0.2898]	0.0201 [0.8871]

This scenario is true for most of the non-crisis periods (with the exception of Pre-GFC subperiod). However, the sign of the estimated Fama betas from both of the pooled samples display similar sign during crisis periods. The estimated beta for the pooled high income group during the AFC and GFC subperiods are -0.3490 and 0.8868 as compared to the estimated Fama betas of -0.1699 and 0.1846 from the pooled medium income group for the same subperiods. From these observations, we suggest that the existence of forward bias puzzle is dependent upon the nation's income level. The phenomenon exists differently between the high and medium income economies during the non-crisis periods. As for the crisis periods, we compare the results between the AFC and the GFC subperiods. The forward bias puzzle exists in all of the pooled samples during the AFC subperiod and disappears during the GFC subperiod. This implies that the forward rates failed to provide proper direction for the future spot exchange rates movement during the AFC but reverted to become reliable indicator for the future movements in spot exchange rates during the GFC. It shows that each crisis has different consequences on the existence of the forward bias puzzle. In addition, we have graphed out the estimated beta from the pooled high income and pooled medium income samples in order to provide a perspective for the comparisons of the estimated Fama beta between these two pooled samples. Figure 4.1 on the following page shows the evolution of the estimated Fama beta for these two pooled samples.

There are four (4) lines shown in the graph. The two (2) horizontal lines represent the estimated Fama beta for the whole period for the two (2) pooled samples. The estimated Fama beta for the pooled medium income sample is 0.2252, signifying the absence of forward bias puzzle in contrast with the estimated Fama beta of -0.1730 for pooled high income sample which denotes the presence of forward bias puzzle.

Figure 4.1: Evolution of Fama beta for High-Income and Medium-Income Markets



The figure above shows the evolution of the estimated Fama beta for pooled medium income and pooled high income samples. The two (2) horizontal lines are the estimated Fame beta for the whole period while the curvy lines show the estimated Fama beta under each subperiod for both the pooled medium income and pooled high income samples respectively.

Meanwhile the two (2) curvy lines indicate the evolution of the estimated Fama beta for pooled high income and pooled medium income samples respectively throughout the six (6) subperiods. We notice that the estimated Fama beta for both the pooled samples usually move in different directions throughout the period. We also observe that the changes in the estimated Fama beta are larger for pooled high income as compared to the pooled medium income. This could be due to the popularity of the rich nations' currencies in the global foreign exchange market. The reaction of this group of currencies to economic environment is more elastic as compared to the medium income nations' currencies. Overall, this graph supports our claim that the country's income level is an important characteristic in affecting the existence of the forward bias puzzle phenomenon.

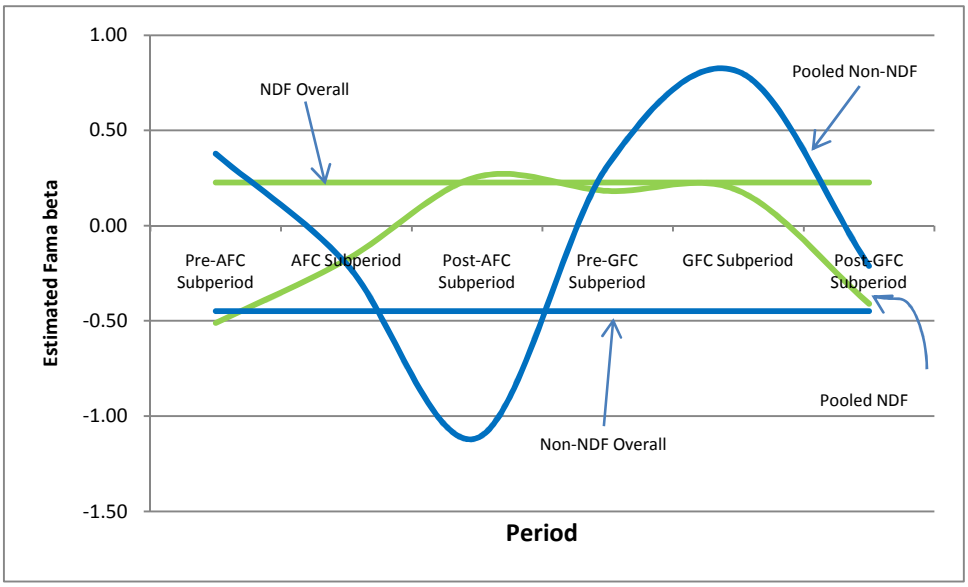
The second institutional characteristic employed is the extent of foreign exchange market liberalisation which is represented by the existence or non-existence of the non-

deliverable forward (NDF) markets. Before the Pre-GFC period, both of the pooled NDF and pooled non-NDF samples display different signs in terms of the estimated Fama beta (except for during the AFC period). From the Pre-GFC onwards, the estimated Fama beta for both of these pooled samples show similar signs. However, we could not identify any particular difference in the pattern of the existence of forward bias puzzle between these two pooled samples. This implies that the forward bias puzzle is not dependent on the extent of foreign exchange liberalization of a particular market even though this characteristic is very closely related to the country's income level – rich nations tend to have more liberalised foreign exchange markets and vice versa. Bansal & Dahlquist (2000) have suggested that the country's attributes like gross national product (GNP) and inflation are important in explaining the forward bias puzzle. Therefore our findings do not only provide further support to Bansal & Dahlquist (2000) but also enrich the literature by showing that the extent of foreign exchange liberalisation contains little explanatory power for the forward bias puzzle. Similar to the first characteristic of the nations' income level, we have also graphed the evolution of the estimated Fama beta for the pooled NDF and pooled non-NDF samples respectively under Figure 4.2 on the following page.

There is no surprise that Figure 4.2 resembles closely Figure 4.1 as there are overlapping constituents among the four pooled samples. The pooled non-NDF sample contains almost the same members of currencies as pooled high income sample while the pooled NDF sample almost the same as pooled medium income sample. Similarly, the two (2) horizontal lines are the estimated Fama beta for pooled non-NDF and pooled NDF samples for the whole period respectively. The pooled NDF sample shows an estimated Fama beta of 0.2268 while the pooled non-NDF sample reports an estimated Fama beta of -

0.4494. Again, these results indicate the absence of the forward bias puzzle in the pooled NDF sample and the presence in the pooled non-NDF sample.

Figure 4.2: Evolution of Fama beta for NDF and Non-NDF Marketss



The figure above shows the evolution of the estimated Fama beta for pooled NDF and pooled non-NDF samples. The two (2) horizontal lines are the estimated Fama beta for the whole period while the curvy lines show the estimated Fama beta under each subperiod for both the pooled NDF and pooled non-NDF samples respectively.

The curvy lines show the evolution of the estimated Fama beta for pooled NDF and pooled non-NDF samples respectively throughout the six (6) subperiods. In the earlier subperiods (from Pre-AFC to Post-AFC subperiods), the estimated Fama beta for both samples move in opposite direction but seems to converge in the same direction from the Pre-GFC subperiod onwards. Therefore we suggest that the extent of foreign exchange liberalisation is a weaker characteristic in explaining the existence of forward bias puzzle.

4.1.1.2 Johansen Cointegration

Besides the conventional Fama regression, we have also adopted another popular technique to test for foreign exchange markets efficiency: the Johansen cointegration test. Before we apply the Johansen cointegration test, we have to determine the stationarity property of the exchange rate series. Only non-stationary series integrated at the same order

are eligible for the cointegration test. We test for the stationarity property of the exchange rate series with three (3) commonly used unit root tests: augmented Dickey & Fuller (1979) (ADF), Phillips & Perron (1988) (PP) and Kwiatkwoski et al. (1992) (KPSS). Both the ADF and PP unit root tests have the null hypothesis of non-stationary while the KPSS' null hypothesis is stationary. Hence a rejection under the ADF and PP unit root tests indicate stationarity while rejection under KPSS denotes non-stationary. If there are conflicting results, we take the majority results as final. The results for the cointegration tests between spot and forward exchange rates are presented in Table 4.4 on the next page.

Both the spot and forward exchange rates must be non-stationary in order for the cointegration test to be conducted. A particular currency would not be tested for cointegration if either one of the series is stationary. Panel A of Table 4.4 shows the summary of the unit root tests results. The first and second lines of Panel A reveal the non-stationary currencies while the third line summed up the currencies to be excluded from the cointegration test. CNY is excluded in the Pre-AFC, AFC and Post-AFC subperiods due to the use of fixed exchange rate regime during these times and also for the GFC subperiod due to the stationary property of the spot and forward exchange rates series. MYR is excluded in the Pre-AFC subperiod due to the stationarity issue and for the Post-AFC because of the fixed peg adopted during this period. Similarly, IDR is excluded for the whole period but not any of the subperiods and THB is excluded for the whole period and Pre-GFC subperiod. Lastly, INR, PHP, NZD and KRW are all excluded in the Pre-GFC subperiod due to the stationarity issue.

Table 4.4: Unit Root Tests Results for Spot and Forward Exchange Rates

Unit root tests are conducted prior to the cointegration test. Exchange rate series which are tested as stationary are to be excluded from cointegration test. We have employed three (3) popular unit root tests, namely Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski et al. (KPSS) tests. The lag-length in the ADF test, meant to address the issue of serial correlation, is chosen based on the minimization of Akaike Information Criterion (AIC). Meanwhile the PP test is specifically devised to cater for mild serial correlation when testing for a unit root and therefore no lag is needed in this equation. The residual spectrum at frequency zero in the PP test is estimated through the Bartlett kernel approach. The critical values for the ADF and PP tests are as tabulated by MacKinnon, Haug & Michelis (1999). Similar to the PP test, the residual spectrum at frequency zero in the KPSS test is estimated through the Bartlett kernel approach. The Lagrange-Multiplier test statistic computed is compared against the critical values as tabulated by Kwiatkowski et al. (1992). The currencies shown in Panel A are stationary at the critical value of at least 0.10 level. If a currency is tested as stationary by two or more stationarity tests, it is excluded from the Johansen cointegration test. The currency in bold indicates exclusion. CNY and MYR are also excluded during certain subperiods due to the adoption of fixed peg regime. Panels B and C show the test statistics value derived from the respective unit root tests for spot and forward exchange rates. * and ** denote rejection at the 0.05 and 0.10 levels of significance. Rejection under ADF and PP tests indicate stationarity while rejection under KPSS points to the opposite.

Panel A: Results Summary	Whole Period			Pre-AFC Subperiod			AFC Subperiod			Post-AFC Subperiod			Pre-GFC Subperiod			GFC Subperiod			Post-GFC Subperiod		
Spot	IDR & THB			INR, MYR, NZD & PHP			-			-			-			CNY			-		
Forward	IDR & THB			MYR, NZD & THB			-			-			THB			CNY			-		
To be excluded	**IDR & THB**			**INR, MYR, PHP, NZD, *CNY & KRW***			**CNY**			**CNY & MYR**			**THB**			**CNY**			-		
	Whole Period			Pre-AFC Subperiod			AFC Subperiod			Post-AFC Subperiod			Pre-GFC Subperiod			GFC Subperiod			Post-GFC Subperiod		
Panel B: Log Spot Rates	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS
AUD	-2.35	-2.40	0.90*	-1.97	-1.92	0.22*	-2.11	-2.09	0.27*	-1.28	-1.32	1.17*	-2.75	-2.68	0.53*	-0.80	-0.95	0.60*	-1.47	-1.63	0.38*
CNY	-0.72	-0.76	0.82*	-	-	-	-	-	-	-	-	-	-1.14	-1.05	0.55*	-3.81*	-3.81*	0.58*	-1.40	-1.45	0.40*
IDR	-3.81*	-3.39**	0.55*	-1.88	-1.94	0.15*	-1.18	-0.84	0.48*	-2.67	-2.26	0.57*	-1.59	-1.83	0.48*	-1.70	-0.92	0.53*	-2.83	-3.02	0.14**
INR	-2.30	-2.19	0.94*	-4.11*	-4.06*	0.07	-1.17	-1.46	0.26*	-0.72	-0.70	1.23*	-1.97	-1.77	0.64*	-0.93	-0.92	0.67*	-1.98	-2.04	0.21*
JPY	-2.20	-2.27	0.64*	-1.55	-1.60	0.28*	-0.91	-0.83	0.41*	-1.89	-1.92	0.80*	-2.15	-2.17	0.26*	-2.73	-2.36	0.13**	-1.91	-2.13	0.27*
KRW	-3.11	-3.01	0.45*	-1.43	-1.17	0.28*	-1.98	-1.40	0.44*	-1.49	-1.34	0.86*	-2.17	-2.05	0.44*	-1.19	-1.19	0.63*	-2.10	-2.14	0.28*
MYR	-1.94	-1.69	0.61*	-4.33*	-3.82*	0.22*	-1.87	-1.96	0.39*	-	-	-	-2.50	-2.37	0.19*	-1.07	-1.13	0.60*	-3.15	-2.65	0.15*
NZD	-2.37	-2.41	0.77*	-3.45*	-3.00	0.08	-1.27	-1.86	0.35*	-1.64	-1.66	1.15*	-1.92	-1.86	0.54*	-0.80	-0.82	0.66	-2.75	-2.65	0.30*
PHP	-2.68	-2.48	1.56*	-3.57*	-4.44*	0.11	-1.53	-1.98	0.40*	-1.32	-1.29	1.00*	-1.48	-1.60	0.28*	-0.96	-1.10	0.65*	-2.43	-2.24	0.21*
SGD	-2.69	-2.61	1.53*	-1.50	-1.30	0.33*	-2.00	-2.08	0.31*	-2.31	-2.43	1.08*	-3.08	-2.39	0.14*	-1.28	-1.25	0.52*	-2.33	-2.22	0.31
THB	-3.68*	-3.38**	1.06*	-2.65	-3.13	0.25*	-3.02	-3.12	0.42*	-2.00	-1.87	1.03	-2.95	-4.00*	0.24*	-1.34	-1.64	0.72*	-1.23	-1.34	0.30*
TWD	-2.89	-2.44	0.75*	-2.88	-2.77	0.24*	-0.95	-0.93	0.47*	-1.11	-1.03	0.84*	-2.86	-2.57	0.13*	-1.27	-1.32	0.43*	0.21	0.20	0.44*

Table 4.4: Unit Root Tests Results for Spot and Forward Exchange Rates (continued...)

	Whole Period			Pre-AFC Subperiod			AFC Subperiod			Post-AFC Subperiod			Pre-GFC Subperiod			GFC Subperiod			Post-GFC Subperiod		
Panel C: Log Forward Rates	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS
AUD	-2.38	-2.39	0.90*	-1.61	-1.68	0.22*	-1.97	-2.07	0.27*	-1.31	-1.31	1.17*	-2.84	-2.78	0.53*	-0.74	-0.88	0.60*	-1.49	-1.63	0.38*
CNY	-0.99	-0.97	0.81*	-	-	-	-	-	-	-	-	-	-0.65	-0.58	0.69*	-4.18*	-3.91*	0.41*	-1.50	-1.60	0.38*
IDR	-3.89*	-3.42*	0.52*	-2.15	-2.15	0.13**	-0.61	-0.90	0.48*	-2.23	-2.18	0.59*	-1.82	-1.81	0.49*	-1.65	-0.90	0.54*	-3.48	-2.90	0.14**
INR	-3.07	-3.09	0.65*	-	-	-	-2.03	-1.99	0.24*	-0.86	-0.67	1.23*	-1.90	-1.68	0.65*	-1.00	-0.88	0.67*	-2.00	-2.07	0.21*
JPY	-2.15	-2.30	0.64*	-2.29	-1.57	0.28*	-0.53	-0.82	0.41*	-1.93	-1.91	0.80*	-2.15	-2.19	0.25*	-2.57	-2.39	0.13**	-1.87	-2.13	0.27*
KRW	-1.74	-1.82	1.03*	-	-	-	-	-	-	-1.93	-2.11	0.45*	-2.08	-1.99	0.44*	-1.15	-1.20	0.63*	-2.13	-2.17	0.28*
MYR	-2.03	-1.76	0.59*	-4.47*	-3.92*	0.24*	-1.83	-1.84	0.38*	-	-	-	-2.49	-2.39	0.18*	-1.04	-1.11	0.60*	-2.80	-2.70	0.16*
NZD	-2.38	-2.40	0.77*	-3.42**	-2.95	0.08	-1.92	-1.82	0.36*	-1.65	-1.66	1.15*	-1.95	-1.87	0.54*	-0.86	-0.83	0.66*	-2.54	-2.61	0.30*
PHP	-2.71	-2.50	1.55*	-1.97	-4.67*	0.23*	-1.70	-1.90	0.40*	-1.26	-1.28	0.99*	-1.39	-1.32	0.27*	-0.77	-0.92	0.66*	-2.09	-2.12	0.23*
SGD	-2.72	-2.64	1.52*	-1.50	-1.28	0.33*	-1.86	-2.19	0.32*	-2.35	-2.44	1.08	-3.16**	-2.48	0.14**	-1.23	-1.25	0.52*	-2.24	-2.18	0.31*
THB	-3.79*	-3.51*	1.05*	-4.57*	-4.76*	0.15*	-2.69	-2.70	0.42*	-2.00	0.67	1.03*	-3.11	-3.53*	0.24*	-1.16	-1.08	0.61*	-1.19	-1.28	0.30*
TWD	-3.00	-2.46	0.74*	-2.88	-2.77	0.24*	-0.92	-0.91	0.47*	-1.32	-1.07	0.85	-2.53	-2.56	0.14**	-1.27	-1.32	0.44*	0.12	-0.08	0.43*

After determining the stationarity property of the spot and forward exchange rates series, we proceed to test for cointegration for those currencies integrated of order one, or I(1). We have conducted a cointegration test between the spot and forward exchange rates for each eligible sample currency under the whole period as well the six (6) subperiods. Cointegration implies that there is a long run relationship which governs the movement between the spot and forward exchange rates and hence the subsequent movements are made predictable from one another. The forward exchange rates are unbiased predictor of future spot exchange rates if there is cointegration between these two series of exchange rates (Baillie & Bollerslev, 1989; Barkoulas, Baum & Chakraborty, 2003). Therefore we suggest that the foreign exchange markets are efficient *within-country* if the spot and forward exchange rates are cointegrated. Since there are only two series in the cointegration test between the spot and forward exchange rates, the series are cointegrated if, and only if, there is one cointegrating vector. As explained in the previous chapter, the existence of two (2) cointegrating vectors in this relationship is known as trivial cointegration and we deem trivial cointegration as equivalent to no cointegration. We present the results from the Johansen cointegration test between the spot and forward exchange rates in Table 4.5 on the following page.

The table shows the number of cointegrating vector from the cointegration test between the spot and forward exchange rates at the significant level of at least 10% [based on the critical values computed by MacKinnon, Haug & Michelis (1999)]. The foreign exchange markets are efficient if, and only if, there is one cointegrating vector between the spot and forward exchange rates. We observe that the foreign exchange markets in Asia-Pacific are generally efficient *within-country* as evidenced by the cointegration between the spot and forward exchange rates. These results are in common agreement with those studies

reported in the literature (e.g. Baillie & Bollerslev, 1989; Jeon & Seo, 2003; Kan & Andreosso-O'Callaghan, 2007). For the whole period, there are three (3) currency markets which show sign of inefficiency: CNY, PHP and SGD, in which the spot and forward exchange rates are not cointegrated (or cointegrated trivially). In fact, for CNY, there is no sign of cointegration at all between the spot and forward exchange rates for all the subperiods. Meanwhile, the spot and forward exchange rates for PHP and SGD are cointegrated for all the subperiods with the exception of Pre-AFC subperiod.

Table 4.5: Johansen Cointegration between Spot and Forward Exchange Rates

We conducted the Johansen (1989, 1991) cointegration test between the spot and forward exchange rate series for each country. The test statistics for this cointegration exercise are trace statistics (λ-trace) and maximum eigenvalue (λ-max) with the critical values tabulated by MacKinnon, Haug & Michelis (1999). A cointegration between spot and forward exchange rates implies market efficiency in which the forward rates are unbiased predictor of future spot exchange rates. As we have only two variables for each currency market, the market is efficient only and only if there is one cointegrating vector. This table shows the number of cointegrating vector at the critical value of at least 0.05 level. NA indicates not applicable either due to the stationarity property of the spot or forward exchange rate series or both or data availability issue. As indicated by the existence of cointegration between the spot and forward exchange rates for most currencies, we suggest that the foreign exchange markets in Asia-Pacific are generally efficient within-country.

	Whole Period		Pre-AFC Subperiod		AFC Subperiod		Post-AFC Subperiod		Pre-GFC Subperiod		GFC Subperiod		Post-GFC Subperiod	
	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max
AUD	1	1	0	0	1	1	1	1	1	1	1	1	1	1
CNY	0	0	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
IDR	NA	NA	0	0	1	1	0	0	1	1	1	1	1	1
INR	1	1	NA	NA	1	0	1	1	1	1	1	1	1	1
JPY	1	1	1	1	1	1	1	1	1	1	1	1	1	1
KRW	1	1	NA	NA	NA	NA	1	1	1	1	1	1	1	1
MYR	1	1	NA	NA	1	1	NA	NA	1	1	0	0	1	1
NZD	1	1	NA	NA	1	1	1	1	1	1	1	1	1	1
PHP	2	2	NA	NA	1	1	1	1	1	1	1	1	1	1
SGD	2	2	0	0	1	1	1	1	1	1	1	1	1	1
THB	NA	NA	1	1	1	1	1	1	NA	NA	1	1	1	1
TWD	1	1	1	1	0	1	1	1	1	1	1	1	1	1

Next, in Table 4.5 we look at both of the crisis periods contained within the whole sample period. Both the AFC and GFC have little impact on the *within-country* market efficiency for our sample currencies. Only INR and TWD show some unconvincing sign of inefficiency during the AFC subperiod while for the GFC subperiod, only the MYR report failure of *within-country* market efficiency. Moving out from the crisis periods, we observe

that all of the foreign exchange markets, except for CNY during the Post-AFC and IDR during the Post-GFC subperiods, report markets efficiency during both the post-crisis subperiods. These results disagree with Jeon & Seo's (2003) claim regarding the immediate recovery of *within-country* efficiency in Asia-Pacific after the AFC period. Our post-crisis results show that the number of markets which displayed signs of inefficiency is not different from those shown during crisis periods. Besides, our results also show that the Pre-AFC subperiod contains more inefficient markets as compared to the AFC subperiod. This finding contrasts with another claim made by Jeon & Seo (2003) d that the Asia-Pacific foreign exchange market *within-country* efficiency became weaker immediately after the AFC as compared to Pre-AFC period. Moreover, there is also no difference in the number of inefficient markets between the Pre-GFC and GFC subperiods. Therefore we would like to suggest that the *within-country* market efficiency is not made any weaker by the crises. Our claims are reasonably stronger as we have the opportunity to study not only the AFC but also the GFC period. Generally, our results show that the *within-country* efficiency for Asia-Pacific foreign exchange market is resilient to disturbances in the financial markets. There is no unusual breakdown in the state of *within-country* efficiency during the crises as tested with the Johansen cointegration technique. All the pre-crisis, crisis and post-crisis subperiods display almost similar results in terms of market efficiency.

4.1.1.3 Reconciliation of Conflicting Results

By comparing the results from the Fama regression with those obtained from the Johansen cointegration technique, we notice that both sets provide conflicting views with regards to *within-country* market efficiency. The Fama regression results indicate a widespread rejection of the forward unbiasedness hypothesis while the Johansen cointegration results point to the validity of the forward rates as unbiased predictors of

future spot exchange rates. In fact, these findings are not entirely a breakthrough as most studies in the literature reported similar findings. However, as far as we are concerned, there is no serious effort made in reconciling the overall conflicting results from these two popular techniques. Most research papers which worked on this area of interest usually adopt either one of the techniques and seldom both.

We have attempted to make a reconciliation of the overall conflicting results through the adoption of an alternative technique as suggested by Pilbeam & Olmo (2011). Pilbeam & Olmo (2011) have discussed the econometric biases based on Fama regression and proved that there is in fact a negative bias in the estimated beta. They have suggested two similar but not identical alternative models to test for the forward unbiasedness hypothesis. The most notable changes made to the Fama regression in the Pilbeam & Olmo (2011) models are the use of exchange rate levels instead of log and the replacement of changes in the spot exchange rates with ratio of spot to lagged forward exchange rates as the regressand. We have conducted the regression of both models with the generalized method of moment (GMM) technique due to the overlapping nature of our daily data. Tables 4.6 and 4.7 in the following pages show the results from the Pilbeam-Olmo models.

Table 4.6 on the next page reports the estimated α (and the corresponding standard error of estimate in parentheses) using the Pilbeam-Olmo's Model 1 (Equation 3.3) which employed the assumption of risk neutrality. The market is efficient if the estimated α is not significantly different from zero. For the whole period, all the foreign exchange markets in our sample, except for MYR, display evidence in support of market efficiency. From the six (6) subperiods, the evidence against market efficiency, again, is very sparse. The markets are generally efficient *within-country*. However, we would like to point out that the inefficient markets as indicated from the Pilbeam-Olmo's models are not exactly the same

as those inefficient markets as reported under the Johansen cointegration test results. We would like to reemphasise our main purpose of introducing the Pilbeam-Olmo models which is to provide an overall reconciliation for the conflicting results obtained from both the conventional Fama regression and the Johansen cointegration test. We have succeeded in showing the foreign exchange markets in Asia-Pacific are generally efficient *within-country* as shown by both the results from the regression and cointegration techniques.

Table 4.6: Pilbeam & Olmo (2011) Regression Model 1

Pilbeam & Olmo (2011) have suggested a modified-form of regression from Fama's (1984) regressions. We have adopted the Pilbeam & Olmo (2011) models to test for the forward unbiasedness hypothesis. Results from Model 1 and Model 2 are presented in Table 4.6 and Table 4.7 respectively. Model 1 of Pilbeam & Olmo (2011) assumes the absence of risk premium. The ratio of spot to lagged forward exchange rates is regressed on a constant. We infer that the market is efficient if the estimated constant is insignificantly different from zero. * and ** indicate significance at the 0.05 and 0.10 level respectively. The table below shows the estimate of α of equation 3.3 and the figures in parentheses are the standard error of estimates. 'NA' indicates 'not available' either due to data availability issue or the adoption of fixed exchange rate regime during the particular period. The results show, generally, that the markets are efficient within-country and thus consistent with the findings from Johansen cointegration test results. Post-GFC period reports perfect efficiency for all the currency markets in Asia-Pacific. Meanwhile, the highest number of inefficiency is reported is during the Pre-GFC subperiod with only two currency markets (i.e. PHP and THB) which portrayed sign of inefficiency.

	Whole Period	Pre-AFC Subperiod	AFC Subperiod	Post-AFC Subperiod	Pre-GFC Subperiod	GFC Subperiod	Post-GFC Subperiod
Equation 3.3 - α estimates							
AUD	-0.0023 (0.0044)	0.0066 (0.0108)	0.0124 (0.0097)	-0.0037 (0.0054)	-0.0055 (0.0090)	-0.0022 (0.0174)	-0.0112 (0.0212)
CNY	0.0039 (0.0041)	NA	NA	NA	0.0010 (0.0008)	-0.0023** (0.0012)	-0.0021 (0.0028)
IDR	0.0086 (0.0158)	0.0000 (0.0034)	0.0760 (0.1286)	0.0041 (0.0151)	-0.0016 (0.0059)	-0.0047 (0.0244)	-0.0091 (0.0060)
INR	-0.0024 (0.0026)	NA	0.0085 (0.0121)	-0.0029** (0.0017)	-0.0075 (0.0063)	0.0020 (0.0100)	-0.0074 (0.0100)
JPY	0.0013 (0.0037)	-0.0001 (0.0407)	0.0067 (0.0184)	0.0026 (0.0045)	0.0047 (0.0071)	-0.0074 (0.0100)	-0.0063 (0.0073)
KRW	-0.0017 (0.0055)	NA	NA	-0.0089 (0.0059)	-0.0028 (0.0038)	0.0119 (0.0187)	-0.0020 (0.0135)
MYR	0.0039** (0.0023)	0.0007 (0.0027)	0.0031 (0.0764)	NA	-0.0031 (0.0032)	0.0006 (0.0067)	-0.0091 (0.0066)
NZD	-0.0020 (0.0044)	0.0031 (0.0051)	0.0144** (0.0081)	-0.0050 (0.0057)	-0.0057 (0.0116)	0.0012 (0.0171)	-0.0060 (0.0137)
PHP	-0.0010 (0.0034)	-0.0028* (0.0003)	0.0156 (0.0259)	0.0000 (0.0027)	-0.0124* (0.0040)	0.0006 (0.0075)	-0.0078 (0.0071)
SGD	0.0006 (0.0021)	0.0044 (0.0048)	0.0077 (0.0105)	0.0017 (0.0025)	-0.0036 (0.0031)	-0.0008 (0.0070)	-0.0058 (0.0053)
THB	-0.0059 (0.0052)	-0.0152 (0.0102)	0.0095 (0.0361)	0.0012 (0.0036)	-0.0309* (0.0088)	-0.0073 (0.0104)	-0.0088 (0.0080)
TWD	0.0011 (0.0024)	0.0027* (0.0013)	0.0072 (0.0171)	-0.0008 (0.0022)	0.0032 (0.0040)	0.0024 (0.0058)	-0.0039 (0.0074)

Moving on to Table 4.7 on the following page, we report the regression results from Pilbeam-Olmo's Model 2 which caters for the existence of risk premium. The markets are

efficient if α and ρ are jointly insignificant. This condition is tested using the Wald test. Panel A shows the results from the Wald test while Panels B and C report the estimated coefficients for α and ρ respectively.

Table 4.7: Pilbeam & Olmo (2011) Regression Model 2

Pilbeam & Olmo (2011) have suggested a modified-form of regression from Fama's (1984) regressions. We have adopted the Pilbeam & Olmo (2011) models to test for the forward unbiasedness hypothesis. Results from Model 1 and Model 2 are presented in Table 4.6 and Table 4.7 respectively. Model 2 of Pilbeam and Olmo (2011) assumes the presence of risk premium. We infer that the market is efficient if the estimated coefficients are jointly insignificantly different from zero. * and ** indicate significance at the 0.05 and 0.10 level respectively. Panel A shows the Wald statistics results for (α = ρ = 0) while Panels B and C report the values of the estimated coefficients. 'NA' indicates 'not available' either due to data availability issue or the adoption of fixed exchange rate regime during the particular period. The numbers in parentheses under Panels B and C are the standard error of estimates. The results, similar to Model 1, show that the markets are generally efficient within-country and thus consistent with the findings from Johansen cointegration test results. From Panel A, we observed more disturbances to within-country markets efficiency in the region during the AFC period than the GFC. This empirical evidence implies that AFC is a more destabilising event than the GFC.

	Whole Period	Pre-AFC Subperiod	AFC Subperiod	Post-AFC Subperiod	Pre-GFC Subperiod	GFC Subperiod	Post-GFC Subperiod
Panel A: Equation 3.4 - Wald F-test value for (α = ρ = 0) ; *bold indicates inefficiency with the existence of risk premium*							
AUD	0.33	0.94	2.77**	0.24	0.36	0.31	0.39
CNY	0.62	NA	NA	NA	2.12	4.90*	0.37
IDR	0.69	0.91	0.68	0.27	0.71	0.11	4.61*
INR	2.07	NA	1.02	3.93*	0.79	0.85	1.05
JPY	0.15	0.05	1.09	1.48	1.54	1.51	0.95
KRW	0.54	NA	NA	1.56	0.82	1.91	1.10
MYR	1.45	0.26	1.50	NA	0.59	0.32	1.34
NZD	0.32	18.80*	4.03*	0.43	0.44	0.44	0.80
PHP	2.73**	393.59*	3.22*	1.21	6.17*	0.67	2.05
SGD	0.11	5.28*	3.67*	1.55	0.68	0.34	0.99
THB	0.67	1.51	3.86*	1.53	28.71*	0.52	0.82
TWD	1.21	3.41*	0.52	0.87	2.21	0.66	0.40
Panel B: Equation 3.4 - α estimates							
AUD	-0.01 (0.03)	-1.23 (2.08)	-0.12 (0.14)	-0.01 (0.04)	-0.08 (0.19)	-0.10 (0.14)	-0.27 (0.63)
CNY	0.07 (0.07)	NA	NA	NA	0.06** (0.03)	-0.14* (0.06)	0.00 (0.41)
IDR	-0.03 (0.03)	-0.30 (0.28)	-0.04 (0.17)	-0.08 (0.24)	-0.19 (0.17)	-0.18 (0.38)	-0.46** (0.26)
INR	-0.08 (0.06)	NA	-0.31 (0.22)	-0.04 (0.03)	0.01 (0.13)	-0.12 (0.09)	-0.72 (0.57)
JPY	-0.01 (0.04)	-0.89 (3.43)	-0.24 (0.32)	-0.09 (0.07)	-0.39 (0.26)	-0.17 (0.17)	-0.13 (0.15)
KRW	-0.06 (0.06)	NA	NA	-0.08 (0.08)	-0.13 (0.10)	-0.12 (0.15)	-0.67 (0.47)
MYR	-0.06* (0.02)	-0.61 (0.88)	-0.33 (0.33)	NA	-0.02 (0.08)	-0.12 (0.15)	-0.22 (0.17)
NZD	-0.02 (0.02)	-1.19* (0.59)	-0.10 (0.07)	0.00 (0.03)	-0.12 (0.27)	-0.09 (0.16)	-0.43 (0.55)
PHP	-0.04** (0.02)	-0.69* (0.15)	-0.20 (0.12)	-0.03 (0.02)	0.03 (0.06)	-0.11 (0.10)	-0.32 (0.30)
SGD	-0.01 (0.02)	-0.62* (0.29)	-0.27** (0.16)	-0.11 (0.08)	-0.03 (0.08)	-0.18 (0.21)	-0.07 (0.21)
THB	-0.02 (0.07)	-1.52 (3.59)	-0.31 (0.28)	-0.08 (0.05)	0.28* (0.06)	-0.12 (0.25)	-0.04 (0.28)
TWD	-0.08 (0.05)	0.05 (0.54)	-0.18 (0.19)	-0.06 (0.04)	-0.46 (0.39)	-0.15 (0.17)	0.06 (0.73)

Table 4.7: Pilbeam & Olmo (2011) Regression Model 2 (continued...)

Panel C: Equation 3.4 - ρ estimates							
AUD	0.02 (0.04)	1.59 (2.67)	0.20 (0.20)	0.02 (0.07)	0.10 (0.25)	0.12 (0.18)	0.29 (0.70)
CNY	-0.48 (0.50)	NA	NA	NA	-0.39** (0.21)	0.98* (0.39)	-0.02 (2.77)
IDR	326 (279)	722 (662)	634 (629)	746 (2,012)	1,799 (1,611)	1,761 (3,714)	4119** (2,375)
INR	3.58 (2.63)	NA	12.93 (9.18)	1.70 (1.24)	-0.98 (5.59)	5.51 (4.23)	32.81 (26.08)
JPY	1.23 (4.03)	107.88 418.43	31.24 (38.25)	10.76 (7.32)	45.28 (30.26)	16.55 (17.31)	11.06 (13.31)
KRW	61.25 (66.58)	NA	NA	86.24 (86.01)	123.72 (99.26)	148.26 (156.78)	773.51 (545.84)
MYR	0.22* (0.07)	1.52 (2.20)	1.19 (1.05)	NA	0.06 (0.30)	0.40 (0.50)	0.70 (0.55)
NZD	0.03 (0.04)	1.71* (0.85)	0.20** (0.12)	0.00 (0.06)	0.17 (0.40)	0.13 (0.22)	0.59 (0.78)
PHP	1.84** (1.04)	18.27* (3.96)	7.99** (4.24)	1.25 (0.81)	-2.13 (3.09)	5.17 (4.58)	14.18 (13.57)
SGD	0.01 (0.04)	0.89* (0.41)	0.44** (0.25)	0.20 (0.14)	0.04 (0.13)	0.25 (0.31)	0.08 (0.29)
THB	0.66 (2.56)	39.14 (93.29)	12.24 (10.15)	3.39** (2.05)	-11.48* (2.36)	3.78 (8.51)	1.06 (9.19)
TWD	2.72 (1.75)	-1.34 (14.82)	5.86 (6.12)	1.85 (1.47)	15.18 (12.77)	4.85 (5.49)	-1.95 (23.21)

The Wald test results for the whole period are almost similar to Pilbeam-Olmo's Model 1 in which all the foreign exchange markets in our sample, except for PHP, fail to reject the efficient markets hypothesis (EMH). An interesting observation emerges from the results for the subperiods. We notice that the AFC subperiod reports the highest number of rejection (i.e. five) of markets efficiency among all the subperiods. As compared to the GFC, which records only a single rejection of market efficiency, AFC seems to be the more disturbing event between the two crises.

After reconciling the conflicting results between Fama regression and Johansen cointegration test, we have reached a conclusion that the foreign exchange markets in Asia-Pacific are generally efficient *within-country*. In the next section, we have done some robustness tests on the findings of the *within-country* efficiency condition.

4.1.1.4 Robustness Tests for *Within-country* Efficiency

In this section, we have regrouped our samples according to only crisis and non-crisis periods. Instead of breaking up the whole period into six subsample periods, we have categorised our sample of currencies into AFC, GFC and non-crisis observations. The non-crisis observations are made up of data during the Pre- and Post- AFC and GFC respectively. As elaborated in the previous chapter, we have used three (3) dummy variables to segregate the observations into AFC, GFC and non-crisis observations. Dummy 1 (D_1) is equal one (1) during the non-crisis period and zero otherwise. Meanwhile, Dummy 2 (D_2) and Dummy 3 (D_3) are equal to one (1) during the AFC and GFC periods respectively and zero during the non-crisis period. From this segregation, the estimated beta related to D_1 represents the non-crisis period while the beta related to D_2 and D_3 characterise the AFC and GFC period respectively. We estimated equation 4.2 as follows:

$$\Delta s_{t+1,i} = \beta_{i,1} D_1 fp_{t,i} + \beta_{i,2} D_2 fp_{t,i} + \beta_{i,3} D_3 fp_{t,i} + \varepsilon_{t+1,i} \quad (4.2)$$

$$D_1 = \begin{cases} 1, non-crisis\ period \\ 0, \quad otherwise \end{cases}$$

$$D_2 = \begin{cases} 1, AFC\ period \\ 0, \ otherwise \end{cases}$$

$$D_2 = \begin{cases} 1, GFC\ period \\ 0, \ otherwise \end{cases}$$

The above equation is estimated with the generalised method of moments (GMM) technique to be consistent with the conventional Fama regression we conducted earlier. With this regrouping, we are able to test whether there is any significant difference in the estimated Fama beta for crisis and non-crisis periods as well as between both AFC and GFC subperiods. We have utilised the Wald-test to investigate the equality of the estimated

Fama beta. Table 4.8 on the following page showcases the results for the estimated Fama beta and the corresponding Wald test.

The emphasis of our robustness test is mainly on the existence of the forward bias puzzle which refers to the estimated negative Fama beta from the standard regression. Therefore we compare and contrast the estimated Fama beta from Table 4.8 with the results from Table 4.1 (Page 154). Overall, the robustness results support the analyses provided by the original regression results discussed in the earlier sections. The sign of the Fama beta for non-crisis period are almost the same as the estimated Fama beta for the whole period with the exception of THB. The estimated β_1 for THB is -0.05 as per equation 4.2 compared to the Fama beta of 0.30 estimated from the whole period. This implies inconclusive evidence for the existence of the forward bias puzzle in the THB market during the non-crisis period. As for the other foreign exchange markets in Asia-Pacific, the existence of the forward bias puzzle during the non-crisis period is quite conclusive as supported by the results from the robustness test – it exists in the AUD, INR, JPY, KRW, NZD and SGD markets and is absent from the other markets. These countries are relatively richer (except for India) as compared to the other countries in the region.

Moving on to the AFC period, the sign of the estimated β_2 for all the foreign exchange markets in Table 4.8 are almost similar to the estimated Fama beta during the AFC subperiod as per Table 4.1. The exceptions are INR and TWD foreign exchange markets – the estimated β_2 for both currency markets are larger than zero in Table 4.8 as compared to a negative value in Table 4.1. This implies the forward bias puzzle reported in the earlier section for these two markets is not supported in this robustness test. However, the majority of the inferences are robust to this regrouping of samples. During the AFC

subperiod, the forward bias puzzle is only restricted to IDR, JPY, MYR and SGD foreign exchange markets which represent a marked reduction from the non-crisis period.

Table 4.8: Results of Robustness Test on Fama Regression

The conventional Fama regression is tested for robustness with a respecified model of equation (4.2): $\Delta s_{t+1,i} = \beta_{i,1} D_1 fp_{t,i} + \beta_{i,2} D_2 fp_{t,i} + \beta_{i,3} D_3 fp_{t,i} + \varepsilon_{t+1,i}$. D_1, D_2 and D_3 are dummy variables which take the value of '1' for non-crisis, Asian financial crisis (AFC) and global financial crisis (GFC) periods and zero otherwise. The regression equation is estimated with the generalised method of moment (GMM) and the standard error of estimates is heteroscedasticity and autocorrelation consistent (HAC). The theoretical value, according to the uncovered interest rate parity, of the beta estimate is '1'. We report the results of the beta estimates (i.e. β_1, β_2 and β_3) in the first three (3) columns and the standard error of estimates are in parentheses. The last four (4) columns show the Wald test results on the equality of the beta estimates. * and ** indicate significance at the 5% and 10% levels of confidence. The results reported below are comparable to the results reported under Table 4.1 (Page 154). The results from the main analysis under Table 4.1 are rather robust with strong agreement from the results below. The equality test of the beta estimates provides further insight to the effect of crisis to the foreign exchange market efficiency or to be more specific, the forward unbiasedness hypothesis. We find that the value of the estimated Fama beta is not exactly unique and they are not overwhelmingly different under different period. Therefore we do not discuss the value of the estimated beta in depth but rather emphasise on the sign of the estimated beta to signify the existence of the forward bias puzzle.

	Fama Regression (Beta Estimate)			Wald Test (F-test value)			
	Noncrisis, β_1	AFC, β_2	GFC, β_3	$\beta_1=\beta_2=\beta_3$	$\beta_1=\beta_2$	$\beta1=\beta_3$	$\beta_2=\beta_3$
AUD	-1.36*	0.71	-0.09	2.84**	5.25*	1.34	0.41
	(0.45)	(0.79)	(0.98)				
CNY	0.78*	NA	0.7540*	NA	NA	0.01	NA
	(0.19)	NA	(0.22)				
IDR	0.28	-0.17	-0.27	0.20	0.33	0.07	0.00
	(0.29)	(0.74)	(2.06)				
INR	-0.48	0.20	0.69	1.86	2.57	2.37	0.43
	(0.33)	(0.27)	(0.68)				
JPY	-0.09	-0.31	1.09*	3.13*	0.05	5.71*	2.09
	(0.77)	(0.73)	(0.00)				
KRW	-0.71	NA	1.18	NA	NA	1.12	NA
	(0.45)	NA	(1.73)				
MYR	0.87	-0.07	-1.96	1.12	0.78	1.99	0.90
	(0.76)	(0.72)	(1.86)				
NZD	-1.28*	3.03*	1.23	11.80*	21.48*	4.82*	1.77
	(0.40)	(0.83)	(1.05)				
PHP	0.12	1.28*	0.77**	2.49**	4.11*	1.68	0.56
	(0.23)	(0.51)	(0.44)				
SGD	-0.15	-0.79	0.08	0.20	0.25	0.10	0.39
	(0.33)	(1.24)	(0.63)				
THB	-0.05	1.84*	0.19	5.54*	10.85*	0.57	9.20*
	(0.27)	(0.51)	(0.16)				
TWD	0.57**	0.18	0.77	0.28	0.37	0.10	0.53
	(0.29)	(0.58)	(0.58)				

Similarly, the existence of the forward bias puzzle in the GFC subperiod is also lesser as compared to the non-crisis period – only two (2) foreign exchange markets, namely the IDR and MYR markets, report a negative β_3. The negative β_3 for AUD reported in Table 4.8 is not the same as the Fama beta reported in the GFC subperiod in Table 4.1

and hence the inference about the forward bias puzzle for AUD during this subperiod is not exactly robust or conclusive. Nevertheless, our suggestion that the forward bias puzzle is more prominent during the non-crisis period as compared to the crisis period is basically robust to the respecification of the regression model. The crises in our whole sample period, namely the AFC and GFC, can be viewed as correction to the market inefficiency as represented by the existence of a lesser forward bias puzzle reported during both crisis periods.

We have also tested the equality of the estimated Fama beta among the non-crisis (β_1), AFC (β_2) and GFC (β_3) subperiods using the Wald test. From an overview, the estimated Fama betas for the foreign exchange markets in Asia-Pacific are not consistent throughout the whole sample period. The sign of the estimated Fama beta changes from positive to negative and vice versa repeatedly. However, this overview cannot confirm whether the estimated values are significantly different from each other. Therefore we have explicitly tested the equality hypothesis with Wald test. The results show that less than half of the foreign exchange markets in our sample report significant differences in the estimated beta. Those foreign exchange markets are AUD, JPY, NZD, PHP and THB. For the AUD and PHP foreign exchange markets, the source of difference is between the estimated beta for non-crisis (β_1) and AFC (β_2).

Refer to Table 4.8, there is no significant difference between the estimated beta for non-crisis (β_1) and GFC (β_3) and between the AFC (β_2) and GFC (β_3). As for the JPY market, the source of difference is between the estimated beta for non-crisis (β_1) and GFC (β_3). The NZD and THB markets contain two sources of difference in the estimated beta. For NZD, the estimated Fama beta for non-crisis (β_1)) is significantly different from both the crises' beta (β_2 and β_3) while for THB, the estimated Fama beta for AFC (β_1) is

significantly different from both the non-crisis and GFC's beta estimates (β_1 and β_3). The other currency markets show no significant difference in the estimated beta even though the sign of the beta estimate could be different. These results suggest that the values of the estimated beta are not exactly unique and hence we must interpret the estimated value with caution. As a result, we do not discuss the value of the estimated beta but focus rather on the estimated sign. To a large extent, the estimated Fama beta for the whole period is representative of the particular currency market as the Fama beta are generally not significantly different among the three (3) clusters (i.e. non-crisis, AFC and GFC).

Table 4.9: Results of Robustness Test on Pooled Fama Regression

We test the robustness of the results related to the selected institutional characteristics (i.e. income level and the extent of foreign exchange market liberalisation) which we have obtained from the pooled Fama regression. Similar to the individual regression, the β_1, β_2 and β_3 represent the non-crisis, Asian financial crisis (AFC) and global financial crisis (GFC) period. The theoretical value, according to the uncovered interest rate parity, of the beta estimate is '1'. We report the results of the beta estimates and the corresponding standard error of estimates (parentheses) in the first three (3) columns. The last four (4) columns show the Wald test results on the equality of the beta estimates. * and ** indicate significance at the 5% and 10% levels of confidence respectively. The results reported below are comparable to the results reported under Table 4.3 (Page 159), Panel A. The results from the main analysis under Table 4.3 are generally supported by the results below. The equality test of the beta estimates provides further insight to the effect of crisis to the foreign exchange market efficiency or to be more specific, the forward unbiasedness hypothesis. We find that the GFC is not as distinctive as the AFC when compared against the non-crisis period. Therefore this finding supported our claim that the AFC is the more impactful event between the two crises in terms of effect to the foreign exchange market efficiency.

	Pooled Fama Regression (Beta Estimate)			Wald Test (F-test value)			
	Noncrisis, β_1	AFC, β_2	GFC, β_3	$\beta_1=\beta_2=\beta_3$	$\beta_1=\beta_2$	$\beta_1=\beta_3$	$\beta_2=\beta_3$
Pooled ex-CNY&MYR	0.16* (0.02)	0.54* (0.05)	0.24* (0.05)	27.26*	54.39*	1.84	17.35*
Pooled Hi Inc	-0.68* (0.09)	-0.03 (0.18)	0.80* (0.13)	47.96*	11.80*	94.05*	14.35*
Pooled Med Inc	0.18* (0.02)	0.55* (0.06)	0.17* (0.07)	16.26*	31.60*	0.03	16.74*
Pooled NDF	0.18* (0.02)	0.56* (0.05)	0.20* (0.06)	21.06*	41.68*	0.05	19.17*
Pooled Non-NDF	-1.06* (0.12)	-0.10 (0.20)	0.64* (0.17)	42.12*	18.43*	79.10*	8.54*

Next, we look at the robustness of our results related to the institutional characteristics (i.e. the nations' income level and the extent of foreign exchange liberalisation) of the sample currencies. We have earlier used the pooled sample approach to investigate whether the forward bias puzzle is characterised by the institutional features

and we should continue the same approach in the robustness test. A pooled regression, similar in spirit to equation 4.2, is estimated for our sample currencies. The results from the respecified pooled regression model are presented in Table 4.9.

The results from the respecified pooled regression are generally similar to the conventional pooled regression reported under Table 4.3 (Page 159). The non-crisis (β_1) and GFC (β_3) estimated Fama beta are all similar in sign to the whole period and GFC subperiod estimated beta. The high income and the non-NDF pooled samples report negative beta coefficient for the non-crisis (β_1) period which is identical in sign with the whole period in our main analysis. This confirms the existence of the forward bias puzzle in these groups of pooled samples during the non-crisis period. In the meantime, all the pooled samples show an estimated beta larger than zero for the GFC period (β_3) which is in agreement with the results from Table 4.3.

The difference in the sign of the estimated beta is reported for some of the pooled samples under the AFC period (β_2). While the results from Table 4.3 show negative beta coefficients for all the pooled samples, the results from the respecified regression model in Table 4.9 show negative beta for only pooled high income and pooled non-NDF samples for the AFC period (β_2). This finding slightly weakens the inference we made regarding the existence of the forward bias puzzle during the AFC subperiod in the main analysis. As for the equality of the estimated Fama beta among the non-crisis, AFC and GFC periods, the pooled results report an overwhelming rejection of equality of the estimated betas. There are only three (3) exceptions out of a total of twenty (20) tests. The exceptions reported are for the equality of the estimated beta for non-crisis (β_1) and GFC (β_3) for the pooled overall, medium income and NDF samples. This result shows that the GFC is not as distinctive as the AFC when compared against the non-crisis period. And this finding generally supports

our claim that the AFC is the more disturbing crisis between the two in terms impact to the foreign exchange market efficiency in the Asia-Pacific region.

The robustness test is also conducted on the Pilbeam & Olmo's (2011) modified Fama regression model. As shown in the previous chapter, the following respecified regression equation is estimated to correspond with Pilbeam-Olmo's Model 1:

$$\left[\left(\frac{S_{i,t+1}}{F_{i,t}}\right) - 1\right] = \alpha_{i,1}D_1 + \alpha_{i,2}D_2 + \alpha_{i,3}D_3 + \varepsilon_{i,t+1} \quad (4.3)$$

Similar to the earlier explanation in this section, D_1, D_2 and D_3 are the dummy variables for non-crisis, AFC and GFC periods. We estimate $\alpha_{i,j}$ for Pilbeam-Olmo's Model 1 for each currency *i* during the non-crisis, AFC and GFC periods. The foreign exchange markets are efficient if none of the estimated coefficients are significant. The results for the robustness test on Pilbeam-Olmo's Model 1 are exhibited in Table 4.10.

We compare the results reported in Table 4.10 with those reported in Table 4.6 on page 171 to investigate the robustness of our results in the main analysis. The robustness test results are almost in total agreement with the results we reported in Table 4.6. For the non-crisis period, we validated the inefficiency reported for the INR, PHP and THB foreign exchange markets in the main analysis with the results in Table 4.10. Meanwhile for the crisis periods, the results in the main analysis which show evidence of inefficiency in the NZD and CNY foreign exchange markets during the AFC and the GFC subperiods respectively are confirmed with the respecified model. The inconsistencies between the results from Table 4.10 on the next page and Table 4.6 are reported for the KRW market during the non-crisis period and the MYR market during the non-crisis and AFC subperiods. We could attribute these inconsistencies due to the missing data for KRW in

the early period (i.e. prior to February 2002) and the sudden adoption of a fixed exchange rate regime at the height of the AFC for the MYR market.

Table 4.10: Results of Robustness Test on Pilbeam-Olmo's Model 1

We extended the robustness test on Pilbeam-Olmo Model 1 by respecifying the equation to the following: $\left[\left(\frac{S_{i,t+1}}{F_{i,t}}\right) - 1\right] = \alpha_{i,1}D_1 + \alpha_{i,2}D_2 + \alpha_{i,3}D_3 + \varepsilon_{i,t+1}$. The D1, D2 and D3 are dummy variables to represent the non-crisis, Asian financial crisis (AFC) and global financial crisis (GFC) periods. Correspondingly, the estimated α_1, α_2 and α_3 represent the related periods. The market is efficient if none of the estimated coefficients are significant. We report the results of the alpha estimates and the corresponding standard error of estimates (parentheses) in the table below. * and ** indicate significance at the 5% and 10% levels of confidence respectively. The results reported below are comparable to the results reported under Table 4.6 (Page 171). Our results reported in the main analysis (Table 4.6) are generally supported with the robustness test results.

	Pilbeam&Olmo - Model 1		
	Noncrisis, α_1	AFC, α_2	GFC, α_3
AUD	-0.0044	0.0124	-0.0022
	(0.0046)	(0.0098)	(0.0171)
CNY	0.0001	NA	-0.0023**
	(0.0010)		(0.0012)
IDR	0.0014	0.0760	-0.0047
	(0.0095)	(0.1210)	(0.0259)
INR	-0.0045*	0.0085	0.0020
	(0.0023)	(0.0119)	(0.0101)
JPY	0.0022	0.0067	-0.0074
	(0.0037)	(0.0164)	(0.0088)
KRW	-0.0064**	NA	0.0120
	(0.0036)		(0.0194)
MYR	-0.0037	0.0560*	0.0020
	(0.0027)	(0.0260)	(0.0069)
NZD	-0.0049	0.0144**	0.0012
	(0.0047)	(0.0080)	(0.0167)
PHP	-0.0038**	0.0156	0.0006
	(0.0022)	(0.0244)	(0.0075)
SGD	-0.0001	0.0077	-0.0008
	(0.0019)	(0.0099)	(0.0070)
THB	-0.0079*	0.0095	-0.0073
	(0.0035)	(0.0344)	(0.0109)
TWD	0.0000	0.0072	0.0024
	(0.0019)	(0.0167)	(0.0058)

In a nutshell, the robustness test results provided some comfort to the results from the main analysis regarding the *within-country* market efficiency. Our results are generally robust to the respecification of the sample period and remodelling of the standard regression equations with few contradictions between the two sets of results (i.e. main analysis results against robustness tests results). In the next section, we have extended the Johansen cointegration technique to test for the *across-country* efficiency for the collective

Asia-Pacific foreign exchange markets. This approach is pioneered by Baillie & Bollerslev (1989) and continued to be used by Jeon & Seo (2003) and Kan & Andreosso-O'Callaghan (2007).

4.1.2 *Across-country* Efficiency

Across-country efficiency looks at the foreign exchange markets jointly as one single market. The tenet of the efficient market hypothesis (EMH) holds if there is no predictability of one country's spot exchange rate with another country's spot exchange rate. It is necessary to clarify that *across-country* efficiency is a distinct concept from the *within-country* efficiency because the former concept is not based on the forward unbiasedness hypothesis. *Across-country* efficiency is related to *within-country* efficiency in the testing methodology. We have extended the Johansen cointegration technique used in the testing of *within-country* efficiency to *across-country* efficiency. In order to avoid potential confusion, it is important to note that the finding of cointegration in *within-country* efficiency test denotes markets efficiency (i.e. evidence in support of forward unbiasedness hypothesis) while cointegration reported in *across-country* efficiency represents a violation of market efficiency (i.e cointegration implies predictability of one country's spot exchange rate with another country's spot exchange rate). Table 3.10 (Page 138) in the previous chapter provided a useful summary and guidance for the interpretation of results in this chapter.

We have conducted the Johansen cointegration test on the non-stationary or I(1) spot exchange rates. The I(1) spot exchange rates are as identified in Table 4.4 (Page 165). First, we run a bivariate cointegration test by pairing each eligible currency in our sample with one another. Next, we perform the multivariate cointegration tests on all the sample

currencies as a whole. We have also further broken up the whole sample currencies into two (2) specific locality groups – Southeast Asia (IDR, MYR, PHP, SGD and THB) and Northeast Asia (CNY, JPY, KRW and TWD). We shall first discuss the results from the bivariate cointegration followed by the multivariate cointegration.

4.1.2.1 Bivariate Cointegration

From the 12 sample currencies, we are able to pair up all the currencies into 64 unique pairs for the bivariate cointegration test. However, not all pairs are tested for cointegration as some of the spot exchange rates might not be eligible due to stationarity, fixed peg or data availability issue. The foreign exchange market efficiency is violated if there is evidence of cointegration between the two currencies. Since we run cointegration on only two currencies at a time, they are only cointegrated if, and only if, there is one cointegrating vector in the relationship. The existence of two cointegrating vector in a bivariate cointegration test is a case of trivial cointegration and we deem trivial cointegration as equivalent to no cointegration. Table 4.11 presents the bivariate cointegration test results.

Table 4.11 shows the number of cointegrating vector from the bivariate cointegration test at the 5% level of significance based on the critical value computed by MacKinnon, Haug & Michelis (1999). We report the results under both the test statistics used in the cointegration test: trace statistics (λ-trace) and maximum eigenvalue (λ-max). A result is convincing if both the test statistics report an equal number of cointegrating vectors. We have assumed the existence of an intercept and trend in the bivariate cointegration test but our results are robust to the assumption of an intercept but no trend. At a quick glance, the foreign exchange markets in Asia-Pacific are generally efficient

across-country when tested using the bivariate cointegration technique. From the whole period, most of the currency pairs are efficient except for the CNY-crosses (e.g. CNY-AUD, CNY-KRW, CNY-MYR, CNY-NZD and CNY-PHP). This finding could be due to the fact that the People's Bank of China (PBOC) is still holding the discretionary power in determining the direction of the CNY. It is likely that the PBOC determines the daily middle point for the CNY after studying the direction of other regional currencies.

Table 4.11: Johansen Bivariate Cointegration Test Results

We conducted a bivariate cointegration test by pairing up each of the non-stationary spot exchange rate with one another for the whole period and the six subperiods. The test statistics for this cointegration exercise are trace statistics (λ-trace) and maximum eigenvalue (λ-max) with the critical values tabulated by MacKinnon, Haug & Michelis (1999). The figures shown below are the number of cointegrating vector at 5% level of significant. 'NA' denotes 'not available' due to i) the stationarity of the spot exchange rate, ii) the adoption of fixed exchange rate regime during that particular period or iii) data availability issue.

	Whole Period		Pre-AFC Subperiod		AFC Subperiod		Post-AFC Subperiod		Pre-GFC Subperiod		GFC Subperiod		Post-GFC Subperiod	
Currency Pairs	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max
AUD-CNY	0	1	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
AUD-IDR	NA	NA	0	0	0	0	0	0	0	1	0	1	0	0
AUD-INR	0	0	NA	NA	0	0	1	1	0	0	0	0	0	0
AUD-JPY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUD-KRW	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
AUD-MYR	0	0	NA	NA	0	0	NA	NA	0	0	0	0	0	0
AUD-NZD	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
AUD-PHP	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
AUD-SGD	0	0	0	0	0	0	0	1	0	0	0	0	0	0
AUD-THB	NA	NA	0	0	1	1	0	0	NA	NA	0	0	0	0
AUD-TWD	0	0	0	0	0	0	1	0	0	0	0	0	0	1
CNY-IDR	NA	NA	NA	NA	NA	NA	NA	NA	0	1	NA	NA	0	0
CNY-INR	0	0	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
CNY-JPY	0	0	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
CNY-KRW	1	1	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
CNY-MYR	1	1	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
CNY-NZD	0	1	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
CNY-PHP	1	1	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
CNY-SGD	0	0	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
CNY-THB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0
CNY-TWD	0	0	NA	NA	NA	NA	NA	NA	0	0	NA	NA	0	0
IDR-INR	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0
IDR-JPY	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
IDR-KRW	NA	NA	NA	NA	0	0	0	0	0	0	0	1	0	0
IDR-MYR	NA	NA	NA	NA	0	0	NA	NA	0	0	0	0	0	0
IDR-NZD	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0
IDR-PHP	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0
IDR-SGD	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
IDR-THB	NA	NA	0	0	1	1	0	0	NA	NA	0	0	0	0
IDR-TWD	NA	NA	0	0	0	0	0	1	0	0	0	0	1	1

Table 4.11: Johansen Bivariate Cointegration Test Results (continued...)

INR-JPY	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
INR-KRW	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
INR-MYR	0	0	NA	NA	0	0	NA	NA	0	0	0	0	0	0
INR-NZD	0	0	NA	NA	0	1	1	1	0	0	0	0	0	0
INR-PHP	0	0	NA	NA	0	1	0	0	0	0	0	0	0	0
INR-SGD	0	0	NA	NA	0	0	1	1	0	0	0	0	0	0
INR-THB	NA	NA	NA	NA	1	1	0	0	NA	NA	0	0	0	0
INR-TWD	0	0	NA	NA	0	0	0	0	0	0	0	0	0	1
JPY-KRW	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
JPY-MYR	0	0	NA	NA	0	0	NA	NA	0	0	0	0	0	0
JPY-NZD	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
JPY-PHP	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
JPY-SGD	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JPY-THB	NA	NA	0	0	0	0	0	0	NA	NA	0	0	0	0
JPY-TWD	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KRW-MYR	0	0	NA	NA	0	0	NA	NA	0	0	0	0	0	0
KRW-NZD	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
KRW-PHP	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
KRW-SGD	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
KRW-THB	NA	NA	NA	NA	1	1	0	0	NA	NA	0	0	0	0
KRW-TWD	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
MYR-NZD	0	0	NA	NA	0	0	NA	NA	0	0	0	0	0	0
MYR-PHP	0	0	NA	NA	1	1	NA	NA	0	0	0	0	0	0
MYR-SGD	0	0	NA	NA	0	0	NA	NA	0	0	0	0	0	0
MYR-THB	NA	NA	NA	NA	1	1	NA	NA	NA	NA	0	0	0	0
MYR-TWD	1	0	NA	NA	0	0	NA	NA	0	0	0	0	0	0
NZD-PHP	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
NZD-SGD	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0
NZD-THB	NA	NA	NA	NA	1	1	0	0	NA	NA	0	0	0	0
NZD-TWD	0	0	NA	NA	0	0	2	0	0	0	0	0	0	0
PHP-SGD	2	2	NA	NA	0	0	0	0	0	0	0	0	0	0
PHP-THB	NA	NA	NA	NA	2	0	0	0	NA	NA	0	0	0	0
PHP-TWD	1	1	NA	NA	0	0	0	0	0	0	0	0	0	0
SGD-THB	NA	NA	0	0	1	1	0	0	NA	NA	0	0	0	0
SGD-TWD	0	0	0	0	0	0	1	1	0	0	0	0	0	1
THB-TWD	NA	NA	0	0	1	1	2	0	NA	NA	0	0	0	0

Moving on to the subperiods, we observe that there is no convincing sign of inefficiency for all the non-crisis periods (i.e. Pre-AFC, Post-AFC, Pre-GFC and Post GFC). A convincing sign of inefficiency refers to the result of one cointegrating vector reported under both the λ-trace and λ-max test statistics. As for the crisis periods, we have the opportunity to study the impact of AFC and GFC on the *across-country* efficiency. First, in the AFC subperiod, the foreign exchange markets in Asia-Pacific show some convincing signs of market inefficiency, especially among the THB-crosses pairs (AUD-

THB, IDR-THB, INR-THB, KRW-THB, MYR-THB, NZD-THB, SGD-THB and TWD-THB). The foreign exchange markets remain *across-country* efficient for most of the other currency pairs. This finding indicates that the THB is a main source of market inefficiency during the AFC subperiod. This result support the finding from Gong, Lee & Chen (2004) which suggested that the transmission channel originated in Thailand during the AFC period. As a matter of record, the Bank of Thailand floated the THB in the international market in early July 1997 and from there, the turmoil quickly spilled over to neighbouring countries like Malaysia, Indonesia, the Philippines and South Korea before being a full-blown financial crisis. Therefore the results reported under the bivariate cointegration give us an additional perspective on the contagion effect during the AFC.

The next crisis which is contained within the full sample period is the global financial crisis (GFC) emanating from the meltdown in the United States' subprime mortgage market. We note that the foreign exchange markets in Asia-Pacific are efficient *across-country* without any convincing sign of inefficiency. Even though there are some studies (e.g. Dooley & Hutchison, 2009 and Baba & Packer, 2009) which suggested that the foreign exchange markets were affected by the subprime crisis, it seems that the foreign exchange market efficiency in this region is generally upheld during the crisis. This finding is not to be confused with the heightened volatility and the massive unwinding of JPY-carry trade reported during the GFC. Our study focuses only on the aspect of market efficiency and hence we suggest that the 'chaotic' markets during the GFC did not affect foreign exchange market efficiency in this region. Our results show that the AFC is the more disturbing crisis as compared to the GFC in upsetting the market efficiency condition in Asia-Pacific. The results in this section support the finding reported under the Pilbeam-Olmo's Model 2 which also suggested that the AFC as the more troubling event than the

GFC. In the next section, we shall look at the *across-country* efficiency in Asia-Pacific through the multivariate cointegration method.

4.1.2.2 Multivariate Cointegration

In the multivariate cointegration test, we have grouped all the 12 currencies in the sample for testing. Furthermore, we have also created two more clusters according to a narrower locality: Northeast Asia and Southeast Asia. Northeast Asia cluster consists of CNY, JPY, KRW and TWD while the Southeast Asia cluster contains IDR, MYR, PHP, SGD and THB. We did not create an Australasia cluster because we have only two currencies in the Australasia locality and as such the results from this locality have already been reported in the bivariate cointegration section. Similar to the bivariate cointegration test, we have assumed an intercept and trend in the cointegrating relationship. Table 4.12 below shows the results from the multivariate cointegration test for the whole period as well as the six (6) subperiods.

Table 4.12: Johansen Multivariate Cointegration Test Results

In a multivariate cointegration test, we conducted the test on the whole group of the 12 Asia-Pacific spot exchange rate series as well as under two specific geographical localities namely Southeast Asia (Indonesia, Malaysia, Philippines, Singapore and Thailand) and Northeast Asia (China, Japan, Korea and Taiwan). Again, stationary series are excluded from the test. The table below shows the number of cointegrating vector at the 0.05 level. 'NA' indicates 'not available' due to insufficient number of sample currencies in the cluster for multivariate cointegration (a minimum of three (3) currencies are needed for multivariate cointegration).The test statistics for this cointegration exercise are trace statistics (λ-trace) and maximum eigenvalue (λ-max) with the critical values tabulated by MacKinnon, Haug & Michelis (1999). A cointegrated system indicates a violation of market efficiency as it implies predictability of one spot exchange rate with another spot exchange rate. For the whole period, the overall Asia-Pacific foreign exchange market is efficient as no evidence of cointegration among these set of spot exchange rates. However, violation of market efficiency occurred in the Northeast and Southeast Asia clusters respectively for the whole period. There are also evidence of market inefficiency in all the subperiods.

	Whole Period		Pre-AFC Subperiod		AFC Subperiod		Post-AFC Subperiod		Pre-GFC Subperiod		GFC Subperiod		Post-GFC Subperiod	
	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max	λ-trace	λ-max
Asia-Pacific	0	0	2	0	2	2	1	1	1	1	2	1	3	1
Northeast Asia	2	0	NA	NA	0	0	0	0	1	1	0	0	0	0
Southeast Asia	1	1	0	0	1	1	0	0	0	0	0	0	0	0

The results shown in Table 4.12 are the number of cointegrating vectors detected from the multivariate cointegration test at 5% level of significant based on the critical values computed by MacKinnon, Haug & Michelis (1999). The test statistics used are the trace statistics (λ-trace) and maximum eigenvalue (λ-max) and the results are reported under both of these test statistics. The presence of a cointegrating vector represents a violation of the tenet of predictability under the efficient markets hypothesis (EMH). In the overall Asia-Pacific market, we do not detect any sign of cointegration in the whole period and this finding supports the notion of market efficiency. However, in the subperiods, there is strong evidence of cointegration and hence a violation of market efficiency in the overall Asia-Pacific market.

Narrowing the geographical scope, we have results from the Northeast and Southeast Asia clusters. There is some weak sign of cointegration (i.e. cointegration is only reported under the λ-trace) for the Northeast Asia currencies in the whole period. The *across-country* market efficiency is only convincingly rejected under the Pre-GFC subperiod for the Northeast Asia region. Under other subperiods (i.e. Post-GFC, GFC and Post-GFC), there is no sign of cointegration in this narrowed cluster. Meanwhile, in the Southeast Asia region, *across-country* market efficiency is convincingly rejected for the whole period as well as the AFC subperiod. In the other subperiods, our results support the notion of *across-country* market efficiency in Southeast Asia. This finding, again, shows that the AFC is a very distressing event in the region and caused disturbance to foreign exchange market efficiency.

Our overall results are in agreement with Jeon & Seo (2003) in which the AFC is seen as a disturbance to market efficiency in the Asia-Pacific. However, our evidence of inefficiency is stretched to all subperiods post-AFC. Hence this finding disputes the claim

made by Jeon & Seo (2003) that the AFC effect did not last long. Their claim is true if we just look narrowly at only the Southeast Asia foreign exchange markets. When we include more currencies in the Asia-Pacific region, market inefficiency continues to be reported throughout the subperiods. Our results are also in general agreement with Baillie & Bollerslev (1989) which reported general violation in the *across-country* markets efficiency. In comparison with Kan & Andreosso-O'Callaghan (2007), our results are only consistent with their findings to a certain extent.

From our results, the *across-country* market efficiency is only mildly violated in the Northeast Asia and Southeast Asia and only for a limited time period and this is in agreement with Kan & Andreosso-O'Callaghan (2007). But when we include the entire sample currencies and treat them all as one group under Asia-Pacific, the results show an extended violation of market efficiency throughout the subperiods which do not concur with the conclusions from Kan & Andreosso-O'Callaghan (2007). Therefore the interpretation of *across-country* cointegration test results could be sensitive to the number of currencies included in the analysis and also the time period involved.

4.1.2.3 Forward Premium Stationarity

Crowder (1994) has argued that the finding of a cointegrating vector among a group of spot exchange rate series may not necessarily represent a violation of market efficiency. In a risk-averse environment, the existence of a stationary risk premium could distort the interpretation of the cointegrating vector found in the multivariate cointegration test. The stationary error correction term in a cointegrated system may act as the proxy for the covariance stationary risk premium and therefore the foreign exchange market could still be efficient despite the existence of a cointegrating vector. In order to examine this possibility,

we test the stochastic characteristic of the forward premium. If the forward premium is stationary or I(0), the error correction term could potentially be a proxy for the risk premium in a cointegrated system and hence reduce the strength of the argument against market efficiency. It must be noted that the finding of a stationary forward premium does not prove market efficiency but it only reduces the strength of the argument against market efficiency. A similar line of reasoning as mooted by Crowder (1994) has been used by Barkoulas, Baum & Chakraborty, (2003), Aroskar, Sarkar & Swanson, (2004) and Kan & Andreosso-O'Callaghan (2007). We tested the stationarity behaviour of the forward premium with two of the popular unit root tests: augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). Both of these unit root tests have the null hypothesis of non-stationary and therefore a rejection of the null hypothesis indicates stationarity. We present the results from the unit root tests in Table 4.13 below.

Table 4.13: Forward Premium Stationarity Test Results

We have employed two (2) popular unit root tests, namely Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski et al. (KPSS) tests to test for the stationarity behaviour of the forward premium. The lag-length in the ADF test, meant to address the issue of serial correlation, is chosen based on the minimization of Akaike Information Criterion (AIC). Meanwhile the PP test is specifically devised to cater for mild serial correlation when testing for a unit root and therefore no lag is needed in this equation. The residual spectrum at frequency zero in the PP test is estimated through the Bartlett kernel approach. The figures below show the test statistic values and those values in bold refer to non-stationary forward premium. * and ** denote rejection at the 0.05 and 0.10 levels of significance respectively. The critical values for the ADF and PP tests are as tabulated by MacKinnon, Haug & Michelis (1999). Rejection under the ADF and PP tests indicate stationarity of forward premium. The finding of stationary forward premium reduces the argument against market inefficiency as reported under some of the across-country efficiency test results.

	Whole Period		Pre-AFC Subperiod		AFC Subperiod		Post-AFC Subperiod		Pre-GFC Subperiod		GFC Subperiod		Post-GFC Subperiod	
Currency	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
AUD	-4.03*	-74.85*	-8.84*	-8.79*	-19.86*	-19.86*	-3.88*	-43.78*	-12.33*	-25.40*	-22.91*	-22.91*	-15.31*	-15.55*
CNY	-4.87*	-3.45*	NA	NA	NA	NA	NA	NA	-3.79	-3.94*	NA	NA	**-3.03**	-3.36**
IDR	-6.10*	-7.03*	-6.05*	-6.00*	-6.89*	-15.13*	-4.43*	-3.13*	-5.03*	-21.10*	**-1.49**	-5.60*	-7.09*	-13.97*
INR	-4.66*	-39.14*	NA	NA	-3.25**	-7.92*	-4.08*	-21.67*	**-2.07**	-11.60*	-3.77	-16.25*	-12.85*	-12.87*
JPY	-3.77*	-78.45*	-9.86*	-12.91*	-17.79*	-17.79*	-3.46*	-45.31*	-4.60*	-26.46*	-10.16*	-25.31*	-17.79*	-17.88*
KRW	-3.92*	-48.91*	NA	NA	NA	NA	-5.03*	-25.55*	-3.85*	-20.77*	**-3.04**	-19.82*	-11.92*	-11.87*
MYR	-3.34**	-3.47*	-4.06*	-8.06*	**-3.01**	-11.48*	NA	NA	-4.46*	-11.23*	-3.54*	-9.07*	-14.66*	-14.68*
NZD	-3.78*	-79.17*	-11.94*	-11.97*	-4.27*	-19.20*	-4.98*	-43.55*	-9.92*	-25.30*	-10.90*	-23.62*	-14.95*	-14.90*
PHP	-5.99*	-40.56*	**-2.36**	-4.62*	-7.47*	-9.97*	-3.78*	-18.46*	-6.21*	-22.82*	-4.76*	-17.43*	-13.82*	-13.88*
SGD	-4.68*	-63.20*	-3.33**	-9.43*	**-2.25**	-11.98*	**-3.04**	-49.23*	-9.44*	-24.15*	**-2.89**	-21.05*	-7.50*	-21.53*
THB	-3.85*	-7.57*	-4.71*	-3.43**	-5.51*	-11.78*	-6.85*	-26.10*	**-2.92**	-4.97*	-4.64*	-5.18*	-15.06*	-15.06*
TWD	-5.94*	-41.21*	-12.44*	-12.44*	**-2.45**	-12.78*	-4.60*	-22.51*	-6.58*	-15.65*	**-2.06**	-11.16*	-6.80*	-12.88*

From a quick look at Table 4.13 on the previous page, we notice that most of the forward premia for all of the currencies are stationary. In fact, there is no convincing evidence of non-stationarity among the forward premia. Even though some of the ADF test results show failure to reject the null hypothesis of non-stationarity (e.g. SGD during AFC, Post-AFC, and GFC subperiods and TWD during AFC and GFC subperiods), none of the Phillips-Perron test results support the null hypothesis of non-stationarity. At most, some of these conflicting results are just inconclusive. Looking back at the general results, we conclude that the forward premium is usually a stationary process and therefore the existence of a cointegrating vector in a system of spot exchange rates does not necessarily indicate market inefficiency. The error correction term detected in a cointegrated system of spot exchange rates could be acting as a representation for the covariance stationary risk premium and consequently the foreign exchange markets could still be efficient. Our results are consistent with the most of the recent studies such as Barkoulas, Baum & Chakraborty, (2003), Aroskar, Sarkar & Swanson, (2004) and Kan & Andreosso-O'Callaghan (2007) which also reported stationary forward premium. However, our results are in contrast with the conclusion from Crowder (1994) which states that the forward premium is non-stationary and the foreign exchange markets are indeed inefficient.

4.2 Event-study Analysis and Markets Efficiency

One of the important criteria for an efficient market is that the prices of a traded-asset should reflect all available and relevant information, including the market expectations of the future state of economy. We have adopted the event-study analysis to test for the validity of this criterion to infer the state of market efficiency in the Asia-Pacific foreign exchange markets. This approach is often viewed as a test of semi-strong form market efficiency as introduced by Fama (1970). We have employed 107 macroeconomic

announcements from all the countries studied in our sample (i.e. the 12 Asia-Pacific markets plus the United States) as the events. The event-window is set as one-day following Fatum & Scholnick (2008) which show that the reactions of the exchange rates happen within the same day as the announcement day. In addition, Andersen et al. (2003) and Almeida, Goodhart & Payne (1998) claim that the exchange rates respond within hours (even minutes) after a surprise announcement. Therefore it is important for us to use a short window period which is not longer than one-day. The market is efficient if the exchange rates react only to the surprise elements of the key macroeconomic announcements. Many studies have shown that the exchange rates respond only to the surprise elements of an announcement (e.g. Fatum & Scholnick, 2008; Andersen et al., 2003). Therefore we must disentangle the expectation component from an announcement to obtain the surprise element. Significant reaction to variables other than the surprise elements constitutes a violation of market efficiency.

With such a vast number of macroeconomic announcements, it is necessary for us to group them into smaller sub-categories in order to have a more focused discussion. As elaborated in the Methodology Chapter, we have three broad categories to group all the macroeconomic indicators into one each. The three categories are 1) Interest rates, prices and money, 2) Production and business activities and 3) Total output, international trade and employment. The rationale and definition of this grouping are already explained in Table 3.8 (Page 122). As the macroeconomic announcements are collected from various countries, it is also useful for us to discern the U.S. events with those from the other countries. The U.S. being the world's largest and most influential economy should have more significant events than the rest of the other countries. Moreover, USD is used as the numeraire currency in our exchange rates quotation against all the other currencies in the

sample and hence it is logical to dedicate a section to the U.S. events. We call the macroeconomic anouncements from the rest of other countries as domestic macroeconomic announcements. Our study is one of the few studies which employed such a high number of macroeconomic announcements from the Asia-Pacific region.

Firstly, we show that most of the currency markets in Asia-Pacific are efficient as evidenced by the relatively small numbers of rejections of the market efficiency hypothesis. Next, we direct our focus to the reaction of exchange rates to the U.S. macroeconomic shocks followed by those domestic macroeconomic surprises. Lastly, we compare all the macroeconomic shocks jointly and provide a ranking based on their significance. It is no surprise to note that the currency markets under the free-float regime report a higher number of significant reactions to the surprises in macroeconomic announcements than those under other variations of managed-float regime. This observation validated the argument that the floating exchange rates are absorbers of macroeconomic shocks (Artis & Ehrmann, 2006; Edwards & Levy-Yeyati, 2005). However, the currencies under a managed-float regime also report significant movements to the macroeconomic surprises which indicate that these currencies are not totally rigid or 'artificial' – they are still allowed to react to surprises.

4.2.1 Results on Market Efficiency

The market is efficient if the exchange rates react only to the macroeconomic surprises. We extract the surprises or news elements from a macroeconomic announcement by subtracting the actual numbers with the market expectations as shown in equation 4.4 as follows:

$$N_{i,t} = A_{i,t} - E_{i,t} \tag{4.4}$$

N, A and *E* are the news, actual announced figures and the market expected numbers. The subscript *i* and *t* denote country and time respectively. In order to draw meaningful comparison among all the macroeconomic shocks, we standardise the news by dividing it with its own standard deviation as follows:

$$\widehat{N_{i,t}} = \frac{A_{i,t} - E_{i,t}}{\sigma_i} \tag{4.5}$$

where σ_i is the standard deviation of the particular macroeconomic shocks. The market efficiency condition is tested by regressing the same-day change in the exchange rates during the announcement day on a constant and the announcement shocks. Market efficiency is violated if the constant is significant. A significant α implies that there are other information which could be used to predict the movement in exchange rates. The regression equation is represented as follows:

$$\Delta s_t = \alpha_i + \beta_i \widehat{N_{i,t}} + \varepsilon_t \tag{4.6}$$

Δs denotes one-day change in the spot exchange rate and the ε is a white noise residual. From the total of 107 macroeconomic shocks, there is a high chance of the detection of some significant α's. We provide an overall view of market efficiency by looking at the total results. Unlike the results from the testing of the forward unbiasedness hypothesis through the Fama regression and Johansen cointegration technique, our results from the event-study analysis are only suggestive in nature on whether the market is efficient. Firstly, we present the results on the market efficiency condition based on the significance of α (i.e. significant implies inefficiency & insignificant otherwise) in Table 4.14 in the following pages.

Table 4.14: Event-Study Analysis and Market Efficiency

We have employed 107 macroeconomic indicators' surprises from all the countries in our sample as the events and we have set one-day change (i.e. same day as the announcement) as the event window. We run a regression of the one-day change in the exchange rates on a constant and the macroeconomic surprises, $\Delta s_t = \alpha_i + \beta_i N_{i,t} + \varepsilon_t$ for each series of the exchange rates individually. In an efficient market, the exchange rates should have reflected all the available and relevant information and only react to the surprises or news elements. We deem the market efficiency condition is violated if the constant, α, in the regression is significantly different from zero. The first column shows the country in which the macroeconomic indicators originate while the second column the name of the event. There are two rows to each event: the upper row reports the estimated coefficient α and the lower row the corresponding standard error of estimates. The results for each country are reported in the following 12 columns. The figures in bold indicate significance at the minimum of 0.10 level hence a violation of markets efficeincy. At the last row of the table, we report the number of significant α detected from all the macroeconomic indicators for each currency (i.e. number of violation of markets efficiency condition). The results show encouraging support for market efficiency in Asia-Pacific. Out of the 107 macroeconomic indicators (except for CNY and MYR which contain only 106 and 107 macroeconomic indicators due to data availability issue), the highest number of reported violations of market efficiency (i.e. significance of α) is 43 which is for CNY market. All the other currency markets, except for PHP market which indicates 24 significant α, show less than 20 violations of market efficiency. From these results, we infer that most of the currency markets in Asia-Pacific are efficient. As CNY is under the pegged exchange rate regime, it is no surprise that this currency market is an outlier among all the major Asia-Pacific foreign exchange markets.

Country	Event		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Australia	Current Account Balance	Coef.	-0.0002	-0.0001	-0.0005	0.0005	0.0003	0.0005	-0.0008	0.0005	0.0002	0.0000	-0.0007	-0.0002
		s.e.	0.0011	0.0002	0.0009	0.0003	0.0009	0.0010	0.0009	0.0012	0.0006	0.0005	0.0005	0.0003
Australia	Consumer Prices (QoQ)	Coef.	**0.0023**	0.0000	0.0020	0.0007	0.0011	-0.0006	0.0011	**0.0035**	0.0010	**0.0008**	**0.0016**	0.0001
		s.e.	**0.0012**	0.0002	0.0014	0.0006	0.0011	0.0009	0.0009	**0.0012**	0.0007	**0.0004**	**0.0007**	0.0003
Australia	Employment Change	Coef.	**-0.0015**	-0.0002	0.0003	0.0004	-0.0002	0.0001	-0.0008	-0.0009	0.0002	-0.0001	0.0000	0.0000
		s.e.	**0.0008**	0.0001	0.0009	0.0002	0.0005	0.0007	0.0008	0.0008	0.0003	0.0003	0.0004	0.0002
Australia	Gross Domestic Product (QoQ)	Coef.	0.0005	0.0001	0.0019	**-0.0010**	0.0006	0.0000	0.0013	0.0016	0.0001	0.0000	**0.0017**	-0.0002
		s.e.	0.0011	0.0001	0.0014	**0.0004**	0.0009	0.0008	0.0008	0.0012	0.0007	0.0004	**0.0009**	0.0003
Australia	Producer Price Index (QoQ)	Coef.	-0.0004	0.0000	0.0008	0.0002	**-0.0027**	**-0.0026**	-0.0004	-0.0001	0.0006	-0.0005	-0.0003	-0.0003
		s.e.	0.0018	0.0001	0.0008	0.0007	**0.0010**	**0.0011**	0.0008	0.0018	0.0006	0.0007	0.0006	0.0007
Australia	RBA Cash Target	Coef.	-0.0012	**-0.0002**	0.0008	-0.0003	0.0003	0.0002	0.0001	-0.0011	-0.0001	0.0001	0.0003	0.0001
		s.e.	0.0008	**0.0001**	0.0007	0.0004	0.0005	0.0005	0.0004	0.0008	0.0004	0.0003	0.0004	0.0003
Australia	Retail Sales s.a. (MoM)	Coef.	-0.0007	**-0.0002**	0.0007	-0.0002	-0.0006	0.0001	0.0016	-0.0011	0.0002	0.0001	0.0018	-0.0004
		s.e.	0.0008	**0.0001**	0.0026	0.0004	0.0007	0.0007	0.0013	0.0008	0.0005	0.0005	0.0018	0.0003
Australia	Trade Balance	Coef.	-0.0007	-0.0001	-0.0003	-0.0004	-0.0002	**0.0012**	-0.0001	-0.0012	0.0003	0.0000	**-0.0005**	0.0002
		s.e.	0.0008	0.0001	0.0006	0.0004	0.0007	**0.0007**	0.0005	0.0008	0.0003	0.0003	**0.0003**	0.0003
Australia	Unemployment Rate	Coef.	-0.0009	-0.0002	0.0012	**0.0005**	0.0001	0.0005	0.0007	-0.0007	**0.0009**	0.0000	0.0010	0.0001
		s.e.	0.0007	0.0001	0.0011	**0.0002**	0.0006	0.0009	0.0013	0.0008	**0.0005**	0.0004	0.0006	0.0002
China	Consumer Price Index (YoY)	Coef.	-0.0009	-0.0001	-0.0002	**0.0008**	-0.0005	-0.0006	-0.0004	-0.0013	-0.0002	-0.0002	-0.0008	-0.0001
		s.e.	0.0010	0.0001	0.0006	**0.0004**	0.0007	0.0007	0.0005	0.0009	0.0005	0.0004	0.0005	0.0003
China	Industrial Production (YoY)	Coef.	0.0008	-0.0001	-0.0003	0.0004	-0.0002	0.0007	-0.0004	0.0002	0.0001	-0.0002	0.0001	-0.0004
		s.e.	0.0012	0.0001	0.0007	0.0006	0.0010	0.0007	0.0005	0.0013	0.0007	0.0004	0.0009	0.0003

Table 4.14: Event-Study Analysis and Market Efficiency (*continued*)

Country	Event		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
China	Producer Price Index (YoY)	Coef.	0.0003	**-0.0002**	-0.0006	-0.0001	-0.0010	-0.0001	-0.0003	0.0001	0.0000	-0.0001	-0.0007	-0.0003
China	Trade Balance (USD)	Coef.	0.0008	-0.0002	0.0007	-0.0003	-0.0007	-0.0017	0.0004	0.0007	0.0003	-0.0002	0.0002	-0.0001
		s.e.	0.0014	0.0001	0.0006	0.0006	0.0009	0.0013	0.0006	0.0014	0.0006	0.0005	0.0004	0.0003
Indonesia	Bank Indonesia Reference Rate	Coef.	-0.0010	-0.0002	**-0.0013**	-0.0007	-0.0008	0.0000	**-0.0011**	-0.0009	-0.0002	0.0004	-0.0008	0.0001
		s.e.	0.0013	0.0001	**0.0005**	0.0006	0.0008	0.0015	**0.0004**	0.0014	0.0006	0.0005	0.0005	0.0004
Indonesia	Inflation NSA (MoM)	Coef.	-0.0006	0.0001	0.0001	0.0000	-0.0004	0.0000	-0.0004	-0.0010	-0.0004	0.0002	-0.0001	-0.0001
		s.e.	0.0010	0.0002	0.0006	0.0004	0.0007	0.0007	0.0006	0.0009	0.0004	0.0003	0.0004	0.0003
Indonesia	Total Trade Balance	Coef.	**-0.0018**	-0.0001	-0.0006	-0.0004	0.0001	-0.0006	-0.0008	**-0.0021**	**-0.0006**	-0.0003	**-0.0006**	-0.0003
		s.e.	**0.0007**	0.0001	0.0006	0.0003	0.0006	0.0005	0.0006	**0.0007**	**0.0003**	0.0003	**0.0003**	0.0003
India	Qtrly GDP YoY%	Coef.	-0.0016	0.0003	-0.0008	-0.0006	**-0.0023**	-0.0005	0.0001	-0.0005	-0.0001	-0.0007	0.0007	**-0.0008**
		s.e.	0.0015	0.0002	0.0006	0.0010	**0.0012**	0.0010	0.0010	0.0018	0.0007	0.0005	0.0018	**0.0004**
India	Industrial Production YoY	Coef.	**0.0023**	0.0000	0.0010	**0.0013**	-0.0002	0.0003	0.0004	0.0006	-0.0002	0.0001	0.0001	0.0001
		s.e.	**0.0013**	0.0001	0.0007	**0.0005**	0.0008	0.0009	0.0004	0.0010	0.0004	0.0003	0.0003	0.0003
Japan	Adjusted Current Account Total	Coef.	0.0008	**-0.0003**	-0.0001	**0.0009**	-0.0002	0.0004	0.0006	0.0010	0.0003	0.0000	-0.0001	**0.0004**
		s.e.	0.0010	**0.0001**	0.0009	**0.0003**	0.0006	0.0005	0.0005	0.0009	0.0004	0.0003	0.0004	**0.0003**
Japan	All Industry Activity Index (MoM)	Coef.	0.0010	**-0.0003**	**0.0009**	0.0000	-0.0010	0.0004	-0.0004	0.0014	0.0000	0.0005	0.0002	-0.0004
		s.e.	0.0008	**0.0001**	**0.0005**	0.0004	0.0007	0.0007	0.0006	0.0009	0.0004	0.0004	0.0003	0.0003
Japan	Current Account Total	Coef.	0.0003	**-0.0003**	0.0002	**0.0009**	**-0.0012**	0.0010	**0.0012**	0.0003	0.0002	-0.0001	-0.0005	0.0005
		s.e.	0.0010	**0.0001**	0.0009	**0.0003**	**0.0007**	0.0008	**0.0006**	0.0010	0.0004	0.0003	0.0004	0.0003
Japan	Consumer Confidence	Coef.	-0.0008	-0.0001	0.0009	-0.0004	-0.0007	0.0008	0.0000	0.0003	0.0001	-0.0004	0.0005	0.0007
		s.e.	0.0015	0.0001	0.0009	0.0012	0.0011	0.0011	0.0005	0.0014	0.0005	0.0004	0.0006	0.0005
Japan	Coincident Index CI	Coef.	**-0.0013**	**-0.0002**	-0.0008	0.0000	-0.0003	0.0007	-0.0004	-0.0009	0.0002	-0.0003	-0.0005	-0.0001
		s.e.	**0.0007**	**0.0001**	0.0006	0.0003	0.0005	0.0007	0.0003	0.0007	0.0003	0.0003	0.0003	0.0002
Japan	Gross Domestic Product (QoQ)	Coef.	-0.0001	-0.0001	-0.0004	0.0002	-0.0009	0.0003	-0.0003	-0.0016	0.0004	-0.0001	-0.0008	0.0003
		s.e.	0.0009	0.0002	0.0015	0.0004	0.0009	0.0008	0.0009	0.0010	0.0004	0.0004	0.0008	0.0002
Japan	Housing Starts (YoY)	Coef.	-0.0004	-0.0001	**-0.0012**	-0.0004	0.0001	-0.0007	**-0.0007**	-0.0002	**-0.0008**	**-0.0007**	0.0001	**-0.0006**
		s.e.	0.0007	0.0001	**0.0005**	0.0003	0.0006	0.0006	**0.0004**	0.0007	**0.0003**	**0.0002**	0.0005	**0.0003**
Japan	Industrial Production (MoM)	Coef.	-0.0009	-0.0001	-0.0002	-0.0003	-0.0007	-0.0009	-0.0003	-0.0007	-0.0003	**-0.0004**	0.0000	-0.0004
		s.e.	0.0007	0.0001	0.0004	0.0003	0.0005	0.0006	0.0004	0.0008	0.0003	**0.0002**	0.0003	0.0002
Japan	Leading Index CI	Coef.	**-0.0015**	**-0.0002**	-0.0006	0.0000	-0.0004	0.0007	-0.0003	**-0.0011**	0.0003	-0.0004	**-0.0006**	-0.0001
		s.e.	**0.0006**	**0.0001**	0.0005	0.0003	0.0005	0.0006	0.0003	**0.0007**	0.0003	0.0002	**0.0003**	0.0002
Japan	Large Retailers' Sales	Coef.	0.0003	**-0.0002**	0.0008	0.0002	0.0006	-0.0002	0.0003	0.0003	**0.0007**	-0.0002	-0.0002	0.0000
		s.e.	0.0007	**0.0001**	0.0006	0.0003	0.0007	0.0005	0.0004	0.0008	**0.0004**	0.0003	0.0005	0.0002

Table 4.14: Event-Study Analysis and Market Efficiency (*continued*)

Country	Event		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Japan	Japan Money Stock M2 YoY	Coef.	**0.0017**	-0.0002	0.0005	**0.0008**	0.0006	-0.0006	0.0001	**0.0016**	0.0001	0.0001	0.0007	**0.0004**
		s.e.	**0.0010**	0.0001	0.0006	**0.0003**	0.0005	0.0007	0.0005	**0.0009**	0.0004	0.0003	0.0005	**0.0002**
Japan	Machine Orders (MoM)	Coef.	0.0005	-0.0001	-0.0003	0.0003	0.0004	-0.0001	0.0000	-0.0002	0.0002	0.0001	-0.0001	0.0000
		s.e.	0.0008	0.0001	0.0005	0.0003	0.0005	0.0006	0.0005	0.0008	0.0003	0.0003	0.0005	0.0002
Japan	Machine Orders YOY%	Coef.	-0.0003	-0.0001	0.0008	0.0004	0.0006	0.0001	0.0000	-0.0003	0.0003	0.0002	0.0000	0.0000
		s.e.	0.0010	0.0001	0.0006	0.0004	0.0006	0.0008	0.0005	0.0011	0.0004	0.0003	0.0007	0.0003
Japan	Merchandise Trade Balance Total	Coef.	0.0002	**-0.0003**	0.0000	0.0001	-0.0001	0.0002	-0.0001	0.0005	0.0002	-0.0003	**-0.0008**	0.0000
		s.e.	0.0007	**0.0001**	0.0008	0.0003	0.0006	0.0006	0.0004	0.0008	0.0005	0.0003	**0.0004**	0.0003
Japan	Natl CPI YoY	Coef.	0.0009	0.0001	0.0002	-0.0005	-0.0001	0.0000	-0.0004	0.0007	0.0002	0.0001	0.0008	0.0003
		s.e.	0.0007	0.0001	0.0004	0.0004	0.0005	0.0006	0.0004	0.0008	0.0005	0.0003	0.0006	0.0002
Japan	Tankan Lge Manufacturers Index	Coef.	-0.0004	0.0001	-0.0002	-0.0008	0.0010	-0.0011	-0.0007	-0.0005	-0.0004	0.0002	-0.0002	-0.0005
		s.e.	0.0011	0.0001	0.0011	0.0005	0.0012	0.0008	0.0006	0.0011	0.0005	0.0005	0.0004	0.0004
Japan	Trade Balance - BOP Basis	Coef.	0.0010	**-0.0003**	**0.0009**	0.0000	-0.0010	0.0004	-0.0004	0.0014	0.0000	0.0005	0.0002	-0.0004
		s.e.	0.0008	**0.0001**	**0.0005**	0.0004	0.0007	0.0007	0.0006	0.0009	0.0004	0.0004	0.0003	0.0003
Japan	Tokyo CPI YoY	Coef.	0.0008	0.0000	0.0002	-0.0005	-0.0002	0.0001	-0.0004	0.0005	0.0002	0.0000	0.0007	0.0002
		s.e.	0.0007	0.0001	0.0004	0.0004	0.0005	0.0006	0.0004	0.0008	0.0005	0.0003	0.0006	0.0002
Japan	Tertiary Industry Index (MoM)	Coef.	0.0003	-0.0001	0.0000	**0.0006**	-0.0001	0.0007	0.0006	0.0005	0.0001	**0.0005**	0.0001	-0.0001
		s.e.	0.0008	0.0001	0.0008	**0.0003**	0.0005	0.0006	0.0005	0.0009	0.0004	**0.0003**	0.0004	0.0002
Japan	Jobless Rate	Coef.	0.0003	-0.0001	-0.0002	-0.0005	0.0004	-0.0004	-0.0004	0.0003	**-0.0007**	-0.0001	0.0003	0.0001
		s.e.	0.0007	0.0001	0.0007	0.0003	0.0006	0.0005	0.0004	0.0007	**0.0004**	0.0002	0.0006	0.0003
Korea, South	Consumer Price Index (MoM)	Coef.	**-0.0012**	0.0001	-0.0003	-0.0002	0.0003	**-0.0012**	-0.0007	-0.0011	-0.0001	0.0000	-0.0002	-0.0004
		s.e.	**0.0007**	0.0002	0.0006	0.0004	0.0006	**0.0006**	0.0005	0.0008	0.0004	0.0003	0.0003	0.0003
Korea, South	GDP at Constant Price (YoY)	Coef.	0.0008	0.0000	**-0.0018**	-0.0006	-0.0012	0.0008	-0.0008	0.0005	-0.0007	0.0006	-0.0012	0.0005
		s.e.	0.0020	0.0002	**0.0009**	0.0003	0.0014	0.0008	0.0009	0.0019	0.0005	0.0005	0.0010	0.0004
Korea, South	Industrial Production (MoM)	Coef.	0.0005	**-0.0003**	-0.0001	0.0000	-0.0002	-0.0001	**-0.0008**	-0.0001	**-0.0010**	**-0.0010**	-0.0002	-0.0005
		s.e.	0.0008	**0.0001**	0.0006	0.0004	0.0006	0.0008	**0.0004**	0.0008	**0.0004**	**0.0003**	0.0003	0.0004
Malaysia	CPI YoY	Coef.	0.0006	**-0.0002**	-0.0005	-0.0004	-0.0003	-0.0002	-0.0001	0.0005	-0.0006	-0.0002	0.0000	-0.0001
		s.e.	0.0009	**0.0001**	0.0005	0.0004	0.0007	0.0006	0.0005	0.0010	0.0004	0.0003	0.0004	0.0003
Malaysia	GDP YoY%	Coef.	**0.0024**	-0.0001	0.0016	**0.0014**	0.0008	-0.0008	0.0002	0.0017	**0.0016**	0.0007	0.0004	0.0004
		s.e.	**0.0011**	0.0002	0.0009	**0.0007**	0.0011	0.0009	0.0008	0.0011	**0.0006**	0.0004	0.0005	0.0004
Malaysia	Industrial Production YoY	Coef.	0.0005	-0.0001	-0.0002	0.0002	-0.0003	-0.0010	**-0.0010**	0.0000	**-0.0007**	-0.0003	0.0000	-0.0002
		s.e.	0.0011	0.0001	0.0005	0.0003	0.0006	0.0008	**0.0005**	0.0010	**0.0004**	0.0003	0.0004	0.0002

Table 4.14: Event-Study Analysis and Market Efficiency (*continued*)

Country	Event		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Malaysia	Overnight Rate	Coef.	0.0007	-0.0001	**0.0017**	**0.0011**	-0.0008	**0.0023**	0.0004	0.0008	0.0003	0.0001	0.0033	0.0006
		s.e.	0.0021	0.0002	**0.0006**	**0.0005**	0.0014	**0.0010**	0.0006	0.0019	0.0007	0.0006	0.0020	0.0004
Malaysia	Trade Balance	Coef.	0.0003	-0.0005	**-0.0012**	-0.0005	-0.0007	-0.0007	**-0.0007**	0.0000	**-0.0009**	-0.0001	-0.0003	0.0001
		s.e.	0.0013	0.0004	**0.0005**	0.0004	0.0008	0.0009	**0.0003**	0.0010	**0.0004**	0.0003	0.0004	0.0003
New Zealand	Consumer Prices (QoQ)	Coef.	0.0003	-0.0001	0.0007	0.0006	-0.0004	0.0005	**0.0019**	0.0008	0.0005	0.0005	-0.0002	0.0005
		s.e.	0.0012	0.0003	0.0009	0.0004	0.0011	0.0010	**0.0008**	0.0014	0.0011	0.0004	0.0011	0.0005
New Zealand	GDP QoQ	Coef.	-0.0007	NA	0.0001	-0.0002	-0.0002	**0.0015**	-0.0005	0.0001	-0.0001	0.0003	0.0001	0.0005
		s.e.	0.0009	NA	0.0010	0.0007	0.0007	**0.0007**	0.0006	0.0011	0.0004	0.0003	0.0005	0.0004
New Zealand	RBNZ Official Cash Rate	Coef.	-0.0005	0.0000	0.0000	0.0001	-0.0007	0.0003	-0.0004	-0.0002	-0.0001	**-0.0006**	-0.0006	-0.0003
		s.e.	0.0010	0.0001	0.0009	0.0004	0.0007	0.0009	0.0005	0.0014	0.0004	**0.0003**	0.0005	0.0003
New Zealand	Retail Sales (MoM)	Coef.	0.0000	**-0.0002**	0.0009	0.0001	-0.0004	-0.0004	0.0000	0.0001	-0.0005	0.0001	0.0003	0.0000
		s.e.	0.0008	**0.0001**	0.0008	0.0003	0.0006	0.0006	0.0005	0.0008	0.0010	0.0003	0.0004	0.0002
New Zealand	Trade Balance	Coef.	0.0000	**-0.0003**	-0.0005	-0.0003	**-0.0010**	0.0003	-0.0004	0.0006	-0.0001	-0.0003	0.0007	-0.0002
		s.e.	0.0009	**0.0001**	0.0008	0.0003	**0.0006**	0.0006	0.0004	0.0009	0.0005	0.0003	0.0006	0.0002
New Zealand	Unemployment Rate	Coef.	0.0005	-0.0001	0.0026	0.0008	-0.0006	0.0014	0.0035	0.0013	0.0007	**0.0013**	-0.0005	0.0004
		s.e.	0.0014	0.0002	0.0042	0.0005	0.0014	0.0013	0.0024	0.0016	0.0005	**0.0008**	0.0013	0.0005
Philippines	Consumer Price Index NSA (MoM)	Coef.	-0.0007	-0.0001	-0.0005	-0.0004	0.0006	0.0006	-0.0002	-0.0004	-0.0003	0.0003	-0.0003	0.0001
		s.e.	0.0013	0.0001	0.0006	0.0006	0.0011	0.0010	0.0004	0.0014	0.0006	0.0004	0.0005	0.0003
Philippines	Gross Domestic Product (YoY)	Coef.	0.0021	**-0.0005**	0.0006	0.0004	0.0002	-0.0005	0.0004	0.0020	-0.0003	0.0004	0.0007	-0.0007
		s.e.	0.0013	**0.0001**	0.0014	0.0007	0.0012	0.0006	0.0006	0.0014	0.0007	0.0005	0.0005	0.0004
Philippines	Overnight Borrowing Rate	Coef.	0.0031	**-0.0002**	0.0000	0.0001	-0.0012	0.0005	-0.0002	**0.0032**	0.0000	-0.0001	-0.0002	-0.0004
		s.e.	0.0021	**0.0001**	0.0007	0.0007	0.0012	0.0013	0.0005	**0.0018**	0.0005	0.0004	0.0008	0.0004
Singapore	Advance GDP Estimate (QoQ)	Coef.	-0.0012	-0.0004	-0.0004	-0.0006	-0.0011	-0.0032	**-0.0016**	-0.0010	**-0.0020**	-0.0009	**-0.0018**	**-0.0015**
		s.e.	0.0031	0.0003	0.0013	0.0009	0.0014	0.0030	**0.0007**	0.0017	**0.0007**	0.0009	**0.0005**	**0.0006**
Singapore	CPI (YoY)	Coef.	-0.0007	-0.0001	0.0003	0.0000	0.0004	0.0003	-0.0004	-0.0008	0.0000	-0.0002	-0.0002	-0.0002
		s.e.	0.0007	0.0001	0.0005	0.0004	0.0005	0.0007	0.0005	0.0007	0.0003	0.0003	0.0004	0.0003
Singapore	GDP (YoY)	Coef.	-0.0009	-0.0002	0.0008	0.0000	0.0001	-0.0005	0.0002	0.0004	-0.0006	0.0003	0.0000	-0.0004
		s.e.	0.0015	0.0002	0.0015	0.0010	0.0015	0.0011	0.0008	0.0016	0.0008	0.0006	0.0007	0.0007
Singapore	Industrial Production YoY	Coef.	0.0000	0.0000	0.0005	0.0002	-0.0008	-0.0003	-0.0003	0.0008	0.0005	0.0003	-0.0005	0.0002
		s.e.	0.0007	0.0001	0.0005	0.0003	0.0006	0.0005	0.0004	0.0008	0.0005	0.0003	0.0010	0.0002
Singapore	Non-oil Domestic Exports (YoY)	Coef.	0.0002	**-0.0002**	0.0000	-0.0001	-0.0001	-0.0003	-0.0003	0.0002	0.0005	-0.0001	0.0004	0.0001
		s.e.	0.0007	**0.0001**	0.0005	0.0004	0.0005	0.0007	0.0005	0.0008	0.0004	0.0003	0.0004	0.0002

Table 4.14: Event-Study Analysis and Market Efficiency (*continued*)

Country	Event		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Singapore	Retail Sales (YoY)	Coef.	0.0013	0.0000	0.0009	0.0002	-0.0009	**0.0012**	0.0007	0.0014	**0.0009**	0.0005	0.0004	0.0004
		s.e.	0.0010	0.0001	0.0007	0.0004	0.0009	**0.0007**	0.0004	0.0010	**0.0005**	0.0004	0.0004	0.0003
Singapore	Unemployment Rate (sa)	Coef.	-0.0003	**-0.0003**	-0.0007	0.0002	-0.0018	-0.0022	-0.0006	-0.0004	**-0.0020**	0.0000	0.0008	-0.0004
		s.e.	0.0021	**0.0002**	0.0016	0.0008	0.0013	0.0028	0.0006	0.0022	**0.0009**	0.0006	0.0006	0.0011
Thailand	Benchmark Interest Rate	Coef.	0.0014	**-0.0003**	0.0004	**-0.0010**	0.0001	0.0003	0.0000	0.0013	**-0.0014**	**-0.0015**	**-0.0014**	-0.0002
		s.e.	0.0021	**0.0001**	0.0005	**0.0005**	0.0012	0.0016	0.0005	0.0016	**0.0008**	**0.0005**	**0.0006**	0.0005
Thailand	Current Account Balance (USD)	Coef.	-0.0005	**-0.0002**	**-0.0010**	-0.0006	-0.0011	-0.0015	**-0.0008**	-0.0007	**-0.0012**	**-0.0009**	0.0000	**-0.0011**
		s.e.	0.0011	**0.0001**	**0.0006**	0.0006	0.0007	0.0010	**0.0004**	0.0011	**0.0005**	**0.0003**	0.0008	**0.0004**
Thailand	Consumer Price Index (YoY)	Coef.	-0.0004	0.0001	-0.0001	-0.0003	0.0004	-0.0011	-0.0005	-0.0007	-0.0003	0.0002	0.0001	-0.0003
		s.e.	0.0009	0.0002	0.0006	0.0006	0.0007	0.0008	0.0005	0.0010	0.0004	0.0004	0.0005	0.0004
Thailand	Gross Domestic Product (YoY)	Coef.	-0.0014	0.0000	0.0002	0.0008	0.0005	0.0002	-0.0007	-0.0012	0.0009	0.0001	-0.0011	0.0000
		s.e.	0.0015	0.0002	0.0010	0.0006	0.0012	0.0009	0.0009	0.0015	0.0007	0.0005	0.0007	0.0004
Thailand	Manufacturing Production (YoY)	Coef.	-0.0007	**-0.0002**	-0.0010	-0.0005	-0.0009	-0.0011	**-0.0008**	-0.0005	**-0.0011**	**-0.0008**	-0.0001	**-0.0010**
		s.e.	0.0011	**0.0001**	0.0006	0.0005	0.0007	0.0009	**0.0004**	0.0011	**0.0005**	**0.0003**	0.0008	**0.0004**
Taiwan	Benchmark Interest Rate	Coef.	**-0.0026**	NA	-0.0008	-0.0003	-0.0010	-0.0018	NA	**-0.0024**	0.0003	**-0.0014**	**-0.0018**	-0.0010
		s.e.	**0.0014**	NA	0.0010	0.0011	0.0014	0.0020	NA	**0.0013**	0.0007	**0.0006**	**0.0009**	0.0007
Taiwan	Current Account Balance (USD)	Coef.	0.0035	-0.0001	-0.0001	0.0014	-0.0038	0.0053	-0.0001	0.0025	**0.0029**	0.0001	-0.0010	0.0003
		s.e.	0.0034	0.0001	0.0016	0.0011	0.0023	0.0034	0.0010	0.0025	**0.0013**	0.0009	0.0014	0.0006
Taiwan	CPI YoY%	Coef.	0.0025	-0.0001	-0.0005	0.0009	0.0000	0.0003	0.0002	**0.0025**	-0.0005	0.0006	-0.0003	-0.0001
		s.e.	0.0017	0.0001	0.0008	0.0006	0.0011	0.0011	0.0005	**0.0014**	0.0005	0.0004	0.0005	0.0004
Taiwan	GDP - Constant Prices (YoY)	Coef.	0.0014	-0.0002	0.0013	0.0011	0.0005	**0.0027**	0.0007	0.0010	-0.0003	0.0006	0.0006	0.0003
		s.e.	0.0020	0.0002	0.0008	0.0007	0.0014	**0.0014**	0.0008	0.0017	0.0014	0.0005	0.0004	0.0004
Taiwan	Industrial Production (YoY)	Coef.	-0.0008	-0.0001	0.0000	0.0001	-0.0002	0.0005	-0.0003	-0.0009	-0.0004	-0.0004	-0.0002	-0.0004
		s.e.	0.0007	0.0001	0.0004	0.0004	0.0007	0.0007	0.0005	0.0007	0.0003	0.0004	0.0004	0.0003
Taiwan	Total Trade Bal in US$ Billion	Coef.	-0.0014	0.0001	-0.0013	0.0008	0.0001	-0.0002	0.0001	0.0000	-0.0009	-0.0002	-0.0003	0.0006
		s.e.	0.0017	0.0002	0.0008	0.0007	0.0011	0.0020	0.0008	0.0020	0.0008	0.0006	0.0004	0.0006
Taiwan	Unemployment Rate - sa	Coef.	-0.0017	-0.0001	-0.0003	0.0009	-0.0001	**0.0016**	0.0001	-0.0014	0.0007	-0.0004	**-0.0010**	0.0003
		s.e.	0.0011	0.0001	0.0005	0.0005	0.0010	**0.0009**	0.0005	0.0013	0.0006	0.0005	**0.0006**	0.0004
United States	Advance Retail Sales	Coef.	-0.0003	**-0.0003**	0.0011	0.0002	0.0003	0.0003	-0.0005	-0.0004	0.0001	-0.0002	-0.0004	0.0002
		s.e.	0.0006	**0.0001**	0.0013	0.0003	0.0005	0.0008	0.0015	0.0006	0.0006	0.0003	0.0006	0.0002
United States	Avg Hourly Earning MOM Prod	Coef.	-0.0002	-0.0001	-0.0011	-0.0003	**0.0011**	0.0000	0.0007	0.0000	-0.0001	-0.0002	-0.0002	0.0000
		s.e.	0.0007	0.0001	0.0007	0.0002	**0.0006**	0.0004	0.0005	0.0007	0.0003	0.0003	0.0003	0.0002

Table 4.14: Event-Study Analysis and Market Efficiency (*continued*)

Country	Event		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
United States	Building Permits	Coef.	-0.0013	-0.0001	0.0000	-0.0001	-0.0006	-0.0012	-0.0008	-0.0011	-0.0002	-0.0004	0.0001	0.0001
		s.e.	0.0009	0.0001	0.0004	0.0004	0.0007	0.0008	0.0005	0.0010	0.0004	0.0003	0.0005	0.0003
United States	Business Inventories	Coef.	0.0000	**-0.0003**	0.0008	0.0003	-0.0005	0.0001	-0.0002	0.0002	0.0009	0.0002	-0.0006	0.0001
		s.e.	0.0007	**0.0001**	0.0015	0.0003	0.0006	0.0005	0.0009	0.0007	0.0006	0.0003	0.0005	0.0002
United States	Capacity Utilization	Coef.	0.0006	**-0.0002**	0.0005	-0.0002	0.0001	0.0000	-0.0002	0.0005	**0.0014**	0.0000	-0.0002	**0.0006**
		s.e.	0.0006	**0.0001**	0.0013	0.0003	0.0006	0.0009	0.0007	0.0006	**0.0007**	0.0003	0.0006	**0.0003**
United States	Change in Manufact. Payrolls	Coef.	0.0002	**-0.0002**	**-0.0014**	-0.0004	**0.0014**	0.0001	-0.0002	0.0004	-0.0004	**-0.0005**	-0.0003	0.0000
		s.e.	0.0007	**0.0001**	**0.0006**	0.0003	**0.0007**	0.0005	0.0004	0.0007	0.0003	**0.0003**	0.0003	0.0002
United States	Change in Nonfarm Payrolls	Coef.	0.0002	**-0.0002**	-0.0015	-0.0003	**0.0015**	0.0001	-0.0002	0.0004	-0.0003	-0.0001	**-0.0010**	0.0000
		s.e.	0.0006	**0.0001**	0.0013	0.0002	**0.0006**	0.0005	0.0007	0.0006	0.0004	0.0003	**0.0005**	0.0002
United States	Chicago Purchasing Manager	Coef.	**-0.0015**	**-0.0002**	**-0.0023**	**-0.0006**	-0.0009	-0.0013	**-0.0015**	**-0.0011**	**-0.0007**	**-0.0010**	-0.0001	**-0.0007**
		s.e.	**0.0007**	**0.0001**	**0.0007**	**0.0003**	0.0006	0.0008	**0.0008**	**0.0007**	**0.0003**	**0.0003**	0.0005	**0.0002**
United States	Consumer Confidence	Coef.	-0.0003	-0.0002	-0.0017	0.0000	-0.0001	**0.0017**	0.0001	0.0006	0.0001	-0.0003	-0.0008	0.0000
		s.e.	0.0006	0.0001	0.0016	0.0002	0.0006	**0.0010**	0.0007	0.0006	0.0004	0.0003	0.0005	0.0002
United States	Consumer Price Index (MoM)	Coef.	0.0003	-0.0001	-0.0015	0.0001	-0.0005	0.0013	-0.0005	-0.0001	-0.0002	-0.0003	0.0002	0.0004
		s.e.	0.0007	0.0001	0.0010	0.0003	0.0006	0.0008	0.0009	0.0008	0.0005	0.0003	0.0006	0.0003
United States	Current Account Balance	Coef.	-0.0011	-0.0003	-0.0023	0.0000	**-0.0024**	-0.0014	-0.0004	0.0002	-0.0002	-0.0010	0.0004	-0.0005
		s.e.	0.0011	0.0002	0.0018	0.0004	**0.0009**	0.0013	0.0016	0.0013	0.0005	0.0007	0.0010	0.0005
United States	Durable Goods Orders	Coef.	-0.0004	**-0.0003**	0.0001	0.0000	-0.0007	-0.0004	-0.0003	0.0000	0.0000	-0.0001	-0.0006	**-0.0005**
		s.e.	0.0007	**0.0001**	0.0009	0.0003	0.0005	0.0011	0.0005	0.0008	0.0004	0.0002	0.0004	**0.0002**
United States	Empire Manufacturing	Coef.	**0.0022**	0.0001	**0.0013**	0.0005	-0.0011	**0.0014**	**0.0013**	**0.0020**	**0.0013**	0.0005	0.0001	0.0005
		s.e.	**0.0009**	0.0001	**0.0006**	0.0005	0.0008	**0.0008**	**0.0005**	**0.0010**	**0.0005**	0.0004	0.0005	0.0003
United States	Factory Orders	Coef.	-0.0003	-0.0001	0.0016	**-0.0007**	0.0009	0.0002	**0.0023**	-0.0006	0.0004	0.0005	0.0015	-0.0002
		s.e.	0.0006	0.0001	0.0015	**0.0003**	0.0006	0.0007	**0.0012**	0.0006	0.0004	0.0003	0.0013	0.0002
United States	FOMC Rate Decision	Coef.	-0.0005	**-0.0005**	**-0.0029**	-0.0002	-0.0006	**-0.0023**	-0.0005	-0.0003	-0.0006	-0.0002	-0.0008	**-0.0009**
		s.e.	0.0010	**0.0001**	**0.0013**	0.0004	0.0008	**0.0013**	0.0010	0.0011	0.0005	0.0004	0.0006	**0.0003**
United States	GDP Price Deflator	Coef.	-0.0006	**-0.0003**	-0.0002	-0.0002	-0.0005	-0.0002	-0.0005	-0.0010	-0.0002	**-0.0007**	-0.0002	0.0000
		s.e.	0.0007	**0.0001**	0.0008	0.0003	0.0005	0.0009	0.0005	0.0007	0.0003	**0.0003**	0.0004	0.0002
United States	GDP QoQ (Annualized)	Coef.	-0.0006	**-0.0003**	0.0003	-0.0002	-0.0007	0.0000	-0.0003	-0.0008	0.0002	**-0.0006**	0.0001	-0.0001
		s.e.	0.0007	**0.0001**	0.0009	0.0003	0.0005	0.0013	0.0007	0.0007	0.0004	**0.0003**	0.0004	0.0002
United States	Housing Starts	Coef.	**-0.0013**	-0.0001	-0.0001	-0.0001	-0.0008	**-0.0009**	-0.0007	**-0.0017**	-0.0003	-0.0004	0.0000	0.0001
		s.e.	**0.0007**	0.0001	0.0011	0.0002	0.0005	**0.0005**	0.0006	**0.0008**	0.0004	0.0003	0.0004	0.0002

Table 4.14: Event-Study Analysis and Market Efficiency (*continued*)

Country	Event		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
United States	Import Price Index (MoM)	Coef.	0.0001	**-0.0002**	0.0000	0.0001	-0.0002	-0.0008	**-0.0009**	-0.0002	-0.0001	-0.0002	0.0000	0.0001
		s.e.	0.0008	**0.0001**	0.0007	0.0003	0.0006	0.0006	**0.0005**	0.0008	0.0003	0.0002	0.0003	0.0002
United States	Industrial Production	Coef.	0.0005	**-0.0002**	0.0010	-0.0002	-0.0001	-0.0003	-0.0002	0.0005	**0.0015**	0.0001	-0.0002	**0.0006**
		s.e.	0.0006	**0.0001**	0.0012	0.0003	0.0006	0.0008	0.0007	0.0006	**0.0008**	0.0003	0.0006	**0.0003**
United States	Initial Jobless Claims	Coef.	-0.0005	**-0.0002**	0.0006	0.0001	-0.0003	0.0001	0.0003	-0.0002	**0.0004**	-0.0002	-0.0002	**-0.0002**
		s.e.	0.0003	**0.0001**	0.0007	0.0001	0.0003	0.0004	0.0005	0.0004	**0.0002**	0.0001	0.0003	**0.0001**
United States	ISM Manufacturing	Coef.	**-0.0011**	0.0001	0.0004	-0.0001	-0.0002	-0.0002	-0.0001	**-0.0012**	-0.0002	0.0001	-0.0002	-0.0002
		s.e.	**0.0006**	0.0002	0.0012	0.0003	0.0006	0.0006	0.0010	**0.0006**	0.0005	0.0003	0.0006	0.0002
United States	ISM Non-Manufacturing	Coef.	-0.0004	**-0.0001**	-0.0003	**-0.0006**	0.0006	-0.0007	-0.0005	-0.0006	-0.0005	0.0001	-0.0004	-0.0002
		s.e.	0.0006	**0.0001**	0.0006	**0.0003**	0.0005	0.0004	0.0004	0.0006	0.0004	0.0002	0.0004	0.0002
United States	Leading Indicators	Coef.	-0.0003	**-0.0003**	0.0011	0.0000	-0.0004	0.0006	0.0007	-0.0007	-0.0003	-0.0001	-0.0008	-0.0003
		s.e.	0.0007	**0.0001**	0.0008	0.0003	0.0006	0.0006	0.0011	0.0007	0.0004	0.0003	0.0006	0.0002
United States	New Home Sales	Coef.	0.0001	**-0.0002**	**0.0018**	0.0001	-0.0005	0.0000	0.0009	**0.0012**	-0.0003	-0.0001	0.0005	0.0000
		s.e.	0.0006	**0.0001**	**0.0008**	0.0002	0.0005	0.0004	0.0010	**0.0006**	0.0004	0.0003	0.0006	0.0002
United States	Personal Income	Coef.	**-0.0017**	0.0001	-0.0008	**-0.0005**	-0.0003	-0.0011	**-0.0016**	**-0.0016**	**-0.0007**	-0.0002	-0.0003	-0.0002
		s.e.	**0.0005**	0.0001	0.0011	**0.0003**	0.0005	0.0008	**0.0007**	**0.0006**	**0.0004**	0.0002	0.0006	0.0003
United States	Personal Spending	Coef.	**-0.0017**	0.0000	-0.0004	**-0.0005**	-0.0003	-0.0009	**-0.0015**	**-0.0016**	**-0.0007**	-0.0002	-0.0003	-0.0003
		s.e.	**0.0005**	0.0001	0.0011	**0.0003**	0.0005	0.0008	**0.0007**	**0.0006**	**0.0004**	0.0002	0.0006	0.0003
United States	Philadelphia Fed.	Coef.	-0.0005	**-0.0002**	-0.0005	-0.0003	-0.0007	0.0011	0.0001	-0.0002	0.0002	0.0000	-0.0006	**-0.0004**
		s.e.	0.0007	**0.0001**	0.0014	0.0003	0.0006	0.0010	0.0007	0.0008	0.0004	0.0003	0.0005	**0.0003**
United States	Producer Price Index (MoM)	Coef.	-0.0004	**-0.0004**	0.0018	0.0001	-0.0001	0.0009	-0.0003	-0.0010	0.0005	-0.0001	-0.0001	0.0002
		s.e.	0.0006	**0.0001**	0.0025	0.0002	0.0006	0.0006	0.0010	0.0007	0.0005	0.0003	0.0007	0.0002
United States	Trade Balance	Coef.	0.0000	**-0.0002**	-0.0002	0.0001	0.0005	-0.0001	0.0008	0.0000	-0.0005	-0.0001	-0.0002	-0.0003
		s.e.	0.0007	**0.0001**	0.0012	0.0002	0.0006	0.0009	0.0008	0.0008	0.0008	0.0003	0.0006	0.0002
United States	U. of Michigan Confidence	Coef.	-0.0003	-0.0001	-0.0003	**-0.0004**	-0.0006	0.0003	**-0.0005**	-0.0006	-0.0005	-0.0001	0.0002	**0.0002**
		s.e.	0.0005	0.0001	0.0004	**0.0002**	0.0004	0.0004	**0.0003**	0.0005	0.0004	0.0002	0.0003	**0.0001**
United States	Unemployment Rate	Coef.	-0.0003	**-0.0002**	-0.0012	-0.0004	**0.0010**	0.0003	-0.0001	-0.0001	-0.0002	-0.0003	**-0.0009**	-0.0001
		s.e.	0.0006	**0.0001**	0.0013	0.0002	**0.0006**	0.0006	0.0006	0.0006	0.0004	0.0003	**0.0004**	0.0002
United States	Wholesale Inventories	Coef.	-0.0002	**-0.0003**	-0.0025	0.0000	**-0.0011**	0.0001	-0.0007	-0.0001	-0.0003	-0.0001	-0.0003	0.0003
		s.e.	0.0007	**0.0001**	0.0016	0.0003	**0.0005**	0.0007	0.0010	0.0007	0.0004	0.0003	0.0005	0.0002
Total Significant α			16	43	13	17	10	12	17	14	23	15	13	16

The numbers in bold indicate significance at the minimum 10% level. The values of α show the percentage change in the exchange rates during the macroeconomic announcement. For example, whenever there is an announcement related to the Australian consumer prices, the AUD would depreciate against the USD by 0.23% with a standard error of estimate of 0.12% hence rendering this α significant at the 10% level. And a significant α implies a violation of market efficiency. As expected, we find some significant α's in the Asia-Pacific foreign exchange markets. However, as mentioned, we do not jump to the conclusion that market efficiency is violated merely because of the detection of some significant α's. Out of the 107 macroeconomic shocks, only less than 20 significant α's are reported for 10 of the 12 Asia-Pacific currencies. The CNY and PHP show 43 and 24 significant α's respectively. The JPY records the lowest number of rejections of market efficiency with only 10 significant α's. The relatively small number of significant α's for most of the currency markets (i.e. less than 20% of the total macroeconomic indicators) provide evidence that the markets are more likely efficient than not. Our results provide support to Almeida, Goodhart & Payne (1998) which also confirm market efficiency. We consider this finding as an encouraging support for market efficiency for most of the Asia-Pacific foreign exchange markets with the exception of CNY. The CNY is managed under the crawling-peg regime and as a result, we could not exactly interpret the finding of 43 significant α's as implying market inefficiency. The results related to CNY are, at best, tepid evidence against market efficiency for the CNY market.

Upon establishing support for market efficiency in the Asia-Pacific foreign exchange markets, we have extended our study to identify which of the macroeconomic surprises are more significant in affecting the exchange rate movements and also the quantum of change the surprises impinge on the exchange rates. We look at the U.S. macroeconomic surprises first and followed by the domestic macroeconomic surprises

and finally the joint comparison of all the macroeconomic surprises. In assessing the impact of the macroeconomic surprises on the exchange rates, our study resembles, in a limited way, Cai, Joo & Huang (2009) which used a sample of nine emerging market currencies and a mixture of U.S. as well as domestic macroeconomic shocks. However, only four of our 12 Asia-Pacific currencies overlap with Cai, Joo & Huang (2009) which investigated the announcements for the period of 2000 to 2006. Therefore this portion of our study is only related in a very limited way to their study.

4.2.2 Impact of the United States Macroeconomic Shocks

The United States (U.S.) is the largest economy in the world. The announcements made from the U.S. are keenly watched and studied by a sizeable number of interested groups. The data from the U.S. are also more properly recorded and made available to the mass public. Most of the macroeconomic announcements from the U.S. also contain market expectations data. We have chosen 33 macroeconomic announcements from the U.S. and out of this number, eight (8) indicators fall into the first category: Interest rates, prices and money (IPM), 18 indicators in the second category: Production and business activity (PBA) while the balance of the indicators (7) in the third category: Total output, international trade and employment (TOITE). We expect most of the surprises from the U.S. macroeconomic announcements to be significant because of the importance of the U.S. economy.

In the previous section, we analyse the estimated α to derive market efficiency while in this section, we look at the estimated β to measure the relative impact of the macroeconomic shocks. The estimated beta indicates the impact of one standard deviation shock in a U.S. macroeconomic announcement on the Asia-Pacific exchange rates. The results of the estimated β from equation 4.6 for the U.S. macroeconomic shocks are presented in Table 4.15 in the following pages.

Table 4.15: Exchange Rates Reaction to the U.S. Macroeconomic Surprises

The United States (US) is the largest economy in the world and hence its macroeconomic announcements are closely watched and studied by many interested groups in the world. We estimate the regression of $\Delta s_t = \alpha_i + \beta_i N_{i,t} + \varepsilon_t$ where Δs is the one-day change in the exchange rate and N denotes the standardised surprises in the macroeconomic announcement i. The first column shows the name of the US macroeconomic indicators while the second column indicates the category in which the macroeconomic indicators fall into (i.e. IPM = Interest rate, Prices and Money; PBA = Production and Business Activity; TOITE = Total Output, International Trade and Employment. There are two rows to each event: the upper row reports the estimated β coefficient and the lower row the corresponding standard error of estimates. The results for each country are reported in the following 12 columns. The estimated β measures the impact of standard deviation shock of the macroeconomic announcement on the exchange rates for each currency pair in our sample. The values of the β are comparable because the macroeconomic shocks have been standardised. For example, a positive shock of one standard deviation in the Advance Retail Sales announcement will cause a depreciation of 0.13% in the AUD against the USD (i.e. positive implies depreciation against USD while negative otherwise). Meanwhile the same shock will cause the JPY and NZD to depreciate by 0.11% and 0.10% against the USD respectively. This implies that the Advance Retail Sales announcement shock has a larger significant impact on the AUD than the other two currencies, JPY and NZD.

Event	Category		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Avg Hourly Earning MOM Prod	IPM	Coef.	0.0005	-0.0001	0.0011	-0.0001	0.0003	0.0000	**-0.0013**	0.0003	0.0002	-0.0001	0.0004	0.0000
		s.e.	0.0007	0.0001	0.0008	0.0003	0.0006	0.0004	**0.0006**	0.0008	0.0003	0.0003	0.0003	0.0002
Consumer Price Index (MoM)	IPM	Coef.	-0.0004	-0.0001	0.0000	-0.0001	**0.0015**	**-0.0012**	-0.0006	0.0000	0.0001	0.0005	0.0002	-0.0003
		s.e.	0.0007	0.0001	0.0006	0.0003	**0.0006**	**0.0007**	0.0005	0.0009	0.0003	0.0003	0.0003	0.0002
FOMC Rate Decision	IPM	Coef.	**0.0030**	**0.0002**	0.0004	0.0005	**0.0015**	0.0006	**0.0012**	**0.0048**	0.0006	0.0009	**0.0004**	0.0003
		s.e.	**0.0009**	**0.0001**	0.0008	0.0004	**0.0006**	0.0012	**0.0006**	**0.0012**	0.0005	0.0006	**0.0002**	0.0006
GDP Price Deflator	IPM	Coef.	-0.0010	-0.0002	**-0.0015**	0.0000	-0.0002	0.0002	-0.0004	**-0.0015**	**-0.0006**	-0.0004	0.0000	**-0.0004**
		s.e.	0.0007	0.0001	**0.0006**	0.0002	0.0004	0.0004	0.0009	**0.0008**	**0.0002**	0.0003	0.0003	**0.0001**
Import Price Index (MoM)	IPM	Coef.	0.0003	0.0000	0.0001	0.0003	0.0009	**0.0013**	0.0009	-0.0001	-0.0001	**0.0006**	**0.0007**	**0.0005**
		s.e.	0.0008	0.0001	0.0007	0.0004	0.0006	**0.0007**	0.0006	0.0009	0.0004	**0.0003**	**0.0003**	**0.0002**
Personal Income	IPM	Coef.	0.0004	-0.0001	0.0009	-0.0001	-0.0007	0.0006	**0.0005**	0.0004	0.0000	0.0000	-0.0003	0.0000
		s.e.	0.0005	0.0001	0.0005	0.0004	0.0006	0.0006	**0.0003**	0.0007	0.0003	0.0002	0.0002	0.0002
Personal Spending	IPM	Coef.	**0.0009**	-0.0001	-0.0006	-0.0002	-0.0003	0.0002	0.0000	0.0005	0.0007	-0.0003	0.0006	0.0003
		s.e.	**0.0005**	0.0001	0.0005	0.0003	0.0006	0.0007	0.0007	0.0005	0.0004	0.0002	0.0006	0.0002
Producer Price Index (MoM)	IPM	Coef.	0.0001	0.0000	0.0001	-0.0003	0.0005	-0.0003	0.0005	0.0001	0.0004	0.0001	-0.0004	0.0002
		s.e.	0.0006	0.0001	0.0010	0.0002	0.0005	0.0005	0.0005	0.0006	0.0004	0.0003	0.0004	0.0002
Advance Retail Sales	PBA	Coef.	**0.0013**	0.0001	0.0001	0.0001	**0.0011**	0.0000	0.0011	**0.0010**	0.0002	0.0001	0.0003	0.0000
		s.e.	**0.0006**	0.0001	0.0005	0.0002	**0.0006**	0.0004	0.0007	**0.0005**	0.0003	0.0003	0.0003	0.0002
Building Permits	PBA	Coef.	0.0012	0.0000	0.0004	0.0001	**0.0019**	**0.0014**	0.0003	**0.0018**	**0.0010**	**0.0006**	-0.0003	0.0002
		s.e.	0.0008	0.0001	0.0003	0.0003	**0.0006**	**0.0007**	0.0004	**0.0009**	**0.0003**	**0.0003**	0.0005	0.0003
Business Inventories	PBA	Coef.	-0.0003	0.0000	-0.0003	**0.0007**	0.0006	-0.0001	-0.0005	-0.0007	-0.0005	0.0000	0.0000	0.0003
		s.e.	0.0007	0.0001	0.0009	**0.0003**	0.0005	0.0005	0.0008	0.0006	0.0004	0.0002	0.0003	0.0002
Capacity Utilization	PBA	Coef.	0.0002	**-0.0001**	0.0007	-0.0002	0.0003	-0.0025	0.0001	0.0009	-0.0003	0.0003	0.0001	-0.0001
		s.e.	0.0007	**0.0001**	0.0010	0.0003	0.0010	0.0026	0.0006	0.0007	0.0006	0.0003	0.0005	0.0004

Table 4.15: Exchange Rates Reaction to the United States Macroeconomic Surprises (*continued*)

Event	Category		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Chicago Purchasing Manager	PBA	Coef.	**0.0015**	0.0000	0.0002	0.0002	0.0009	-0.0006	**0.0010**	**0.0011**	0.0003	0.0001	-0.0003	0.0000
		s.e.	**0.0006**	0.0001	0.0007	0.0002	0.0006	0.0007	**0.0006**	**0.0006**	0.0003	0.0003	0.0005	0.0003
Consumer Confidence	PBA	Coef.	**0.0017**	0.0001	0.0008	**0.0004**	-0.0009	0.0021	0.0003	**0.0018**	0.0004	**0.0008**	0.0003	0.0004
		s.e.	**0.0007**	0.0001	0.0017	**0.0002**	0.0012	0.0014	0.0008	**0.0007**	0.0003	**0.0004**	0.0005	0.0003
Durable Goods Orders	PBA	Coef.	0.0000	0.0000	-0.0007	**-0.0006**	0.0000	0.0005	-0.0004	0.0002	-0.0004	-0.0002	0.0001	0.0000
		s.e.	0.0007	0.0001	0.0009	**0.0003**	0.0005	0.0015	0.0004	0.0007	0.0003	0.0002	0.0005	0.0001
Empire Manufacturing	PBA	Coef.	**-0.0014**	-0.0001	**-0.0009**	**-0.0008**	0.0011	-0.0004	**-0.0010**	-0.0006	-0.0004	-0.0002	-0.0003	-0.0004
		s.e.	**0.0009**	0.0001	**0.0004**	**0.0004**	0.0008	0.0008	**0.0006**	0.0009	0.0004	0.0003	0.0004	0.0002
Factory Orders	PBA	Coef.	0.0011	-0.0001	-0.0002	**0.0008**	-0.0001	0.0002	0.0002	0.0007	0.0003	0.0004	-0.0010	-0.0001
		s.e.	0.0007	0.0001	0.0005	**0.0004**	0.0005	0.0005	0.0003	0.0007	0.0003	0.0003	0.0010	0.0002
Housing Starts	PBA	Coef.	0.0003	0.0000	-0.0002	0.0001	0.0008	0.0005	0.0002	0.0001	0.0004	0.0002	-0.0002	0.0001
		s.e.	0.0005	0.0001	0.0007	0.0002	0.0005	0.0004	0.0004	0.0006	0.0003	0.0003	0.0004	0.0002
Industrial Production	PBA	Coef.	-0.0001	-0.0001	**0.0025**	-0.0002	-0.0002	-0.0038	0.0001	0.0007	0.0005	**0.0004**	0.0003	0.0000
		s.e.	0.0007	0.0001	**0.0012**	0.0003	0.0009	0.0029	0.0005	0.0008	0.0006	**0.0002**	0.0004	0.0003
ISM Manufacturing	PBA	Coef.	0.0007	0.0001	-0.0013	0.0004	0.0008	0.0002	-0.0012	0.0008	0.0004	-0.0001	-0.0003	0.0002
		s.e.	0.0006	0.0001	0.0011	0.0003	0.0005	0.0007	0.0009	0.0006	0.0004	0.0003	0.0004	0.0002
ISM Non-Manufacturing	PBA	Coef.	**-0.0012**	0.0001	0.0011	-0.0002	0.0001	-0.0002	0.0001	**-0.0014**	0.0003	-0.0001	0.0000	0.0000
		s.e.	**0.0005**	0.0001	0.0008	0.0002	0.0004	0.0003	0.0003	**0.0006**	0.0003	0.0002	0.0003	0.0001
Leading Indicators	PBA	Coef.	**-0.0014**	**0.0001**	-0.0004	-0.0005	0.0005	-0.0010	-0.0008	-0.0009	0.0002	**-0.0008**	-0.0003	0.0001
		s.e.	**0.0008**	**0.0001**	0.0004	0.0004	0.0007	0.0007	0.0005	0.0008	0.0004	**0.0004**	0.0005	0.0002
New Home Sales	PBA	Coef.	-0.0009	0.0000	0.0004	0.0001	0.0000	**-0.0007**	0.0008	-0.0005	-0.0004	0.0001	0.0002	0.0001
		s.e.	0.0006	0.0001	0.0006	0.0002	0.0005	**0.0003**	0.0010	0.0007	0.0005	0.0002	0.0006	0.0002
Philadelphia Fed.	PBA	Coef.	-0.0002	0.0000	0.0015	0.0003	0.0005	**-0.0031**	0.0000	0.0001	**-0.0009**	0.0002	0.0008	-0.0004
		s.e.	0.0006	0.0001	0.0016	0.0003	0.0007	**0.0019**	0.0006	0.0007	**0.0004**	0.0003	0.0006	0.0003
U. of Michigan Confidence	PBA	Coef.	-0.0004	-0.0001	0.0002	-0.0001	0.0005	0.0000	-0.0003	-0.0003	0.0004	0.0002	0.0003	0.0000
		s.e.	0.0006	0.0001	0.0003	0.0001	0.0003	0.0004	0.0002	0.0005	0.0006	0.0001	0.0003	0.0001
Wholesale Inventories	PBA	Coef.	-0.0010	-0.0002	**-0.0031**	0.0001	-0.0001	0.0007	-0.0005	**-0.0013**	0.0002	-0.0002	-0.0005	-0.0002
		s.e.	0.0007	0.0002	**0.0017**	0.0003	0.0006	0.0008	0.0007	**0.0006**	0.0005	0.0003	0.0006	0.0003
Change in Manufact. Payrolls	TOITE	Coef.	**0.0017**	-0.0001	-0.0013	0.0002	**0.0012**	0.0003	0.0003	**0.0017**	0.0000	-0.0001	-0.0002	0.0000
		s.e.	**0.0007**	0.0001	0.0008	0.0002	**0.0006**	0.0005	0.0005	**0.0007**	0.0003	0.0002	0.0003	0.0002
Change in Nonfarm Payrolls	TOITE	Coef.	**0.0013**	0.0000	-0.0015	0.0003	**0.0018**	0.0001	-0.0013	**0.0015**	-0.0005	**0.0004**	-0.0008	0.0001
		s.e.	**0.0007**	0.0001	0.0018	0.0002	**0.0006**	0.0006	0.0009	**0.0007**	0.0004	**0.0002**	0.0005	0.0002

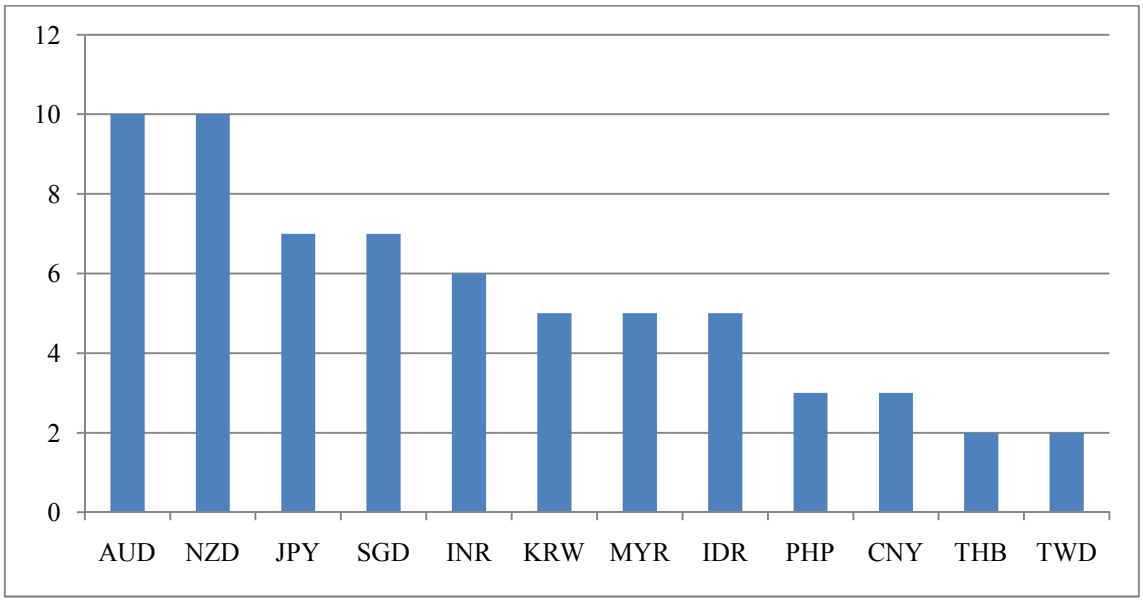
Table 4.15: Exchange Rates Reaction to the United States Macroeconomic Surprises (*continued*)

Event	Category		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Current Account Balance	TOITE	Coef.	0.0016	-0.0001	-0.0003	0.0001	0.0002	0.0020	0.0013	0.0013	0.0008	**0.0012**	0.0011	-0.0001
		s.e.	0.0015	0.0001	0.0015	0.0006	0.0009	0.0015	0.0012	0.0014	0.0006	**0.0005**	0.0008	0.0005
GDP QoQ (Annualized)	TOITE	Coef.	0.0013	-0.0001	-0.0008	0.0000	0.0007	-0.0012	0.0000	0.0013	-0.0004	0.0003	0.0000	-0.0002
		s.e.	0.0009	0.0001	0.0009	0.0003	0.0005	0.0010	0.0008	0.0008	0.0003	0.0003	0.0003	0.0002
Initial Jobless Claims	TOITE	Coef.	0.0002	0.0000	**0.0010**	**0.0003**	**-0.0005**	0.0005	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
		s.e.	0.0003	0.0000	**0.0006**	**0.0001**	**0.0003**	0.0004	0.0003	0.0003	0.0002	0.0001	0.0002	0.0001
Trade Balance	TOITE	Coef.	0.0006	0.0000	0.0012	0.0001	0.0005	0.0002	0.0001	0.0014	0.0001	0.0000	0.0002	0.0003
		s.e.	0.0006	0.0001	0.0008	0.0003	0.0005	0.0007	0.0006	0.0011	0.0003	0.0003	0.0004	0.0002
Unemployment Rate	TOITE	Coef.	-0.0004	0.0000	-0.0002	-0.0001	-0.0010	-0.0010	0.0003	-0.0001	0.0001	-0.0004	-0.0003	-0.0002
		s.e.	0.0007	0.0002	0.0011	0.0003	0.0006	0.0007	0.0005	0.0007	0.0003	0.0002	0.0004	0.0002

A positive beta value indicates appreciation of USD (i.e. depreciation of the particular Asia-Pacific currency) and a negative, otherwise. The first column of Table 4.15 shows the name of the events followed by their corresponding category. There are two rows to each currency. The upper row reports the value of the estimated beta and the lower one shows the corresponding standard error of estimates. Beta estimates which are significant at the minimum 10% level are in bold. Four interesting observations emerge from Table 4.15. Firstly, out of the 33 U.S. macroeconomic shocks, about 79% of them show significant impact on at least one currency. This implies that U.S. events are indeed important in affecting the Asia-Pacific exchange rates changes. Secondly, the effects of the macroeconomic surprises are mostly not homogenous across Asia-Pacific countries as the sign of the beta estimates among the currencies are usually different from one another for each shock. The only exceptions to this observation are the surprises in the Federal Fund Reserve (FFR) rate, Advance Retail Sales and Trade Balance which show a unanimous sign in the estimated beta. For example, a positive one standard deviation shock in the FFR rate will cause the USD to significantly appreciate by 0.3% against the AUD. Similar interpretation applies to other currencies and macroeconomic announcements.

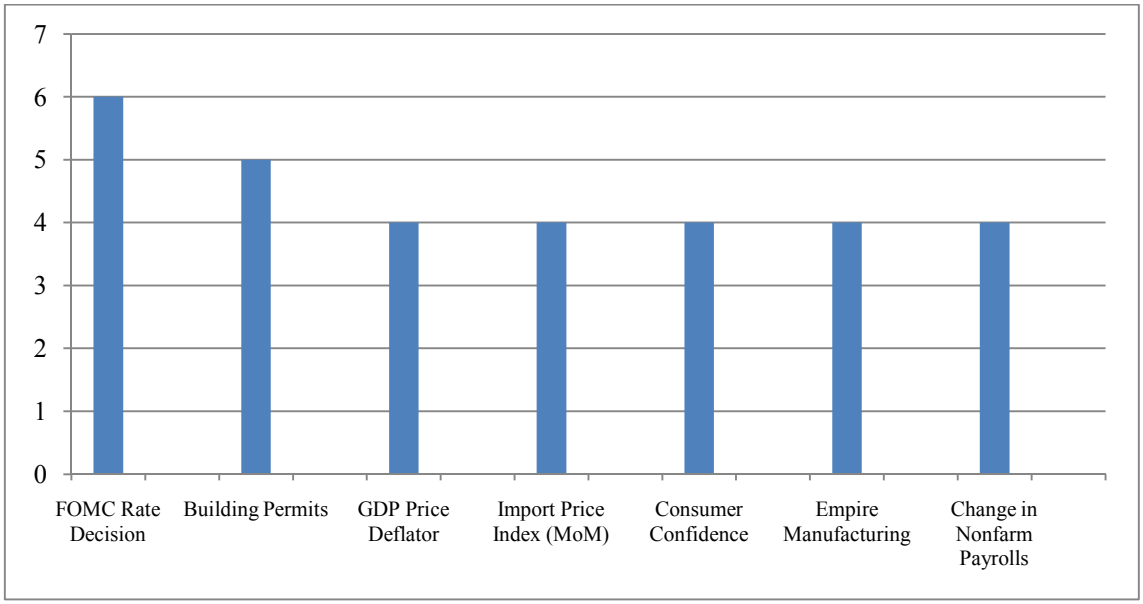
Thirdly, we are also able to compare the responsiveness of the 12 Asia-Pacific currencies to U.S. macroeconomic shocks. The currency which responds to the highest number of macroeconomic shocks is deemed as the most responsive. Figure 4.3 displays the assortment of the most responsive to the least responsive currencies among our sample. The AUD and NZD are the most responsive currencies to the U.S. macroeconomic surprises by reacting significantly to 10 out of the total 33 events. This is followed by JPY and SGD with seven (7) significant events each. The currencies which are least responsive to the U.S. events are THB and TWD.

Figure 4.3: Responsiveness of the Asia-Pacific Currencies to the U.S. Macroeconomic Shocks



The graph shows the number of significant United States (US) macroeconomic surprises detected for each exchange rate in Asia-Pacific. The number implies the responsiveness of the exchange rate to the US macroeconomic surprises. AUD and NZD are the most responsive currencies with 10 significant events followed by JPY and SGD with seven (7) events each. The least responsive currencies are THB and TWD with only two (2) events reported for each currency. THB and TWD are the least responsive currencies to the surprises in the US macroeconomic announcements. We observe that the developed/ rich economies display greater responsiveness to the US macroeconomic surprises.

Figure 4.4: Selected U.S. Macroeconomic Events



The graph shows the selected U.S. macroeconomic surprises which display significant impact to at least four (4) currencies. The surprises in the Federal Fund Reserve rate is the most influential among the US macroeconomic events as it significantly impacts six (6) currencies in the Asia-Pacific region followed by Building Permits surprises which impact five (5) currencies. The surprises of the GDP Price Deflator, Import Price Index, Consumer Confidence, Empire Manufacturing and Change in Nonfarm Payroll show significant impact to four (4) currencies each.

Naturally, we should note that the currencies which fall under the floating exchange-rate regime are more responsive than the currencies under different regime. Our results are in agreement with this natural intuition.

Lastly, we could also extract the most influential events from Table 4.15. The event which significantly impacts the highest number of currencies is deemed as the most influential. We extract the events which significantly affect at least four (4) currencies and tabulate them into Figure 4.4. There are seven (7) U.S. macroeconomic announcements which show significant impact to at least four (4) currencies. The leader of them all is the FFR rate announcement shock which impacts six (6) currencies in the sample. Economically, FFR rate will impact the prices of all financial assets across markets and this economic intuition is supported in our finding. It is also well-known that the FFR rate is widely reported as the most important monetary tool used by the U.S. Federal Reserve to manage the economy. However, the fact that not all currencies in the Asia-Pacific react significantly to this all-important event could be due to the different exchange-rate regime adopted by individual country. The non-reactive currencies to FFR rate surprises are IDR, INR, KRW, PHP, SGD and TWD. Most of these non-reactive currencies are well-known to be tightly managed by their own monetary authority and hence our suspicion is confirmed. The other top U.S. events are Building Permits with five currencies followed by GDP Price Deflator, Import Price Index, Consumer Confidence, Empire Manufacturing and Change in Nonfarm Payroll. In the following section, we shall look at the impact of Asia-Pacific (ex-U.S.) events on the regional exchange rates.

4.2.3 Impact of Domestic Macroeconomic Shocks

There are beliefs among the currency traders that domestic macroeconomic surprises are not as influential as U.S. macroeconomic shocks to the world exchange rates because of the relatively smaller size of the economies here. However, this argument may not hold because the Asia-Pacific economies are now getting larger and their policies create important impacts on global markets. In this section, we present the results of the impact of the domestic macroeconomic surprises on the Asia-Pacific exchange rates. We used a total of 74 macroeconomic anouncements from this region to test for Hypothesis 4 on whether the exchange rates react to domestic macroeconomic surprises. Out of this total, Japan contributes the highest number of events (i.e. 20 events) followed by Australia with nine (9) events. The country with the least events is India with only two. The other countries contribute a minimum of three (3) events to our sample. Similar to Section 4.2.2, we run regression 4.6 for each exchange rate in the sample on each macroeconomic surprise. The results for the β estimates are presented in Table 4.16 in the following pages.

The first column of the table shows the name of the country followed by the name of the macroeconomic events and their respective category in column two and three. There are two rows to each macroeconomic event and the upper row shows the β estimates while the lower one the corresponding standard error of estimates. The bolded coefficients denote significance at the minimum of 10% level of confidence. From a quick glance, we notice that these events are significant in influencing Asia-Pacific exchange rates. Hence we answer Hypothesis 4 in the affirmative that domestic macroeconomic events do affect the regional exchange rates.

Table 4.16: Exchange Rates Reaction to the Asia-Pacific Macroeconomic Surprises

The table below shows the beta estimate and the corresponding standard error of estimate of equation 4.6: $\Delta s_{i,t}=\alpha_i+\beta_i N_{j,t}+\varepsilon_t$, with the Asia-Pacific (ex-US) macroeconomic surprises. These events are considered domestic macroeconomic surprises in our paper. The first column shows the name of the country and followed by the macroeconomic event in the second column. The third column indicates the category of the events which we have broadly segregated into three groups namely (i) Total Output, International Trade and Employment = TOITE, (ii) Interest rates, Prices and Money = IPM and (iii) Production and Business Activity = PBA. There are two rows to each macroeconomic event in which the upper row reports the β coefficient while the lower one the corresponding standard error of estimates. The next twelve columns display the result for each currency in our sample. We used a total of 74 domestic macroeconomic indicators and among these, Japan contributes the highest number of indicators (i.e. 20 indicators) followed by Australia with nine (9) indicators. The bolded coefficients denote significance at the minimum of 10% level of confidence. The estimated beta coefficients are comparable as the regressor has been standardized with its respective standard deviation. For example, a positive shock of one standard deviation in the Australia-Current Account Balance will cause the AUD to significantly appreciate by 0.28% against the USD. At the same time, a similar shock in the Australia-Consumer Prices will cause the AUD to significantly appreciate by 0.32% against the USD. In this instance, the surprises in Australia-Consumer Prices give bigger impact to the AUD exchange rate. However, this comparison must be interpreted with caution as the standard error of estimate should also be taken into account. The comparison of t-statistic may give a better picture of the relative impact of the macroeconomic indicators. Two (2) interesting observations are gathered from this table. (i) Most of the Asia-Pacific exchange rates react significantly to their own macroeconomic surprises with the exception of THB which only shows significant reaction to other countries' macroeconomic surprises. (ii) The Interest Rate setting announcements are significant in most of the currency markets. The Australia (RBA), Indonesia (BI reference rate), Malaysia (BNM overnight rate), New Zealand (RBNZ official rate) and Philippines (overnight borrowing rate) are all significant within their own respective currency markets. The only exception is the Thailand's benchmark interest rate which shows no significant to any currency exchange rate.

Country	Event	Category		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Australia	Current Account Balance	TOITE	Coef.	**-0.0028**	0.0001	-0.0001	-0.0002	0.0007	-0.0001	0.0000	-0.0012	**0.0013**	-0.0004	-0.0002	**0.0006**
			s.e.	**0.0011**	0.0002	0.0006	0.0007	0.0008	0.0013	0.0006	0.0011	**0.0007**	0.0003	0.0004	**0.0003**
Australia	Consumer Prices (QoQ)	IPM	Coef.	**-0.0032**	-0.0001	0.0003	0.0005	0.0002	0.0010	-0.0011	-0.0019	-0.0002	-0.0003	-0.0003	**0.0008**
			s.e.	**0.0012**	0.0001	0.0008	0.0007	0.0010	0.0009	0.0012	0.0012	0.0011	0.0004	0.0005	**0.0004**
Australia	Employment Change	TOITE	Coef.	**0.0005**	0.0005	**0.0008**	0.0001	**0.0004**	-0.0001	0.0021	-0.0001	0.0000	**0.0002**	**-0.0003**	**-0.0002**
			s.e.	**0.0002**	0.0008	**0.0002**	0.0001	**0.0001**	0.0002	0.0046	0.0002	0.0003	**0.0001**	**0.0001**	**0.0000**
Australia	Gross Domestic Product (QoQ)	TOITE	Coef.	-0.0018	0.0000	-0.0020	0.0006	-0.0014	-0.0014	0.0018	0.0004	0.0001	0.0006	0.0009	0.0001
			s.e.	0.0012	0.0001	0.0014	0.0004	0.0011	0.0009	0.0011	0.0015	0.0007	0.0004	0.0010	0.0002
Australia	Producer Price Index (QoQ)	IPM	Coef.	**-0.0035**	-0.0001	0.0008	0.0002	0.0009	-0.0009	0.0000	-0.0021	-0.0010	0.0001	-0.0001	-0.0001
			s.e.	**0.0019**	0.0001	0.0007	0.0008	0.0008	0.0011	0.0007	0.0017	0.0006	0.0007	0.0005	0.0007
Australia	RBA Cash Target	IPM	Coef.	-0.0011	0.0002	-0.0007	0.0002	-0.0003	**-0.0032**	**-0.0010**	-0.0004	**-0.0008**	**-0.0004**	**-0.0005**	-0.0006
			s.e.	0.0010	0.0002	0.0005	0.0007	0.0006	**0.0014**	**0.0004**	0.0009	**0.0005**	**0.0003**	**0.0003**	0.0003
Australia	Retail Sales s.a. (MoM)	PBA	Coef.	**-0.0021**	-0.0001	-0.0003	0.0003	0.0013	-0.0003	0.0002	**-0.0016**	0.0001	-0.0001	0.0021	0.0003
			s.e.	**0.0007**	0.0001	0.0011	0.0002	0.0008	0.0005	0.0005	**0.0007**	0.0004	0.0004	0.0026	0.0002
Australia	Trade Balance	TOITE	Coef.	-0.0010	**0.0001**	-0.0008	-0.0006	0.0003	-0.0005	-0.0002	-0.0002	-0.0004	0.0000	-0.0002	-0.0004
			s.e.	0.0010	**0.0001**	0.0005	0.0004	0.0007	0.0010	0.0005	0.0011	0.0003	0.0004	0.0003	0.0004
Australia	Unemployment Rate	TOITE	Coef.	**0.0014**	-0.0001	-0.0019	-0.0001	0.0003	-0.0003	0.0010	0.0010	**0.0010**	0.0001	0.0003	0.0003
			s.e.	**0.0005**	0.0001	0.0016	0.0003	0.0005	0.0007	0.0006	0.0007	**0.0005**	0.0002	0.0005	0.0002

Table 4.16: Exchange Rates Reaction to the Asia-Pacific Macroeconomic Surprises (*continued*)

Country	Event	Category		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
China	Consumer Price Index (YoY)	IPM	Coef.	-0.0002	0.0000	-0.0003	0.0001	0.0006	0.0009	0.0005	-0.0006	0.0003	0.0002	0.0002	0.0003
			s.e.	0.0008	0.0001	0.0004	0.0004	0.0006	0.0008	0.0005	0.0007	0.0004	0.0003	0.0007	0.0003
China	Industrial Production (YoY)	PBA	Coef.	0.0004	**-0.0003**	**-0.0016**	-0.0003	-0.0006	-0.0005	-0.0007	-0.0013	-0.0004	-0.0003	-0.0002	-0.0003
			s.e.	0.0011	**0.0001**	**0.0006**	0.0005	0.0012	0.0010	0.0005	0.0013	0.0006	0.0004	0.0004	0.0004
China	Producer Price Index (YoY)	IPM	Coef.	-0.0011	0.0001	0.0002	0.0005	0.0002	0.0011	0.0002	-0.0004	0.0002	-0.0001	0.0000	-0.0001
			s.e.	0.0008	0.0001	0.0003	0.0005	0.0004	0.0011	0.0003	0.0007	0.0004	0.0003	0.0004	0.0002
China	Trade Balance (USD)	TOITE	Coef.	-0.0005	0.0001	-0.0003	0.0005	**0.0018**	0.0001	-0.0006	0.0006	-0.0003	0.0000	0.0000	**0.0006**
			s.e.	0.0012	0.0001	0.0006	0.0006	**0.0009**	0.0018	0.0005	0.0013	0.0005	0.0005	0.0003	**0.0002**
Indonesia	Bank Indonesia Reference Rate	IPM	Coef.	0.0000	**-0.0002**	**0.0013**	0.0002	0.0001	0.0007	**-0.0005**	-0.0004	0.0006	0.0003	-0.0001	0.0004
			s.e.	0.0008	**0.0001**	**0.0007**	0.0006	0.0007	0.0008	**0.0002**	0.0013	0.0005	0.0003	0.0004	0.0003
Indonesia	Inflation NSA (MoM)	IPM	Coef.	-0.0001	-0.0002	**0.0010**	0.0001	0.0002	-0.0002	0.0001	-0.0002	0.0001	-0.0002	-0.0001	-0.0001
			s.e.	0.0007	0.0002	**0.0005**	0.0002	0.0006	0.0005	0.0006	0.0006	0.0003	0.0003	0.0003	0.0002
Indonesia	Total Trade Balance	TOITE	Coef.	0.0002	0.0001	-0.0001	-0.0004	0.0002	-0.0004	-0.0002	-0.0001	-0.0001	0.0000	0.0000	-0.0001
			s.e.	0.0006	0.0001	0.0003	0.0004	0.0006	0.0005	0.0005	0.0006	0.0003	0.0003	0.0003	0.0003
India	Industrial Production YoY	PBA	Coef.	**-0.0021**	-0.0011	-0.0002	**-0.0003**	0.0003	0.0002	0.0001	**-0.0012**	0.0001	-0.0001	0.0000	0.0001
			s.e.	**0.0005**	0.0007	0.0003	**0.0001**	0.0003	0.0004	0.0025	**0.0003**	0.0001	0.0001	0.0001	0.0002
India	Qtrly GDP YoY%	TOITE	Coef.	-0.0005	-0.0001	0.0000	-0.0007	0.0008	**-0.0019**	-0.0007	-0.0011	-0.0003	-0.0007	-0.0012	**-0.0006**
			s.e.	0.0015	0.0002	0.0007	0.0011	0.0013	**0.0010**	0.0012	0.0015	0.0007	0.0005	0.0008	**0.0003**
Japan	Adjusted Current Account Total	TOITE	Coef.	-0.0001	-0.0002	0.0009	0.0000	0.0001	-0.0002	0.0006	-0.0004	0.0003	0.0001	-0.0002	0.0000
			s.e.	0.0007	0.0002	0.0013	0.0002	0.0006	0.0005	0.0005	0.0007	0.0004	0.0003	0.0004	0.0003
Japan	All Industry Activity Index (MoM)	PBA	Coef.	-0.0006	0.0000	-0.0005	-0.0001	-0.0005	-0.0003	-0.0004	-0.0005	0.0001	-0.0001	-0.0004	-0.0003
			s.e.	0.0007	0.0001	0.0006	0.0003	0.0005	0.0004	0.0005	0.0009	0.0004	0.0003	0.0002	0.0002
Japan	Current Account Total	TOITE	Coef.	0.0000	-0.0002	0.0009	0.0002	0.0003	-0.0003	0.0004	0.0004	0.0001	0.0003	0.0002	-0.0001
			s.e.	0.0008	0.0001	0.0009	0.0003	0.0005	0.0005	0.0004	0.0008	0.0004	0.0003	0.0004	0.0002

Table 4.16: Exchange Rates Reaction to the Asia-Pacific Macroeconomic Surprises (*continued*)

Country	Event	Category		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Japan	Consumer Confidence	PBA	Coef.	0.0007	0.0001	0.0004	-0.0006	0.0008	0.0002	0.0006	0.0006	-0.0001	0.0001	0.0000	0.0005
			s.e.	0.0011	0.0001	0.0005	0.0010	0.0008	0.0009	0.0006	0.0011	0.0004	0.0003	0.0003	0.0004
Japan	Coincident Index CI	PBA	Coef.	-0.0001	0.0000	**0.0006**	**0.0006**	-0.0003	0.0003	-0.0004	-0.0002	0.0001	0.0001	0.0001	-0.0001
			s.e.	0.0004	0.0001	**0.0003**	**0.0002**	0.0004	0.0003	0.0003	0.0005	0.0003	0.0002	0.0004	0.0002
Japan	Gross Domestic Product (QoQ)	TOITE	Coef.	-0.0002	0.0001	-0.0017	0.0001	0.0003	0.0014	**-0.0022**	-0.0005	**-0.0008**	-0.0003	-0.0012	0.0000
			s.e.	0.0006	0.0003	0.0018	0.0002	0.0007	0.0012	**0.0008**	0.0007	**0.0003**	0.0003	0.0012	0.0001
Japan	Housing Starts (YoY)	PBA	Coef.	**0.0012**	0.0001	0.0005	0.0006	0.0002	**0.0007**	**0.0004**	0.0006	0.0001	0.0002	0.0004	0.0003
			s.e.	**0.0007**	0.0001	0.0004	0.0004	0.0005	**0.0004**	**0.0002**	0.0007	0.0003	0.0002	0.0005	0.0002
Japan	Industrial Production (MoM)	PBA	Coef.	**-0.0012**	0.0001	-0.0001	**-0.0006**	-0.0004	-0.0008	-0.0002	-0.0005	-0.0002	-0.0001	-0.0001	**-0.0003**
			s.e.	**0.0007**	0.0001	0.0003	**0.0003**	0.0004	0.0005	0.0003	0.0007	0.0002	0.0002	0.0002	**0.0002**
Japan	Leading Index CI	PBA	Coef.	-0.0003	0.0000	-0.0005	0.0000	0.0003	**-0.0007**	-0.0001	0.0001	0.0001	0.0001	**0.0006**	-0.0001
			s.e.	0.0005	0.0001	0.0003	0.0001	0.0003	**0.0004**	0.0002	0.0005	0.0002	0.0002	**0.0003**	0.0001
Japan	Large Retailers' Sales	PBA	Coef.	**-0.0012**	0.0000	-0.0007	0.0002	**-0.0009**	-0.0008	**-0.0015**	-0.0006	**-0.0009**	-0.0001	-0.0001	-0.0001
			s.e.	**0.0005**	0.0001	0.0006	0.0003	**0.0005**	0.0005	**0.0006**	0.0006	**0.0003**	0.0002	0.0004	0.0002
Japan	Japan Money Stock M2 YoY	IPM	Coef.	-0.0004	0.0000	0.0004	-0.0005	0.0000	0.0000	-0.0007	0.0006	-0.0001	-0.0002	**0.0007**	-0.0002
			s.e.	0.0009	0.0001	0.0008	0.0003	0.0005	0.0006	0.0005	0.0007	0.0004	0.0003	**0.0003**	0.0002
Japan	Machine Orders (MoM)	PBA	Coef.	0.0006	0.0000	0.0002	**-0.0005**	**-0.0012**	-0.0006	-0.0002	-0.0005	0.0003	0.0000	-0.0003	-0.0002
			s.e.	0.0010	0.0001	0.0006	**0.0002**	**0.0005**	0.0006	0.0007	0.0008	0.0003	0.0002	0.0004	0.0002
Japan	Machine Orders YOY%	PBA	Coef.	0.0002	0.0000	-0.0003	**-0.0010**	**-0.0014**	-0.0007	-0.0003	-0.0006	0.0001	-0.0003	**-0.0009**	-0.0002
			s.e.	0.0013	0.0001	0.0007	**0.0003**	**0.0005**	0.0008	0.0006	0.0011	0.0004	0.0003	**0.0005**	0.0003
Japan	Merchnds Trade Balance Total	TOITE	Coef.	**-0.0018**	0.0001	-0.0007	-0.0002	-0.0003	**-0.0014**	-0.0004	-0.0009	-0.0004	-0.0003	-0.0004	-0.0005
			s.e.	**0.0008**	0.0001	0.0005	0.0003	0.0006	**0.0007**	0.0004	0.0008	0.0003	0.0003	0.0004	0.0003
Japan	Natl CPI YoY	IPM	Coef.	**-0.0011**	-0.0001	-0.0004	-0.0005	-0.0006	0.0008	-0.0001	-0.0005	0.0002	-0.0003	-0.0005	**-0.0004**
			s.e.	**0.0006**	0.0001	0.0004	0.0004	0.0005	0.0007	0.0004	0.0008	0.0004	0.0002	0.0003	**0.0002**

Table 4.16: Exchange Rates Reaction to the Asia-Pacific Macroeconomic Surprises (*continued*)

Country	Event	Category		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Japan	Tankan Lge Manufacturers Index	PBA	Coef.	-0.0009	**-0.0002**	**-0.0028**	0.0005	**-0.0015**	0.0002	-0.0004	**-0.0019**	-0.0001	**-0.0011**	**-0.0008**	0.0004
			s.e.	0.0010	**0.0001**	**0.0013**	0.0003	**0.0009**	0.0008	0.0006	**0.0009**	0.0005	**0.0004**	**0.0003**	0.0003
Japan	Trade Balance - BOP Basis	TOITE	Coef.	-0.0006	0.0000	-0.0005	-0.0001	-0.0005	-0.0003	-0.0004	-0.0005	0.0001	-0.0001	-0.0004	-0.0003
			s.e.	0.0007	0.0001	0.0006	0.0003	0.0005	0.0004	0.0005	0.0009	0.0004	0.0003	0.0002	0.0002
Japan	Tokyo CPI YoY	IPM	Coef.	-0.0003	-0.0001	0.0001	-0.0001	0.0002	0.0006	**0.0007**	**-0.0013**	-0.0001	0.0000	0.0001	0.0000
			s.e.	0.0006	0.0001	0.0003	0.0004	0.0005	0.0006	**0.0003**	**0.0007**	0.0004	0.0002	0.0003	0.0002
Japan	Tertiary Industry Index (MoM)	PBA	Coef.	-0.0001	**-0.0002**	-0.0004	-0.0001	0.0002	0.0003	-0.0004	-0.0003	-0.0001	-0.0001	0.0002	-0.0001
			s.e.	0.0005	**0.0001**	0.0005	0.0003	0.0005	0.0006	0.0006	0.0006	0.0003	0.0002	0.0003	0.0002
Japan	Jobless Rate	TOITE	Coef.	-0.0002	0.0000	0.0001	-0.0007	0.0004	-0.0004	-0.0004	-0.0002	-0.0004	-0.0001	0.0003	0.0000
			s.e.	0.0008	0.0001	0.0005	0.0005	0.0006	0.0006	0.0005	0.0008	0.0004	0.0003	0.0006	0.0002
Korea, South	Consumer Price Index (MoM)	IPM	Coef.	-0.0006	0.0002	0.0001	0.0000	0.0001	-0.0009	-0.0006	-0.0004	0.0002	-0.0003	-0.0004	-0.0002
			s.e.	0.0006	0.0002	0.0004	0.0003	0.0005	0.0006	0.0004	0.0006	0.0004	0.0002	0.0002	0.0002
Korea, South	GDP at Constant Price (YoY)	TOITE	Coef.	-0.0004	0.0000	0.0004	0.0002	0.0005	**-0.0008**	-0.0004	-0.0001	0.0006	0.0000	0.0003	0.0002
			s.e.	0.0012	0.0001	0.0005	0.0001	0.0005	**0.0004**	0.0008	0.0015	0.0004	0.0002	0.0005	0.0004
Korea, South	Industrial Production (MoM)	PBA	Coef.	-0.0010	0.0001	-0.0010	-0.0001	0.0006	-0.0008	-0.0002	-0.0003	-0.0003	0.0001	0.0000	-0.0002
			s.e.	0.0013	0.0001	0.0008	0.0008	0.0006	0.0015	0.0005	0.0011	0.0004	0.0003	0.0004	0.0005
Malaysia	CPI YoY	IPM	Coef.	-0.0006	-0.0001	-0.0005	-0.0007	**0.0011**	0.0000	-0.0001	-0.0007	-0.0004	0.0004	0.0004	0.0001
			s.e.	0.0010	0.0001	0.0005	0.0004	**0.0006**	0.0006	0.0003	0.0012	0.0005	0.0006	0.0003	0.0002
Malaysia	GDP YoY%	TOITE	Coef.	-0.0007	0.0000	-0.0007	**-0.0013**	0.0002	-0.0007	-0.0005	-0.0015	-0.0010	**-0.0010**	-0.0007	-0.0007
			s.e.	0.0014	0.0001	0.0012	**0.0008**	0.0009	0.0010	0.0010	0.0012	0.0007	**0.0004**	0.0007	0.0005
Malaysia	Industrial Production YoY	PBA	Coef.	0.0001	-0.0001	-0.0004	-0.0003	**-0.0011**	**-0.0006**	-0.0003	-0.0001	**-0.0005**	**-0.0006**	-0.0004	**-0.0004**
			s.e.	0.0011	0.0001	0.0004	0.0002	**0.0004**	**0.0003**	0.0007	0.0009	**0.0003**	**0.0002**	0.0002	**0.0001**
Malaysia	Overnight Rate	IPM	Coef.	-0.0016	0.0001	**-0.0012**	**-0.0015**	-0.0019	**-0.0022**	**-0.0014**	-0.0009	0.0003	0.0012	0.0000	-0.0003
			s.e.	0.0023	0.0001	**0.0007**	**0.0006**	0.0021	**0.0009**	**0.0006**	0.0021	0.0004	0.0008	0.0006	0.0005
Malaysia	Trade Balance	TOITE	Coef.	0.0001	0.0004	0.0002	0.0000	0.0008	-0.0013	0.0001	-0.0002	-0.0004	0.0001	-0.0003	-0.0002
			s.e.	0.0009	0.0004	0.0005	0.0004	0.0009	0.0009	0.0003	0.0008	0.0005	0.0003	0.0004	0.0003

Table 4.16: Exchange Rates Reaction to the Asia-Pacific Macroeconomic Surprises (*continued*)

Country	Event	Category		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
New Zealand	Consumer Prices (QoQ)	IPM	Coef.	**-0.0018**	-0.0001	-0.0003	0.0001	-0.0001	0.0003	-0.0006	**-0.0028**	0.0011	-0.0003	0.0014	0.0001
			s.e.	**0.0010**	0.0003	0.0007	0.0004	0.0013	0.0006	0.0008	**0.0012**	0.0010	0.0004	0.0010	0.0004
New Zealand	GDP QoQ	TOITE	Coef.	-0.0002	NA	0.0007	0.0005	0.0005	0.0003	-0.0008	**-0.0025**	0.0003	0.0002	0.0001	-0.0001
			s.e.	0.0010	NA	0.0013	0.0004	0.0005	0.0004	0.0009	**0.0008**	0.0003	0.0003	0.0005	0.0002
New Zealand	RBNZ Official Cash Rate	IPM	Coef.	-0.0002	0.0001	-0.0001	0.0002	0.0007	0.0010	**-0.0017**	**-0.0026**	**0.0012**	**0.0006**	**0.0006**	0.0001
			s.e.	0.0014	0.0003	0.0011	0.0002	0.0010	0.0006	**0.0007**	**0.0013**	**0.0004**	**0.0003**	**0.0002**	0.0001
New Zealand	Retail Sales (MoM)	PBA	Coef.	0.0002	**0.0002**	-0.0012	0.0002	0.0000	0.0003	0.0005	-0.0011	0.0005	-0.0001	-0.0005	**0.0003**
			s.e.	0.0007	**0.0001**	0.0007	0.0003	0.0004	0.0004	0.0003	0.0009	0.0006	0.0004	0.0005	**0.0002**
New Zealand	Trade Balance	TOITE	Coef.	0.0009	0.0001	-0.0003	0.0000	**0.0008**	0.0007	-0.0003	0.0001	-0.0001	-0.0002	-0.0001	0.0002
			s.e.	0.0012	0.0001	0.0004	0.0002	**0.0005**	0.0009	0.0003	0.0013	0.0002	0.0002	0.0003	0.0002
New Zealand	Unemployment Rate	TOITE	Coef.	-0.0001	0.0002	0.0024	-0.0002	0.0016	-0.0016	-0.0008	**0.0033**	0.0003	0.0006	**0.0013**	0.0001
			s.e.	0.0015	0.0002	0.0025	0.0010	0.0025	0.0013	0.0009	**0.0018**	0.0005	0.0007	**0.0006**	0.0006
Philippines	Consumer Price Index NSA (MoM)	IPM	Coef.	-0.0012	0.0001	-0.0001	0.0002	-0.0001	-0.0004	0.0000	-0.0007	0.0001	0.0002	**0.0014**	0.0001
			s.e.	0.0010	0.0001	0.0005	0.0005	0.0009	0.0007	0.0004	0.0012	0.0006	0.0004	**0.0005**	0.0002
Philippines	Gross Domestic Product (YoY)	TOITE	Coef.	**-0.0029**	0.0001	-0.0004	**-0.0013**	-0.0002	-0.0019	**-0.0011**	-0.0027	0.0000	-0.0004	0.0001	0.0000
			s.e.	**0.0014**	0.0001	0.0009	**0.0007**	0.0016	0.0014	**0.0005**	0.0017	0.0006	0.0006	0.0004	0.0004
Philippines	Overnight Borrowing Rate	IPM	Coef.	0.0017	0.0000	-0.0001	0.0004	-0.0009	0.0018	0.0007	**0.0018**	**0.0006**	0.0002	**-0.0013**	-0.0002
			s.e.	0.0011	0.0001	0.0004	0.0005	0.0010	0.0017	0.0007	**0.0009**	**0.0002**	0.0002	**0.0005**	0.0002
Singapore	Advance GDP Estimate (QoQ)	TOITE	Coef.	-0.0034	0.0000	-0.0020	0.0003	-0.0010	-0.0019	**-0.0017**	-0.0021	-0.0008	**-0.0037**	**-0.0009**	-0.0003
			s.e.	0.0037	0.0003	0.0015	0.0012	0.0017	0.0042	**0.0006**	0.0020	0.0008	**0.0011**	**0.0005**	0.0005
Singapore	CPI (YoY)	IPM	Coef.	**-0.0015**	-0.0001	-0.0002	0.0001	0.0000	0.0007	0.0000	-0.0015	-0.0001	-0.0003	-0.0005	0.0001
			s.e.	**0.0008**	0.0001	0.0004	0.0004	0.0005	0.0005	0.0003	0.0009	0.0004	0.0003	0.0004	0.0002
Singapore	GDP (YoY)	TOITE	Coef.	0.0023	0.0001	-0.0029	0.0006	-0.0016	0.0020	0.0004	0.0012	0.0021	0.0002	-0.0001	0.0004
			s.e.	0.0018	0.0001	0.0024	0.0007	0.0016	0.0013	0.0008	0.0015	0.0014	0.0006	0.0008	0.0004
Singapore	Industrial Production YoY	PBA	Coef.	-0.0003	0.0000	0.0002	-0.0006	-0.0002	0.0008	0.0000	-0.0008	0.0001	0.0000	0.0006	0.0000
			s.e.	0.0007	0.0001	0.0005	0.0004	0.0005	0.0006	0.0007	0.0007	0.0006	0.0003	0.0007	0.0002
Singapore	Non-oil Domestic Exports (YoY)	TOITE	Coef.	0.0003	0.0001	-0.0004	0.0003	-0.0003	0.0010	0.0005	0.0007	0.0001	0.0001	-0.0003	**0.0003**
			s.e.	0.0005	0.0001	0.0004	0.0003	0.0005	0.0006	0.0005	0.0007	0.0004	0.0002	0.0004	**0.0002**

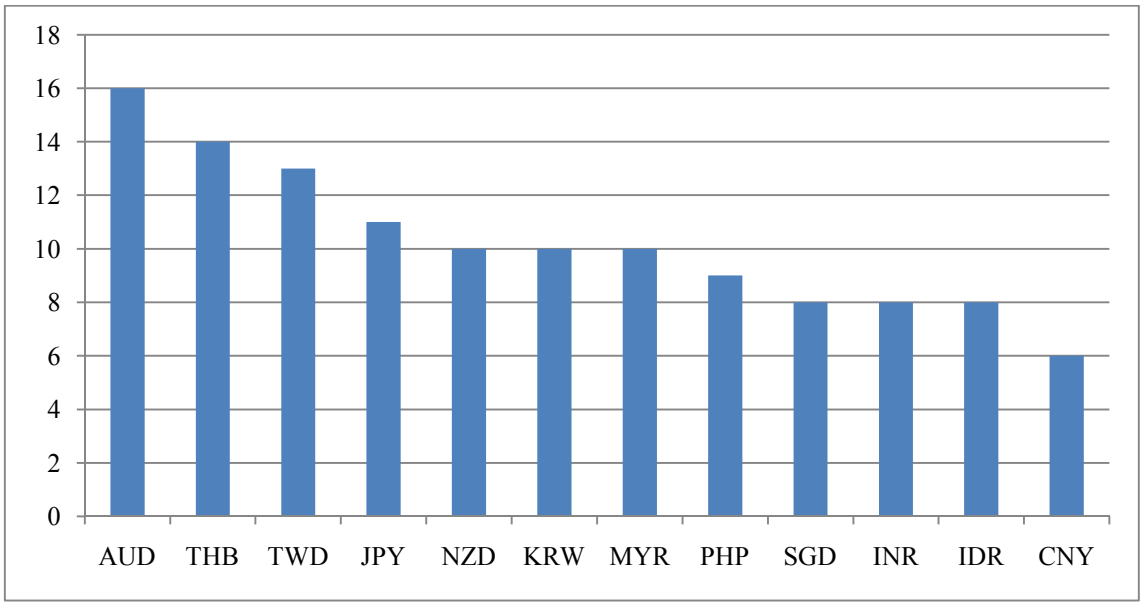
Table 4.16: Exchange Rates Reaction to the Asia-Pacific Macroeconomic Surprises (*continued*)

Country	Event	Category		AUD	CNY	IDR	INR	JPY	KRW	MYR	NZD	PHP	SGD	THB	TWD
Singapore	Retail Sales (YoY)	PBA	Coef.	0.0000	0.0000	0.0006	0.0005	-0.0001	0.0006	0.0001	0.0003	0.0002	0.0000	**0.0010**	**0.0005**
			s.e.	0.0008	0.0001	0.0007	0.0003	0.0005	0.0005	0.0004	0.0008	0.0003	0.0003	**0.0004**	**0.0002**
Singapore	Unemployment Rate (sa)	TOITE	Coef.	-0.0011	-0.0001	-0.0008	0.0007	**-0.0012**	-0.0017	-0.0002	0.0001	-0.0001	-0.0006	-0.0007	0.0000
			s.e.	0.0008	0.0001	0.0007	0.0005	**0.0006**	0.0010	0.0003	0.0008	0.0004	0.0004	0.0005	0.0003
Thailand	Benchmark Interest Rate	IPM	Coef.	-0.0006	0.0000	0.0008	0.0001	0.0002	0.0007	0.0005	-0.0019	0.0009	-0.0004	0.0002	0.0002
			s.e.	0.0008	0.0001	0.0007	0.0006	0.0011	0.0013	0.0006	0.0013	0.0008	0.0006	0.0007	0.0005
Thailand	Consumer Price Index (YoY)	IPM	Coef.	0.0005	0.0000	-0.0002	0.0000	-0.0003	0.0000	-0.0003	0.0002	0.0003	-0.0004	0.0001	0.0001
			s.e.	0.0010	0.0003	0.0003	0.0007	0.0009	0.0017	0.0004	0.0009	0.0005	0.0004	0.0004	0.0004
Thailand	Gross Domestic Product (YoY)	TOITE	Coef.	0.0009	0.0001	0.0002	-0.0001	0.0000	**0.0026**	0.0001	0.0023	-0.0002	0.0005	0.0005	0.0004
			s.e.	0.0014	0.0001	0.0008	0.0005	0.0011	**0.0010**	0.0007	0.0015	0.0004	0.0003	0.0005	0.0004
Thailand	Manufacturing Production (YoY)	PBA	Coef.	-0.0005	0.0001	-0.0005	-0.0003	0.0001	-0.0012	-0.0003	-0.0001	**-0.0005**	0.0000	0.0002	0.0000
			s.e.	0.0013	0.0001	0.0005	0.0003	0.0005	0.0009	0.0003	0.0011	**0.0003**	0.0003	0.0003	0.0004
Thailand	Current Account Balance (USD)	TOITE	Coef.	-0.0005	0.0001	-0.0003	-0.0002	-0.0004	-0.0009	0.0005	-0.0005	0.0001	-0.0001	0.0007	-0.0002
			s.e.	0.0007	0.0001	0.0004	0.0005	0.0005	0.0006	0.0005	0.0009	0.0004	0.0003	0.0013	0.0002
Taiwan	Benchmark Interest Rate	IPM	Coef.	0.0030	NA	-0.0006	0.0008	**0.0025**	0.0009	NA	0.0002	0.0009	0.0012	0.0009	0.0000
			s.e.	0.0020	NA	0.0012	0.0013	**0.0009**	0.0040	NA	0.0020	0.0009	0.0008	0.0009	0.0007
Taiwan	CPI YoY%	IPM	Coef.	**0.0006**	-0.0001	**-0.0004**	-0.0002	-0.0002	-0.0002	-0.0030	**0.0011**	0.0001	0.0000	**0.0002**	**0.0002**
			s.e.	**0.0004**	0.0005	**0.0001**	0.0001	0.0002	0.0002	0.0026	**0.0003**	0.0001	0.0001	**0.0001**	**0.0001**
Taiwan	Current Account Balance (USD)	TOITE	Coef.	-0.0004	0.0000	0.0006	0.0003	-0.0011	0.0007	0.0004	-0.0006	0.0003	**-0.0008**	-0.0001	0.0001
			s.e.	0.0014	0.0000	0.0004	0.0004	0.0009	0.0013	0.0003	0.0012	0.0006	**0.0004**	0.0007	0.0003
Taiwan	GDP - Constant Prices (YoY)	TOITE	Coef.	0.0008	-0.0001	-0.0012	0.0004	-0.0021	-0.0016	-0.0008	0.0002	0.0004	-0.0005	**-0.0010**	**-0.0006**
			s.e.	0.0023	0.0001	0.0008	0.0007	0.0016	0.0019	0.0008	0.0019	0.0010	0.0005	**0.0003**	**0.0003**
Taiwan	Industrial Production (YoY)	PBA	Coef.	-0.0002	0.0000	-0.0001	-0.0009	-0.0004	**-0.0013**	-0.0001	-0.0007	-0.0004	0.0000	-0.0005	-0.0002
			s.e.	0.0008	0.0001	0.0003	0.0006	0.0006	**0.0007**	0.0004	0.0008	0.0003	0.0004	0.0003	0.0002
Taiwan	Total Trade Bal in US$ Billion	TOITE	Coef.	0.0009	0.0000	-0.0004	0.0003	-0.0003	0.0012	0.0005	0.0006	0.0003	-0.0002	-0.0001	0.0000
			s.e.	0.0012	0.0001	0.0004	0.0003	0.0005	0.0010	0.0003	0.0013	0.0004	0.0004	0.0003	0.0004
Taiwan	Unemployment Rate - sa	TOITE	Coef.	-0.0001	0.0000	0.0001	0.0007	-0.0008	0.0006	-0.0001	0.0000	0.0004	0.0001	0.0000	0.0004
			s.e.	0.0007	0.0001	0.0003	0.0005	0.0009	0.0012	0.0004	0.0012	0.0005	0.0005	0.0003	0.0005

There are two noteworthy observations from Table 4.16. First, all of the currencies react significantly to their own macroeconomic shocks with the exception of the THB. For example, the AUD reacts significantly to six (6) out of nine (9) Australian macroeconomic shocks and the CNY reacts to one (1) out of four (4) Chinese macroeconomic shocks. Second, the surprises in the interest-rate setting announcements are significant in most of the currency markets. The surprises in the interest-rate setting announcements which are significant within their own respective currency markets are the Australia (RBA rate), Indonesia (BI reference rate), Malaysia (BNM overnight rate), New Zealand (RBNZ official rate) and Philippines (overnight borrowing rate). Again, THB is not significantly affected by the surprises in its own interest-rate setting announcements. There are some sensible explanations to the peculiar finding related to the THB. The insignificant reaction of THB could be due to the low level of surprises in the Thailand macroeconomic announcements or perhaps there are information leakages in the Thailand market prior to the actual announcements.

Next, we are also interested on how responsive the Asia-Pacific exchange rates are to the domestic macroeconomic surprises. We measure this by looking at the number of significant events, or β, for each exchange rate. The results are graphed out in Figure 4.5. The AUD reacts significantly to the surprises of 16 macroeconomic announcements from Asia-Pacific followed by THB with 14 significant β's. The least responsive currency is the CNY with only six (6) significant β's. Two interesting observations are noted from this graph. First, the THB is a very reactive currency (being second in the ranking) to the Asia-Pacific macroeconomic surprises despite no significant reaction registered with its own country macroeconomic surprises. Second, the AUD remains the most responsive currency to home, as well as overseas, macroeconomic surprises.

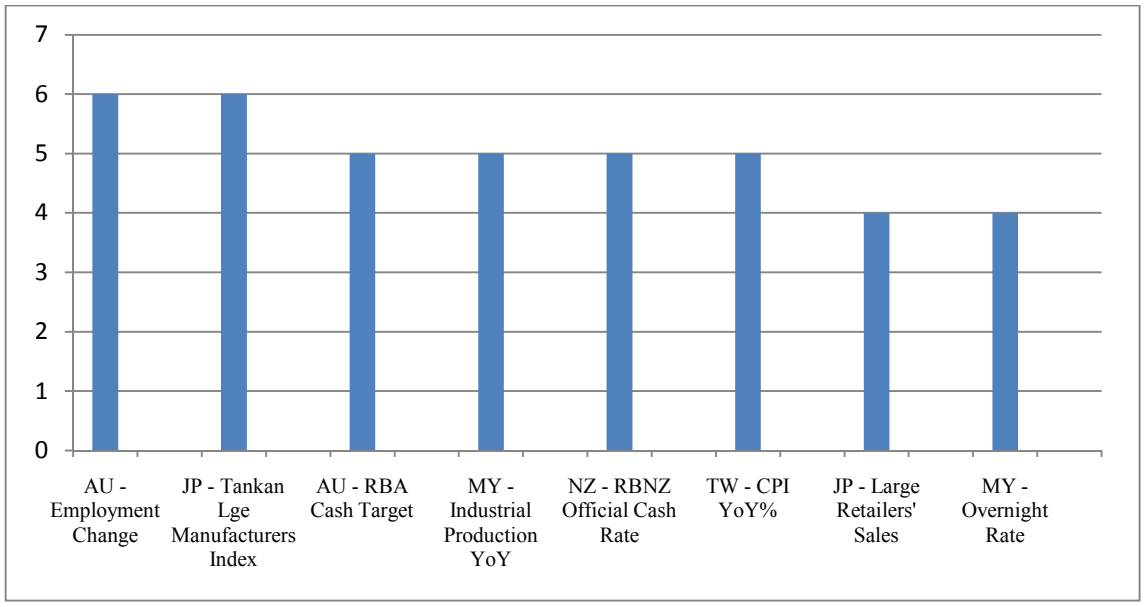
Figure 4.5: Responsiveness of the Asia-Pacific Currencies to Domestic Macroeconomic Shocks



The graph shows the number of significant events detected for each currency in the Asia-Pacific. The AUD is the most reactive currency among its Asia-Pacific counterparts with 16 significant events followed by THB and TWD with 14 and 13 significant events respectively. The CNY is the least responsive to the domestic macroeconomic surprises in the Asia-Pacific. Two interesting observations are worthy of mentioning from this result. (1) The THB, which reports no significant reaction to its own country macroeconomic surprises and only to two US macroeconomic surprises, responds to many other countries' macroeconomic surprises. (2) AUD remains the most responsive currency to macroeconomic surprises, at home and abroad.

Finally, from Table 4.16, we are also able to extract which of the macroeconomic surprises are the most influential in the Asia-Pacific region. We do this by looking at the number of currencies which registered significant β to the particular macroeconomic event. Figure 4.6 shows the selected domestic macroeconomic surprises which significantly affect at least four (4) currencies in the region. There are eight (8) macroeconomic surprises which affect at least four (4) currencies here. We notice that the Australia-Employment Change and the Japan-Tankan Large Manufacturers Index are the most influential events with each significantly affecting six (6) currencies in the region. This is followed by the Australia-RBA Cash Target, Malaysia-Industrial Production, New Zealand-RBNZ Official Cash Rate and Taiwan-CPI with five (5) currencies each. Lastly, the Japan-Large Retailers' Sales and Malaysia-Overnight Rate significantly impact four (4) currency exchange rates.

Figure 4.6: Selected Asia-Pacific Macroeconomic Shocks



The graph show the selected macroeconomic surprises from the Asia-Pacific which display significant impact to at least four (4) currency exchange rates. Both the Australia-Employment Change and the Japan-Tankan Large Manufacturers Index report significant impact to six currency exchange rates each. This is followed by the Australia-RBA Cash Target, Malaysia-Industrial Production, New Zealand-RBNZ Official Cash Rate and Taiwan-CPI with five (5) currency exchange rates each. Lastly, the Japan-Large Retailers' Sales and Malaysia-Overnight Rate significantly impact four (4) currency exchange rates. Two interesting observations are derived from this result. (1) Half of the Top-8 macroeconomic surprises above are related to interest rate announcements. (2) Only five (5) countries are represented in the Top-8 macroeconomic surprises.

There are two (2) notable observations from Figure 4.6 above. First, out of the Top-8 domestic macroeconomic surprises, four (4) events are interest-rate related. This finding implies that the interest-rate related surprises are not only important in their own respective countries but also have a far-reaching impact to the currencies of other countries in the region. Second, from the 12 countries selected in our sample, only four (4) countries are represented in the Top-8 macroeconomic events. We expect the macroeconomic surprises from the larger and advanced economies to be more influential. Australia, Japan and Malaysia are represented by two (2) events each while New Zealand and Taiwan by one (1) each. It is noteworthy that Malaysia as a smaller economy relative to other countries in our sample is represented by two events in the Top-8 events. This could be due to the openness of the Malaysian economy to international trade.

4.2.4 Ranking of Macroeconomic Shocks

After looking at the set of macroeconomic surprises separately for each currency, we move on to study all the currencies in our sample jointly. We do this by running a pooled cross-section time-series regression using all the 12 currencies jointly on each macroeconomic shock. This is basically a similar regression to equation 4.6 but the only difference is the used of pooled sample here. This means that there are only a total of 107 regressions conducted for this purpose, which are much smaller in number as compared to the regressions conducted under Sections 4.2.2 and 4.2.3. By pooling all the currencies, we are able to determine the relative impact of the macroeconomic surprises to the whole of Asia-Pacific currencies. This section serves to answer our fifth research hypothesis on the relative impact of the events.

As we have established the case for market efficiency, it is only consistent that we do not discuss about the findings of the estimated α in this section. Our focus here is on the estimated β. We present only the results of the estimated β which measures the impact of the macroeconomic surprises on the Asia-Pacific currencies as a whole. The values of the estimated β are comparable to one another because the macroeconomic shocks have been standardised with their respective standard deviations. We have sorted and ranked all the 107 macroeconomic events according to their relative significant impacts. The results of the ranking are presented under Table 4.17 in the following pages. The first column of Table 4.17 shows the name of the country and followed by the name of the event and its respective category in columns two and three. The value of the estimated beta is displayed in the next column followed by the standard error of estimates, t-statistics, p-value and the absolute t-statistics value. The bolded events are significant at least at 10% level. The ranking is provided by sorting the absolute t-statistic value (i.e. last column) with the larger

value being more impactful. Even though the estimated β measures the impact of the Asia-Pacific exchange rates to the standard deviation shock in the macroeconomic surprises, we do not simply rank the indicators based on the estimated β. This is because the estimated β could be accompanied by a large standard error of estimate which may render the β inaccurate. Therefore we decided to rank them based on the absolute t-statistics because it is a more precise measure for relative impact.

Table 4.17: Macroeconomic Surprises on Pooled Asia-Pacific Exchange Rates

The table below provides a ranking of the most significant macroeconomic surprises to the pooled Asia-Pacific exchange rates. The first column shows the country while the second column displays the particular macroeconomic indicator and followed by the third column which indicates the broad category of the events (i.e. IPM=Interest rate, Prices and Money; PBA=Production and Business Activity; TOITE=Total Output, International Trade and Employment). The fourth column shows the β estimate of equation 4.6: $\Delta s_t=\alpha+\beta N_t+\varepsilon_t$, which measures the reaction of the Asia-Pacific exchange rate to one standard deviation of shock of the respective macroeconomic indicators. Columns five (5) to eight (8) indicate the corresponding standard error of estimate, t-statistic value, p-value and the absolute t-statistics values. The bolded events are statistically significant at the conventional level of at least 10%. The ranking is obtained by sorting the absolute t-statistics value – the largest being the most significant. 43 out of the total 107 macroeconomic indicators' surprises are significant with the US Federal Reserve Rate and the Australia Cash Target Rate leading the pack.

Country	Events	Category	Coef. Est.	s.e.	t-stat	p-value	Abs. t-stat
US	**FOMC Rate Decision**	**IPM**	**0.001244**	**0.000253**	**4.9253**	**0.0000**	**4.9253**
AU	**RBA CASH TARGET**	**IPM**	**-0.000735**	**0.000156**	**-4.7035**	**0.0000**	**4.7035**
US	**Building Permits**	**PBA**	**0.000752**	**0.000175**	**4.2954**	**0.0000**	**4.2954**
JP	**Merchnds Trade Balance Total**	**TOITE**	**-0.000630**	**0.000164**	**-3.8370**	**0.0001**	**3.8370**
JP	**Industrial Production (MoM)**	**PBA**	**-0.000391**	**0.000111**	**-3.5228**	**0.0004**	**3.5228**
SG	**Advance GDP Estimate (QoQ)**	**TOITE**	**-0.001476**	**0.000425**	**-3.4722**	**0.0006**	**3.4722**
US	**Consumer Confidence**	**PBA**	**0.000740**	**0.000214**	**3.4534**	**0.0006**	**3.4534**
PH	**Gross Domestic Product (YoY)**	**TOITE**	**-0.000914**	**0.000265**	**-3.4464**	**0.0006**	**3.4464**
JP	**Large Retailers' Sales**	**PBA**	**-0.000529**	**0.000155**	**-3.4145**	**0.0007**	**3.4145**
TW	**Industrial Production (YoY)**	**TOITE**	**-0.000432**	**0.000134**	**-3.2196**	**0.0013**	**3.2196**
JP	**Tankan Lge Manufacturers Index**	**PBA**	**-0.000792**	**0.000248**	**-3.1999**	**0.0015**	**3.1999**
US	**GDP Price Deflator**	**IPM**	**-0.000531**	**0.000168**	**-3.1608**	**0.0016**	**3.1608**
JP	**Housing Starts (YoY)**	**PBA**	**0.000448**	**0.000146**	**3.0816**	**0.0021**	**3.0816**
MY	**GDP YoY%**	**TOITE**	**-0.000735**	**0.000243**	**-3.0232**	**0.0026**	**3.0232**
TW	**Benchmark Interest Rate**	**TOITE**	**0.000980**	**0.000337**	**2.9102**	**0.0040**	**2.9102**
US	**Import Price Index (MoM)**	**IPM**	**0.000438**	**0.000152**	**2.8910**	**0.0039**	**2.8910**
US	**Leading Indicators**	**PBA**	**-0.000438**	**0.000167**	**-2.6210**	**0.0088**	**2.6210**
US	**Current Account Balance**	**TOITE**	**0.000779**	**0.000309**	**2.5258**	**0.0118**	**2.5258**
TH	**Gross Domestic Product (YoY)**	**TOITE**	**0.000637**	**0.000254**	**2.5090**	**0.0125**	**2.5090**
US	**Change in Manufact. Payrolls**	**TOITE**	**0.000339**	**0.000137**	**2.4705**	**0.0136**	**2.4705**
JP	**Machine Orders YOY%**	**PBA**	**-0.000474**	**0.000194**	**-2.4388**	**0.0149**	**2.4388**
US	**Empire Manufacturing**	**PBA**	**-0.000446**	**0.000183**	**-2.4377**	**0.0149**	**2.4377**
US	**Wholesale Inventories**	**PBA**	**-0.000535**	**0.000225**	**-2.3747**	**0.0177**	**2.3747**

Table 4.17: Macroeconomic Surprises on Pooled Asia-Pacific Exchange Rates (*continued*)

Country	Events	Category	Coef. Est.	s.e.	t-stat	p-value	Abs. t-stat
MY	**Overnight Rate**	**IPM**	**-0.000786**	**0.000341**	**-2.3090**	**0.0214**	**2.3090**
US	**Chicago Purchasing Manager**	**PBA**	**0.000360**	**0.000157**	**2.2902**	**0.0221**	**2.2902**
SG	**Retail Sales (YoY)**	**PBA**	**0.000333**	**0.000148**	**2.2529**	**0.0245**	**2.2529**
MY	**Industrial Production YoY**	**PBA**	**-0.000396**	**0.000176**	**-2.2479**	**0.0248**	**2.2479**
CH	**Industrial Production (YoY)**	**PBA**	**-0.000508**	**0.000230**	**-2.2070**	**0.0277**	**2.2070**
SG	**CPI (YoY)**	**IPM**	**-0.000278**	**0.000128**	**-2.1717**	**0.0301**	**2.1717**
US	**Advance Retail Sales**	**PBA**	**0.000431**	**0.000203**	**2.1291**	**0.0334**	**2.1291**
US	**Trade Balance**	**TOITE**	**0.000425**	**0.000204**	**2.0832**	**0.0374**	**2.0832**
AU	**Trade Balance**	**TOITE**	**-0.000316**	**0.000153**	**-2.0599**	**0.0396**	**2.0599**
US	**Initial Jobless Claims**	**TOITE**	**0.000194**	**0.000095**	**2.0585**	**0.0396**	**2.0585**
JP	**Natl CPI YoY**	**IPM**	**-0.000316**	**0.000157**	**-2.0120**	**0.0444**	**2.0120**
IN	**Qtrly GDP YoY%**	**TOITE**	**-0.000605**	**0.000306**	**-1.9740**	**0.0491**	**1.9740**
US	**Unemployment Rate**	**TOITE**	**-0.000315**	**0.000166**	**-1.8998**	**0.0576**	**1.8998**
JP	**All Industry Activity Index (MoM)**	**PBA**	**-0.000318**	**0.000169**	**-1.8828**	**0.0600**	**1.8828**
JP	**Trade Balance - BOP Basis**	**TOITE**	**-0.000318**	**0.000169**	**-1.8828**	**0.0600**	**1.8828**
AU	**Producer Price Index (QoQ)**	**IPM**	**-0.000481**	**0.000266**	**-1.8075**	**0.0716**	**1.8075**
TW	**GDP - Constant Prices (YoY)**	**IPM**	**-0.000537**	**0.000300**	**-1.7876**	**0.0745**	**1.7876**
SG	**Unemployment Rate (sa)**	**TOITE**	**-0.000488**	**0.000283**	**-1.7265**	**0.0855**	**1.7265**
KR	**Industrial Production (MoM)**	**PBA**	**-0.000270**	**0.000159**	**-1.6972**	**0.0899**	**1.6972**
KR	**Consumer Price Index (MoM)**	**IPM**	**-0.000236**	**0.000139**	**-1.6941**	**0.0905**	**1.6941**
TH	Manufacturing Production (YoY)	PBA	-0.000249	0.000155	-1.6062	0.1086	1.6062
JP	Gross Domestic Product (QoQ)	TOITE	-0.000367	0.000241	-1.5233	0.1280	1.5233
IN	Industrial Production YoY	IPM	-0.000315	0.000210	-1.4987	0.1343	1.4987
NZ	Unemployment Rate	TOITE	0.000678	0.000455	1.4901	0.1368	1.4901
JP	Machine Orders (MoM)	PBA	-0.000214	0.000155	-1.3803	0.1677	1.3803
US	Change in Nonfarm Payrolls	TOITE	0.000227	0.000167	1.3590	0.1743	1.3590
TW	Total Trade Bal in US$ Billion	TOITE	0.000239	0.000179	1.3351	0.1825	1.3351
US	Avg Hourly Earning MOM Prod	IPM	0.000197	0.000148	1.3295	0.1839	1.3295
SG	GDP (YoY)	TOITE	0.000404	0.000310	1.3008	0.1941	1.3008
SG	Non-oil Domestic Exports (YoY)	TOITE	0.000193	0.000151	1.2802	0.2007	1.2802
PH	Overnight Borrowing Rate	IPM	0.000383	0.000308	1.2421	0.2147	1.2421
JP	Consumer Confidence	PBA	0.000259	0.000210	1.2346	0.2174	1.2346
AU	Consumer Prices (QoQ)	IPM	-0.000333	0.000271	-1.2252	0.2210	1.2252
US	Housing Starts	PBA	0.000200	0.000164	1.2173	0.2237	1.2173
TH	Current Account Balance (USD)	TOITE	-0.000188	0.000158	-1.1937	0.2329	1.1937
JP	Current Account Total	TOITE	0.000191	0.000166	1.1516	0.2497	1.1516
AU	Unemployment Rate	TOITE	0.000227	0.000205	1.1075	0.2682	1.1075
NZ	Trade Balance	TOITE	0.000165	0.000155	1.0648	0.2871	1.0648
CH	Consumer Price Index (YoY)	IPM	0.000152	0.000149	1.0218	0.3071	1.0218
US	ISM Non-Manufacturing	PBA	-0.000134	0.000131	-1.0215	0.3072	1.0215

Table 4.17: Macroeconomic Surprises on Pooled Asia-Pacific Exchange Rates (*continued*)

Country	Events	Category	Coef. Est.	s.e.	t-stat	p-value	Abs. t-stat
AU	Gross Domestic Product (QoQ)	TOITE	-0.000265	0.000269	-0.9858	0.3247	0.9858
AU	Current Account Balance	TOITE	-0.000199	0.000216	-0.9228	0.3565	0.9228
NZ	Consumer Prices (QoQ)	IPM	-0.000244	0.000274	-0.8885	0.3747	0.8885
US	Personal Spending	IPM	0.000157	0.000179	0.8775	0.3803	0.8775
ID	Bank Indonesia Reference Rate	IPM	0.000201	0.000230	0.8713	0.3839	0.8713
JP	Jobless Rate	TOITE	-0.000130	0.000153	-0.8505	0.3952	0.8505
US	Factory Orders	PBA	0.000184	0.000226	0.8161	0.4146	0.8161
US	New Home Sales	PBA	-0.000117	0.000159	-0.7366	0.4615	0.7366
US	Personal Income	IPM	0.000126	0.000173	0.7275	0.4670	0.7275
AU	Employment Change	TOITE	0.000126	0.000175	0.7165	0.4738	0.7165
CH	Trade Balance (USD)	TOITE	0.000169	0.000242	0.6999	0.4842	0.6999
TW	Unemployment Rate - sa	PBA	0.000104	0.000157	0.6619	0.5083	0.6619
TW	CPI YoY%	TOITE	0.000123	0.000191	0.6479	0.5173	0.6479
US	ISM Manufacturing	PBA	0.000114	0.000180	0.6320	0.5275	0.6320
ID	Total Trade Balance	IPM	-0.000076	0.000120	-0.6305	0.5285	0.6305
US	Durable Goods Orders	PBA	-0.000111	0.000181	-0.6144	0.5390	0.6144
JP	Coincident Index CI	PBA	0.000087	0.000142	0.6115	0.5410	0.6115
MY	CPI YoY	IPM	-0.000090	0.000169	-0.5305	0.5959	0.5305
US	Philadelphia Fed.	PBA	-0.000109	0.000209	-0.5214	0.6022	0.5214
NZ	RBNZ Official Cash Rate	IPM	0.000114	0.000220	0.5196	0.6034	0.5196
US	GDP QoQ (Annualized)	TOITE	0.000089	0.000192	0.4628	0.6436	0.4628
NZ	Retail Sales (MoM)	PBA	-0.000071	0.000163	-0.4343	0.6641	0.4343
US	U. of Michigan Confidence	PBA	0.000041	0.000107	0.3838	0.7012	0.3838
JP	Adjusted Current Account Total	TOITE	0.000064	0.000168	0.3808	0.7034	0.3808
MY	Trade Balance	TOITE	-0.000069	0.000195	-0.3540	0.7234	0.3540
US	Capacity Utilization	PBA	-0.000070	0.000202	-0.3485	0.7275	0.3485
JP	Leading Index CI	PBA	-0.000051	0.000148	-0.3464	0.7291	0.3464
JP	Tertiary Industry Index (MoM)	PBA	-0.000058	0.000168	-0.3424	0.7321	0.3424
JP	Tokyo CPI YoY	IPM	-0.000042	0.000155	-0.2716	0.7860	0.2716
US	Producer Price Index (MoM)	IPM	0.000066	0.000265	0.2496	0.8029	0.2496
KR	GDP at Constant Price (YoY)	TOITE	0.000064	0.000265	0.2414	0.8094	0.2414
CH	Producer Price Index (YoY)	IPM	0.000039	0.000166	0.2357	0.8137	0.2357
US	Business Inventories	PBA	-0.000047	0.000203	-0.2322	0.8164	0.2322
ID	Inflation NSA (MoM)	TOITE	0.000039	0.000167	0.2316	0.8169	0.2316
TH	Benchmark Interest Rate	IPM	0.000060	0.000304	0.1983	0.8429	0.1983
PH	Consumer Price Index NSA (MoM)	IPM	-0.000026	0.000210	-0.1257	0.9000	0.1257
TW	Current Account Balance (USD)	IPM	-0.000041	0.000328	-0.1240	0.9014	0.1240
SG	Industrial Production YoY	PBA	-0.000018	0.000159	-0.1161	0.9076	0.1161
US	Industrial Production	PBA	0.000022	0.000199	0.1114	0.9113	0.1114
NZ	GDP QoQ	TOITE	-0.000023	0.000211	-0.1068	0.9150	0.1068

Table 4.17: Macroeconomic Surprises on Pooled Asia-Pacific Exchange Rates (*continued*)

Country	Events	Category	Coef. Est.	s.e.	t-stat	p-value	Abs. t-stat
JP	Japan Money Stock M2 YoY	IPM	-0.000010	0.000172	-0.0585	0.9534	0.0585
AU	Retail Sales s.a. (MoM)	PBA	-0.000013	0.000327	-0.0397	0.9683	0.0397
US	Consumer Price Index (MoM)	IPM	-0.000005	0.000189	-0.0285	0.9773	0.0285
TH	Consumer Price Index (YoY)	IPM	-0.000002	0.000181	-0.0109	0.9913	0.0109

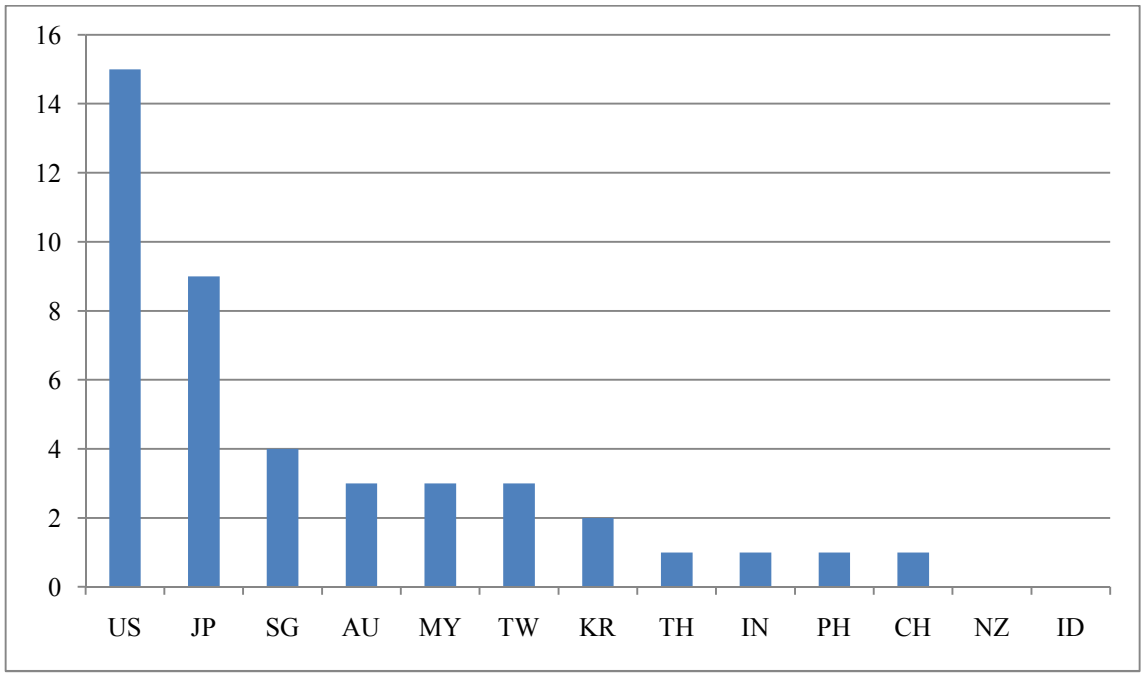
Out of the 107 macroeconomic shocks, only 43 surprises are significant in affecting the Asia-Pacific exchange rates. This represents about 40% from the total events. From the table, we find four interesting observations which justify further discussion. First, the Federal Fund Reserve (FFR) rate news is the most significant event among all the macroeconomic shocks. This is not surprising as the news related to the FFR rate has been shown as the event which significantly impacts the highest number of currencies under Section 4.2.2. This ranking has further vindicated the interpretation of our results that the FFR rate announcement is the most widely-watched scheduled event among the investment community. The second ranked event is the Reserve Bank of Australia Cash Target Rate announcement and this leads us to the second interesting observation – the interest-rate setting announcements are important in relation to other events.

Third, our results here contrasted two of the findings reported by Simpson, Ramchander & Chaudhry (2005). One, they claim that the news related to the Treasury Budget, Trade Balance and Capacity Utilization are the most important events which move the exchange rates whereas our results show that the interest-rate setting announcements are more important. Their key events are ranked much lower than the FFR rate announcement in our list of relative impact. Two, Simpson, Ramchander & Chaudhry (2005) also state that the news related to real economic growth have no significant impact on the exchange

rates. We find opposing evidence to this assertion. From the Top 10 events in our ranking of relative impact, four are related to the Production and Business Activities (PBA) which are proxy for the real economy activities (e.g. U.S. Building Permits and Japan Industrial Production). This finding implies that the exchange rates are tied to the real economy which is also consistent with the results from Pearce & Solakoglu (2007). The fourth interesting point is related to the insignificant finding of the Change in Non-farm Payroll (NFP) announcement. This event has been widely reported as a very important event in affecting the returns of exchange rates (e.g. Almeida, Goodhart & Payne, 1998; Andersen et al., 2003 and Pearce & Solakoglu, 2007). Our result basically finds no support for this claim.

Moving on, we are also interested in exploring which country contributes the higher number of significant events to the Asia-Pacific exchange rates. The number of significant events contributed by each country is graphed under Figure 4.7. The graph shows that many of the significant macroeconomic surprises are from the U.S. with 15 events. This is followed by Japan with nine (9) significant events. However, this is more or less expected in view of the large number of events selected from these two countries with 33 U.S. events and 20 events from Japan. Moving along this logical explanation, it is surprising to find that none of the New Zealand events are significant in influencing the collective Asia-Pacific currencies despite having a total number of six (6) events in our sample. Even though the Reserve Bank of New Zealand Official Cash Rate announcement affects five (5) individual Asia-Pacific currencies, the collective impact of this announcement is diluted to insignificant when the sample currencies are pooled. A reason to this could be due to the early time zone for New Zealand. The market in New Zealand opens when most of the other major financial centres are in hibernation mode. This reason could have reduced the potential impact of the macroeconomic surprises from this country.

Figure 4.7: Number of Significant Events from Each Country to the Pooled Asia-Pacific Exchange Rates



The graph above shows the number of macroeconomic events from each country in the Asia-Pacific which significantly affects the pooled regional exchange rates. We can reasonably expect US and Japan to contribute higher number of significant events because the macroeconomic indicators from these two countries are the largest in our sample. One interesting observation is gathered from this result: none of the New Zealand macroeconomic indicator has any significant impact to the pooled Asia-Pacific exchange rates despite its status as an advanced economy. The most likely reason for this observation is the early time zone for the announcement of New Zealand data which makes the effect of the surprises fades off throughout the day.

4.3 Chapter Summary

We have investigated the foreign exchange markets efficiency using the Asia-Pacific currencies for the period of January 1, 1997 to December 31, 2010 which encompasses two of the most important financial crises in modern history. We have adopted the forward unbiasedness hypothesis and the event-study analysis approaches to explore the market efficiency condition in the Asia-Pacific foreign exchange markets. In the forward unbiasedness hypothesis approach, we have apportioned the whole sample period into six sub-periods to provide further insight into the state of market efficiency under different economic conditions. The contrasting results between the Fama regression and the Johansen cointegration test are reconciled by using the models proposed by

Pilbeam & Olmo (2011). Meanwhile under the event-study analysis approach, we have adopted the conventional regression used to measure the impact of macroeconomic surprises on the exchange rates to test for market efficiency (similar to models used in Almeida, Goodhart & Payne, 1998; Andersen et al., 2003; Cai, Joo & Huang, 2009). We have also drilled down further to uncover the impact of the macroeconomic surprises on the Asia-Pacific exchange rates. We have provided a ranking of the most important (or significant) macroeconomic events to the Asia-Pacific currency market as a whole. If one wishes, we can view these two approaches as a test of the weak- and semi-strong-form efficiency. The former is tested through the forward unbiasedness hypothesis while the latter with the event-study analysis.[24]

Our overall results provide general support for the case of an efficient market in the Asia-Pacific foreign exchange market. The collective findings answer our first research question in affirmative: "Are the foreign exchange markets efficient?". Both the results from the Johansen cointegration test and the event-study analysis provide solid support for market efficiency. Even though results from the Fama regression show widespread rejections of market efficiency, these results are reconcilable with the models proposed by Pilbeam & Olmo (2011). The findings of widespread rejections of the forward unbiasedness hypothesis through the Fama regression are not surprising in view of a large body of literature which reports similar results (e.g. Frankel & Poonawala, 2010; Lothian & Wu, 2011). We find that the popular forward-bias puzzle exists in the Asia-Pacific foreign exchange markets. This finding provides an answer to the second research question: "Does the pervasive forward bias puzzle exists in the Asia-Pacific foreign exchange markets?".

[24] The weak-form efficiency is also investigated through the popular econometric technique known as the random-walk test (Aroskar, Sarkar & Swanson, 2004; Azad, 2009). Meanwhile the semi-strong form is sometimes tested through whether there is evidence of excess returns to be earned by using a certain indicators (or variables) in modeling the returns (Meese & Rogoff, 1983; Cheung, Chinn & Pascual, 2005).

But the forward bias puzzle does not happen at the same time for all the currency markets. We provide further insight to the forward-bias puzzle by grouping the currencies based on two institutional characteristics: (i) national income level and (ii) the extent of liberalisation of the foreign exchange market. We find that the currencies from rich economies usually display contrasting evidence for forward-bias puzzle than the currencies from medium income economies. This observation provides a vindication to the finding reported by Frankel & Poonawala (2010) and Bansal & Dahlquist (2000) which claim that the rich nations' currencies are more prone to the forward-bias puzzle. We also report that the extent of foreign exchange market liberalisation does not affect the existence of the forward-bias puzzle in the later subsample periods.

Next, we find that the states of market efficiency in the Asia-Pacific foreign exchange markets are not consistent throughout the sample period. And this provides an answer to the research question number three: "Are the states of market efficiency consistent over time?". Both the AFC and GFC have little impact to the overall *within-country* market efficiency. But from an *across-country* perspective, the AFC has clearly affected market efficiency while during the GFC currency markets show no convincing sign of inefficiency. We claim the sudden flotation of THB in the advent of 1997/98 AFC as a source of market inefficiency. At the same time, we also suggest that the massive unwinding of the JPY carry trade during the GFC has no distressing impact on the market efficiency condition in this region. We have provided empirical evidence to show that the AFC is a more disturbing event as compared to the GFC in the context of foreign exchange markets efficiency.

As discussed in subsection 3.1, the AFC can be traced back to as early as 1996 when some of the Asian currencies, notably the THB, came under speculative attacks by

institutional hedge funds (Kaminsky & Schmukler, 1999). In 1997 and 1998, the AFC became a full-blown banking crisis when we witnessed the collapse of some large financial institutions (e.g. Bangkok Bank of Commerce in Thailand and Hokkaido Takushoku Bank in Japan). There have also been a frenzy of mergesr and take over of some of the surviving financial institions. In some of the affected countries, the governments had also selectively bailed out some of the ailing financial institutions (e.g. Sime Bank in Malaysia). Due to the fact that the AFC was originated from the currency markets and its subsequent impact on the Asian economies, it is not entirely a surprise to note that the AFC remains as one of the most influential crises in the region.

On the other hand, the GFC took its root from the melt down in the U.S. subprime mortgage market and subsequently spread to the entire banking sector in the U.S. These large financial institutions, example Lehman Brothers and Citibank, are global institutions and have dealings with banks all over the world. As a result, the contagion effect was imminent. In addition, the liquidity squeeze in the interbank USD market caused a global frenzy and affected the businesses in the real sector. Without a proper functioning of the credit market, even a strong establishment like General Electric found it hard to raise funds to meet its short term obligations. The Asia-Pacific countries in our sample are mostly open economies and without doubt, would be affected adversely in the event of deterioration in the larger economies. But the impact of the GFC on the Asian economies is considered as part of the ripple effect and hence might not be as impactful when compared to the AFC.

We answer research questions four and five with an event-study analysis. We have shown that the Asia-Pacific exchange rates also react significantly to domestic macroeconomic shocks besides the well-documented evidence of reaction to the U.S. macroeconomic surprises. This finding provides an answer to our research question number

four: “Are the Asia-Pacific currencies muted to the surprises of their respective macroeconomic indicators?”. It implies the importance of the local macroeconomic surprises to the exchange-rates movement. Finally, we answer the last research question (i.e. “What are the key macroeconomic shocks which significantly affect the exchange-rates movement?”) by providing a ranking of the most significant macroeconomic announcements. We have used the macroeconomic announcements’ surprises to measure the relative impact of those shocks. From the 107 macroeconomic surprises, we find 43 surprises are significant in influencing the Asia-Pacific currencies. Our results suggest that the Asia-Pacific exchange rates respond to a wide range of macroeconomics shocks. The Top Three events are the (1) U.S.-Federal Open Market Committee (FOMC)’s announcement on the Federal Fund Reserve (FFR) rate, (2) the Australia-Reserve Bank of Australia’s announcement on the Target Rate and (3) U.S.-Building Permits.

The results which we have obtained have satisfactorily answered all of the research questions and in turn, achieved the objectives set out in the beginning of this thesis. We have pointed out the interesting observations and provided some discussions on those observations by relating them to the past literature as well as the economic development during the sample period. Table 4.18 on the following page summarises the findings for all the research questions. In the next chapter, we conclude the thesis. We provide a brief summary of the whole thesis and also discuss the implications of the findings for various stakeholders in the foreign exchange markets. Before the thesis is concluded, we suggest some potential room for improvement to this thesis and make some recommendations on promising future follow-up research.

Table 4.18: Summary of Research Questions, Hypotheses and Findings

The table below summarises the findings and relate how these findings provide answers to the research questions and conclusions to the research hypotheses.

Research Questions	Research Hypotheses	Research Findings
1. Are the Asia-Pacific foreign exchange markets efficient?	H_0: Asia-Pacific foreign exchange markets are efficient. H_1: Asia-Pacific foreign exchange markets are not efficient.	The Asia-Pacific foreign exchange markets are generally efficient with only intermittent inefficiencies detected in certain subsample periods.
2. Does the forward bias puzzle exist in the Asia-Pacific foreign exchange markets?	H_0: Forward bias puzzle occurs in the Asia-Pacific foreign exchange markets. H_1: Forward bias puzzle does not occur in the Asia-Pacific foreign exchange markets	The forward bias puzzle exists in the Asia-Pacific foreign exchange markets. However, our evidence further shows that this puzzle is reaffirmed as a statistical artefact as initially claimed by Pilbeam & Olmo (2011).
3. Are the foreign exchange markets consistently efficient under different economic conditions?	H_0: The foreign exchange markets are consistently efficient under different economic conditions. H_1: The foreign exchange markets are not consistently efficient under different economic conditions.	The foreign exchange markets are not consistently efficient under different economic conditions. There is evidence showing that the Asian financial crisis 1997/98 is a more disturbing event than the global financial crisis 2008/09 in terms of impact to the market efficiency in the Asia-Pacific foreign exchange market.
4. Are the Asia-Pacific currencies muted to the surprises of the domestic macroeconomic indicators?	H_0: Asia-Pacific currencies react to domestic macroeconomic surprises. H_1: Asia-Pacific currencies do not react to domestic macroeconomic surprises.	The Asia-Pacific currencies are as responsive to domestic macroeconomic shocks as to those U.S. macroeconomic shocks.
5. What are the key macroeconomic shocks that greatly affect the exchange rate movement?	H_0: Macroeconomic shock 'X' has the highest impact in affecting exchange rate returns. H_1: Macroeconomic shock 'X' is not the strongest factor in affecting exchange rate returns.	The shock in the Federal Open Market Committee (FOMC)'s announcement on the Federal Funds Reserve (FFR) rate is the most significant of all the 107 chosen macroeconomic shocks.

CHAPTER 5

CONCLUSION

5.0 Introduction

In total, there are five crucial chapters which define the essence of this thesis. The first chapter sets the framework of the thesis, followed by the second chapter which discusses the related literature in a critical way and subsequently identifies the literature gap. Chapter Three explains the research design and methodologies while Chapter Four presents the empirical results coupled with analytical insights. Finally, this chapter concludes the thesis. We start this chapter with a recollection of some of the key points from prior chapters. The important contributions are reemphasised once again. Subsequently, we discuss the significant implications of this thesis to academic researchers, policy makers and market participants. Some of the limitations and ways to further improve this thesis are also examined in this chapter. Lastly, we point out the future direction to further enhance this area of interest by suggesting some ideas for follow-up research.

5.1 Summary of Thesis

It is an indisputable fact that the concept of the efficient markets hypothesis (EMH) remains one of the most controversial theories in finance. In short, the EMH postulates that the security prices reflect all relevant available information and there is no opportunity for excess returns. There are equally strong voices and evidence from both supporters (e.g. Fama, 1970; 1998; Brown, 2011) and detractors (e.g. Grossman & Stiglitz, 1980; Shiller, 2003) of EMH. However, the usual focus of the EMH is in the study of capital markets

while the foreign exchange markets continue to be marginalised. The foreign exchange market is the largest financial market in the world with an annual turnover of about USD 1,000 trillion in 2010. Therefore the concept of EMH is especially important in this market because a slight distortion will provide a major profit opportunity. In brief, the research problem of this thesis can be represented by the following statement:

"The foreign exchange market is the largest financial market in the world with a daily turnover of over USD4trillion and a slight distortion in the market efficiency represents a very substantial profits opportunity. Unfortunately, the efficiency of the foreign exchange market remains undetermined. The evidence from the literature thus far is inconclusive and at times, contradictory."

This thesis sets out to solve the above problem. Besides EMH, there are two more major financial economic theories underlying this research namely; (i) uncovered interest-rate parity (UIP) and (ii) fundamental exchange rate theory. This thesis is therefore grounded by very established theories in finance. In the process of solving the research problem, there are three main research objectives which this thesis intends to achieve: (i) to generate a unifying perspective of the foreign exchange market efficiency condition, (ii) to provide a set of consistent results on the forward unbiasedness hypothesis and (iii) to offer a list of ranking of the key macroeconomic indicators which have the most significant impact on exchange rates. We ask five research questions and each of these questions is translated into a corresponding testable research hypothesis. These research objectives are accomplished by conducting some formal empirical testing on the five research hypotheses which have been explained in greater detail in the first chapter.

The sample period for this thesis is set from January 1, 1997 to December 31, 2010. This is an eventful period in the development of the foreign exchange markets and the highlights are presented in Table 3.2 – Page 94. Most past research in exchange rate economics utilized exchange rate data from advanced nations for various reasons with the chief rationale being the convenient availability of such data. Unlike most of these past papers, this thesis employs Asia-Pacific data as the core sample because of three main motivations: (i) the increasing importance of this region to the global economy, (ii) the rich diversity among the Asia-Pacific currencies and (iii) the significant reactions of the Asia-Pacific exchange rates to the recent financial crises within the sample period. We have shown evidence that Asia-Pacific nations are contributing a higher proportion to the global growth than in the past. The currencies in the region are broadly grouped into free- and managed-float regimes. The volatilities of the Asia-Pacific currencies were also greatly elevated during the Asian financial crisis (AFC) 1997/98 and global financial crisis (GFC) 2008/09. All of these observations justify the choice of using the Asia-Pacific data as the core sample.

A thorough literature review on the EMH with a special focus on the foreign exchange markets is presented in Chapter Two. There are two popular approaches used in the literature to test for foreign exchange market efficiency. The first one is based on the uncovered interest-rate parity (UIP) theory while the second one is based on the fundamental exchange rate theory. The UIP also known as the forward unbiasedness hypothesis is commonly tested using the Fama regression and Johansen cointegration techniques. Foreign exchange markets are considered efficient if the forward exchange rates are unbiased predictors of future spot exchange rates. Some of the influential papers which employ the Fama regression are Bilson (1981), Fama (1984), Bansal & Dahlqusit

(2000), Frankel & Poonawala (2010) and Lothian & Wu (2011). Meanwhile papers which use the Johansen cointegration technique include Baillie & Bollerslev (1989), Crowder (1994), Jeon & Seo (2003) and Kan & Andreosso-O'Callaghan (2007).

Meanwhile the papers which employ the Johansen cointegration technique have also extended the technique to test for *across-country* efficiency. To be contrasted from *across-country* efficiency, the testing of the forward unbiasedness hypothesis is considered a *within-country* efficiency test. *Across-country* efficiency looks at the relationship between a set of different currency pairs and test whether one currency pair is predictable with another currency pair. Presence of predictability rejects market efficiency while absence vindicates market efficiency. Using the second approach, foreign exchange markets are deemed efficient if exchange rates react only to the arrival of relevant new information and nothing else. This approach has been used by, amongst others, Almeida, Goodhart & Payne (1998), Andersen et al. (2003) and Pearce & Solakoglu (2007).

In Chapter Three, before the research design and methodologies are detailed, we present the descriptive statistics of the data. The major data used are the daily spot and forward (one-month) exchange rates and 107 macroeconomic announcements from 13 Asia-Pacific countries, including the United States (U.S.). The exchange rate data are obtained from Datastream while the macroeconomic announcements are from the Bloomberg database. A background description and analysis for each of the currency markets are provided. It is important to have some basic understanding of the local currency markets in order to fully appreciate the empirical results which are being discussed in Chapter Four. For example, the Chinese yuan (CNY) market has undergone drastic development within the sample period of this thesis. The CNY was initially managed under the fixed exchange-rate regime but was subsequently shifted to the

crawling-peg regime in 2005. Meanwhile, the Malaysian ringgit (MYR) was managed under a *de-facto* managed-float regime (but *de-jure* free-float) prior to the AFC in 1997/98 but shifted to a fixed peg from September 1, 1998 to July 20, 2005. The MYR has now reverted to a managed-float regime again. The currencies such as Thai baht (THB), Indonesian rupiah (IDR) and South Korean won (KRW) are closely monitored by their respective monetary authorities and interventions are normal occurrences in these markets. Therefore the findings must be carefully interpreted alongside these unique characteristics of the Asia-Pacific foreign exchange markets.

The research design and methodologies are detailed in Chapter Three. Under close scrutiny, there are some closely related papers which we have drawn inspiration from in the design of this thesis. The use of subsample periods in this thesis is related to Jeon & Seo (2003) and Kan & Andreosso-O'Callaghan (2007). However, we have the opportunity to look at a substantially longer period which includes other significant events such as the foreign exchange regime shift in China and Malaysia in 2005 and the GFC in 2008/09. Although the results from the Fama regression generally reject markets efficiency, the results from the Johansen cointegration technique show strong support for market efficiency. While this situation is not entirely unexpected, it presents an obstacle to produce a coherent set of results. Therefore we have adopted the Pilbeam & Olmo (2011) models to reconcile the difference between these two sets of conflicting results. In our second approach, the main inspirations are drawn from Almeida, Goodhart & Payne (1998) and Pearce & Solakoglu (2007). There are many other papers which we constantly relate to in the research design in Chapter Three and the research findings in Chapter Four. All of these papers have been critically reviewed in Chapter Two.

From the amount of evidence we obtained, the support for the concept of EMH in the foreign exchange markets in Asia-Pacific is strong. This provides an affirmative answer to the first research hypothesis. As mentioned, we have studied this subject with two related but distinct approaches: (i) the forward unbiasedness hypothesis and (ii) the event-study analysis. From the forward unbiasedness hypothesis, we have adopted the conventional Fama (1984) regression and the Johansen (1991, 1995) cointegration technique to test for the market efficiency. From the extensive literature review, we believe this thesis is the first work which brings together these two techniques to test for the forward unbiasedness hypothesis under a single study. While the results obtained from the conventional Fama regression are in violation of the notion of market efficiency, the results come as no surprise. There is already a huge volume of evidence indicating the rejection of market efficiency using the conventional Fama regression (e.g. Engel, 1996; Chinn, 2006; Lothian & Wu, 2011) and this phenomenon is now popularly known as the forward bias puzzle (Sarno, 2005). The forward bias puzzle exists in different time period and also among different currencies. The differences in the findings of the existence of the forward bias puzzle among the set of Asia-Pacific currencies can be explained with the two institutional characteristics introduced in this thesis: (i) the countries' income level and (ii) the extent of liberalisation in the foreign markets. Meanwhile, the results from the Johansen cointegration technique have generally supported the case for an efficient foreign exchange market. In view of these contrasting results between the conventional Fama regression and the Johansen cointegration technique, we have adopted the models proposed by Pilbeam & Olmo (2011) to reconcile the results. The results from Pilbeam & Olmo's (2011) models have given strong evidence in support of market efficiency in the Asia-Pacific foreign exchange markets. The forward bias puzzle disappears with the modification in the Fama

regression as recommended by Pilbeam & Olmo (2011). Besides that, we have also carefully devised a robustness test on the forward unbiasedness hypothesis.

The test for market efficiency through the forward unbiasedness hypothesis is also called a *within-country* efficiency test. This test is named as such because it examines the relationship between the spot and forward exchange rates of only one particular currency pair. The results generally support that the foreign exchange markets in Asia-Pacific are *within-country* efficient. Following Baillie & Bollerslev (1989) and Jeon & Seo (2003), we have similarly extended the Johansen cointegration technique to test for *across-country* efficiency. The *across-country* efficiency test constitutes a departure from the forward unbiasedness hypothesis as it does not examine the relationship between the spot and forward exchange rates. The *across-country* efficiency test looks at whether or not the tenet of no predictability in an efficient market is upheld. The EMH is violated if the spot exchange rates of one country are predictable with the spot exchange rates of another country hence the name *across-country* efficiency. We have conducted bivariate and multivariate cointegration tests to examine *cross-country* market efficiency. The bivariate results are strongly in support of market efficiency while the results from the multivariate cointegration test show some sign of violations in the market efficiency. However, in the spirit of Crowder (1994) and Kan & Andreosso-O'Callaghan (2007), we have also tested the stationarity behaviour of the forward premium. The findings show stationary forward premium and this, in turn, has reduced the argument against *across-country* market efficiency as suggested by the multivariate test results. Therefore we tentatively conclude that the foreign exchange markets are generally efficient. Even though this is the case, the state of efficiency is not constant throughout the whole sample period. Disturbances in the

foreign exchange markets are recorded during certain subsample periods for the Asia-Pacific currency markets.

Through the bivariate cointegration test, we have also shown that the AFC 1997/98 is a more disturbing event as compared to the GFC 2008/09 in the Asia-Pacific foreign exchange markets. There are more signs of market inefficiency during the AFC than the GFC. This inference from the bivariate cointegration is also supported by the results obtained from the second modified regression model as proposed by Pilbeam & Olmo (2011). Besides the differences in the subsample periods, the institutional characteristics also influence the state of market efficiency. As the whole sample period encompasses two important financial crises (i.e. AFC and GFC), we are able to draw some interesting inferences regarding the state of market efficiency for currencies under different regimes. From the Pilbeam & Olmo (2011)'s models, it is evident that the free-float currencies are more resilient than the managed-float currencies in the face of a financial crisis. At this point, we just would like to reemphasise that Research Hypotheses Two and Three are answered in the affirmative, similar to Research Hypothesis One.

The results from the event-study analysis also show that the foreign exchange markets are efficient. We have used the standard event-study regression model in the testing of the foreign exchange market efficiency (e.g. Almeida, Goodhart & Payne, 1998; Andersen et al., 2003; Pearce and Solakoglu, 2007). A regression of the exchange rate changes on the macroeconomic surprises is conducted to directly test for the informational efficiency condition of the foreign exchange markets. The results show that most of the currencies do not register any significant reaction to the non-surprise component. This finding implies market efficiency. These results are mostly consistent with the evidence reported in the literature. It must be stressed that the sample currencies employed in this

thesis are largely different from most of the published research papers. The conclusion we made for Research Hypothesis One is not only supported by the results from the forward unbiasedness hypothesis but also reinforced by the results from the event-study analysis approach. The consistent findings from two of these well-established approaches provide comfort and confidence to the conclusion.

Taking the analysis a step further, we measure the relative impact of macroeconomic surprises on the Asia-Pacific currencies. We have compared the relative importance of the domestic macroeconomic shocks with their U.S. counterparts on the Asia-Pacific exchange rates. The evidence shows that the exchange rates in Asia-Pacific are as reactive to the domestic macroeconomic shocks as to the U.S. macroeconomic shocks. This finding represents a departure from the results reported by Cai, Joo & Huang (2009) which states that the domestic macroeconomic shocks are less significant in affecting exchange rates. The Asia-Pacific exchange rates are definitely not muted to domestic macroeconomic shocks. This result provides a rejection of the null statement of Research Hypothesis Four.

Finally, in a novel approach, we have run a pooled regression of all the 12 Asia-Pacific exchange rates on each macroeconomic event. From the results, we have ranked all the 107 macroeconomic indicators selected in this thesis by their relative impacts on the exchange rates. The most impactful event is identified as the shocks in the Federal Open Market Committee (FOMC)'s announcement on the Federal Fund Reserves (FFR) rates followed by the shocks in the Reserve Bank of Australia (RBA)'s announcement on the Cash Target Rate. This finding implies that shocks in interest-rate setting announcements are very important in affecting the exchange rates movement. This finding is logical because most of the monetary authorities in the Asia-Pacific region adopt an inflation-

targeting rather than an exchange-rate targeting policy.[25] In comparison to the literature, many research papers (e.g. Almeida, Goodhart & Payne, 1998; Andersen et al., 2003; Pearce & Solakoglu, 2007) have cited shocks in the U.S. Non-farm payroll (NFP) announcement as the most important event. While the shock in the NFP is still an important event, its significance is overstated. This finding shows that we could not simply generalise the results from the literature which used the advanced countries' currencies to the Asia-Pacific currencies. Therefore the results in this thesis provide an important insight especially to the foreign exchange markets in Asia-Pacific. The results from this ranking provide an answer to Research Hypothesis Five. After identifying the most significant event, we have also provided a ranking on the most reactive currencies in the Asia-Pacific. The Australian dollar (AUD) is identified as the most elastic currency, ahead of Japanese yen (JPY), in the Asia-Pacific region in terms of reaction to the macroeconomic shocks. The New Zealand dollar (NZD) and JPY are the next most reactive currencies to shocks in the macroeconomic announcements. Some thorough discussion on these empirical findings have been provided in Chapter Four.

There are several significant contributions from this thesis. First and foremost, the huge volume of evidence churned out from various analyses in this thesis point to a generally efficient foreign exchange market in Asia-Pacific. This finding implies that there will be no excess returns to be earned by speculating in the Asia-Pacific foreign exchange markets. Secondly, by providing evidence in support of the forward unbiasedness hypothesis, this thesis also contributes to the resolution of the forward bias puzzle. The forward bias puzzle refers to the pervasive finding of a negative beta coefficient from the Fama regression. The general conclusion of this thesis echoes the claim made by Pilbeam

[25] An obvious exception is the Monetary Authority of Singapore (MAS) which adopts the exchange-rate targeting as its monetary policy.

& Olmo (2011) which states that this puzzle is a statistical artefact. Meanwhile, the third significant contribution of this thesis is that it has shown that institutional characteristics, specifically the nations' income levels and the extent of foreign exchange market liberalization, are important in determining the state of market efficiency under different economic conditions. In particular, the evidence of market efficiency varies from currency to currency when the whole sample period is compartmentalized into several subsample periods.

There are two important financial crises which are recorded in the full sample period and this provides an opportunity for this thesis to compare the effects between them in the context of foreign exchange markets efficiency. As another significant contribution, this thesis finds that the AFC is a more disturbing event than the GFC in terms of market efficiency in the region. This thesis has also contributed to the debate on which exchange rate regime is better for the management of a country's foreign exchange policy. The free-float currencies display a more stable pattern of market efficiency as compared to those managed-float currencies. If market efficiency is a concern, the free-float exchange rate regime should be adopted. The next two significant contributions of this thesis are related to the fundamental exchange rate theory. We have provided a list of ranking of the most influential macroeconomic shocks in terms of their relative impact to the Asia-Pacific exchange rates. This ranking is useful in to all interested parties in the foreign exchange markets. Finally, this thesis has also shown that the domestic macroeconomic shocks are as important as their U.S. macroeconomic counterparts. Market participants cannot ignore the domestic macroeconomic announcements in valuing a particular currency.

5.2 Implications of Thesis

The key results from this thesis bring critical implications to various interested parties. In this subsection, the imperative implications are presented from the perspectives of three main players in the foreign exchange markets: (i) researchers, (ii) policy makers and (iii) currency traders. The researchers group can come from the academic institutions or any private entities such as banks, brokerage or think-tanks. Meanwhile policy makers refer to the monetary authority such as those from the central banks or government agencies entrusted with the foreign exchange responsibility. Lastly, currency traders include all the other participants who deal directly in the foreign exchange markets such as those hired by the financial institutions to conduct proprietary trading as well as retail traders.

Researchers may rely upon the findings from this thesis for their future research. This thesis has directly contributed, albeit in a limited fashion, towards the resolution of two key exchange rate puzzles namely the (i) forward bias puzzle and (ii) fundamental disconnect puzzle. We have vindicated the models proposed by Pilbeam & Olmo (2011) by using a different set of currencies but producing a qualitatively similar set of results, and supporting evidence that the forward bias puzzle can be treated as a statistical artifact. Even though the fundamental disconnect puzzle is not directly addressed, the results are supportive of the existence of some solid relationships between exchange rates and macroeconomic fundamentals. As the concept of EMH is a pervasively used assumption in many empirical studies, researchers may also draw upon the findings from this thesis and make a more convincing assumption regarding this theory in the foreign exchange markets in their future research. The evidence from this thesis has tilted the balance in favor of the EMH in the ongoing debate on the validity of EMH.

As for policymakers, the results have pointed out that the free-float exchange rate regime makes the foreign exchange markets more resilient to crises and they display a more consistent pattern of efficiency than currency markets under a managed-float regime. Therefore if market efficiency is a priority for policymakers, opting for a free-float exchange rate regime serves this purpose. However, in choosing an appropriate foreign exchange rate regime, policymakers may have many other considerations to look at and the requirement of market efficiency may not rank very high in the list of priorities. It must be stressed that this thesis does not propose the adoption of one exchange rate regime over another. This thesis is merely providing some objective evidence which the policy makers may be interested to take into account as one of their many considerations. Besides the finding on the foreign exchange rate regimes, the result on the AFC as the more disturbing event than the GFC in the context of foreign exchange market efficiency may be utilized as an additional knowledge to the policymakers. There may be some actions taken by the policymakers which could have contributed to a better efficiency condition during the GFC than the AFC. This finding could be due to various reasons such as the aggressive build-up in the international reserves by the Asian central banks post-AFC or a more solid banking system or a more liberalized financial market as a whole. There is also, however, a possibility that the GFC is less disturbing to the efficiency condition in the Asia-Pacific currency markets because the crisis originated from outside the region.

Finally, for currency traders, the general findings of this thesis point to the condition of market efficiency and hence the absence of excess returns. Therefore it is not really a profitable venture to bet heavily in the foreign exchange markets. For financial institutions, it may be wise to just provide foreign exchange services without establishing a large proprietary foreign exchange trading desk. Whereas for the retail traders, it may be even

better to just stay away from the foreign exchange markets. In an efficient market, no trader can consistently beat the market. And the situation is aggravated for retail investors because it is difficult for them to beat currency traders from large financial institutions who have the latest technology and information at their disposal. Therefore the general public must be wary of those self-claimed foreign exchange gurus who claim to hold the secrets to beating the markets. Logically, any sane person in possession of such privileged skill, if it ever exists, will never want to share it with the whole world. Thus these so-called foreign exchange experts may just make their fortune by selling their trading advice rather than actually trading in the foreign exchange markets. Nevertheless, all is not lost for the foreign exchange markets trading community. There is definitely a need for traders to provide liquidity and to ensure that the markets continue to be efficient. Moreover, the results from this thesis also suggest that market efficiency did break down during some of the subsample periods and hence the existence of a window of profit opportunity. This evidence will ensure the continued existence of currency traders in the foreign exchange markets.

5.3 Limitations of Scope, Potential Improvements and Future Direction

From the onset, it is noted that this thesis is limited in scope. The thesis is intended to investigate the empirical evidence with regards to the theory of efficient markets hypothesis (EMH) in the context of the foreign exchange markets. In addition, this thesis is also offering some empirical evidence to enahance our understanding on a couple of pertinent issues related to two of the major puzzles in exchange rates economics. The first puzzle is the forward bias puzzle while the second one is the fundamental disconnect puzzle. We do not wish to step beyond the boundaries set by these objectives. This thesis does not propose any structural exchange rate model which could predict future exchange

rate movements. There is no theoretical model suggested in this thesis which could address any of the exchange rate puzzles. We do not discuss in detail the exact impact of how the macroeconomic surprises affect the exchange rate movement. All these exclusions are potential research issues for some of our future work.

This thesis may also contain a few other inconsequential limitations. These limitations may be positively viewed as room for further improvement. In this section, five aspects are proposed as potential improvements. Firstly, instead of subjectively partitioning the whole sample period into several subsample periods, some other more objective methods could be pursued. Similar to the general classification of recession, the whole sample period can be broken down based on certain macroeconomic indicators such as the monthly Industrial Production Index (IPI) or Leading Indicator Index. For example, if the reading of the IPI falls below or above a certain threshold for a predetermined consecutive period, we may cut it off and treat the subsequent period as a different subsample period. Alternatively, we may develop a more mathematically-oriented technique in the apportionment of the whole sample period.

Secondly, we may include additional currencies from different continents such as Europe and Latin America. The inclusion of a wider set of currencies enables this thesis to provide a more global view and may also facilitate the comparison among currencies from different regions. For example, we may be able to compare which set of currency markets are more prone to disturbances caused by the AFC and GFC. The third aspect which may be considered for improvement is to introduce more institutional characteristics such as the inflationary environment and the extent of financial market development. The results from this thesis have shown that the institutional characteristics such as the national income level and the extent of foreign exchange markets liberalization as important in the determination

of foreign exchange market efficiency. Therefore we believe more institutional characteristics should be explored.

Fourthly, the results from the event-study analysis may be interpreted alongside some established macroeconomic theory such as the Purchasing Power Parity (PPP) or monetary exchange rate model. The sign of the estimated beta coefficient from the event-study regression provides important insight on whether the exchange rates are reacting as dictated by such theories. It is definitely an interesting exercise to identify whether such theories hold true with the evidence from the Asia-Pacific exchange rates. Fifthly, the foreign exchange market efficiency condition may alternatively be tested from the perspective of excess profits. If a particular trading strategy is able to provide excess returns, it implies that market efficiency may be violated. In conducting such a test, it is necessary have an appropriate exchange rate pricing model and the corresponding risk premium. Currently, there is no known universally-accepted exchange rate model. In most cases, the random walk model is proven to be superior to all other highly sophisticated models (Cheung, Chinn & Pascual, 2005).

Despite the benefits described above for the five potential improvements, they are not without drawbacks. For example, the suggested alternative methods in partitioning the whole sample period still contain some subjective component. The alternative methods may also result in a large number of subsample periods which we want to avoid. In addition, the interpretation of the results from the event-study regression alongside the established theories may also cloud the focus on foreign exchange market efficiency. Meanwhile the inclusion of a wider set of currencies may dilute the attention to Asia-Pacific foreign exchange markets which are intentionally chosen as the core sample. The evidence for other advanced currency markets is widely available in the literature. We may conveniently

draw upon the results from these past studies for comparisons with the evidence reported in this thesis. Therefore the existing methods and approach used here are the optimum options which help to solve the research problem and consequently achieve the desired objectives.

Finally, we would like to share three related research areas which we think may yield fruitful implications to the foreign exchange markets. These suggested areas of research are seen as the future direction for this thesis to follow up. Firstly, the research area related to the non-deliverable forward (NDF) foreign exchange markets is an interesting subject as there are now more currencies which are being traded in such market. This market exists to serve the needs of offshore participants to circumvent certain local foreign exchange restrictions imposed by local regulators. Emerging nations which are transitioning from a closed economy to an open economy are usually reluctant to unleash the controls on their currencies. As a result, the monetary authorities may impose plenty of restrictions to ensure that the currencies move at their desired level. Moreover, the transition process to become a fully liberalized nation may take years or decades. An interesting case in point is China which started to open up its economy in the late 1970s during the era of the late Deng Xiao-Peng. It officially joined the World Trade Organization (WTO) only in 2001. Subsequently, after much pressure from the developed countries, especially the U.S., China abandoned its fixed exchange rate regime and adopted a crawling peg regime in 2005. However, the progress to liberalize its currency has been slow and cautious. As a result, the trading of Chinese yuan (CNY) on the NDF market has picked up strong momentum in view of its growing importance to the global economy. An excellent review of the NDF market has been provided by Ma, Ho & McCauley (2004) and Tsuyuguchi & Wooldridge (2008). The study of emerging market economies is not complete without insights from the NDF markets and hence we believe this is an important

area of research which will contribute immensely to a large body of existing literature on emerging market studies.

The second area of research which we would like to suggest is the emphasis on the crises impacts on the foreign exchange markets. In the whole sample period, we have the opportunity to look at two important crises, namely the AFC and GFC, and their relative impacts on market efficiency. The results under these two crises are markedly different and this finding implies that each crisis affects the market differently. By specifically focusing on the crisis periods, we are able to collate the relative impact of the crises in another dimension. Most of the time, the impact of a particular crisis is usually measured by how much wealth is lost from the market following the crisis. In fact, the effect of the crisis on the structural aspect is equally important as it may alter the system in which the market operates. There will definitely be some valuable lessons which we may draw upon from studying the various economic and financial crises.

The last suggested research area is on the fabrication of a more solid fundamental exchange rate model. As mentioned, there is still no one single universally accepted exchange rate model among economists and practitioners alike. In comparison to the equity market, the foreign exchange market is seriously handicapped in terms of a good model in describing movements in exchange rates. At least in the equity market, the capital asset pricing model (CAPM) and its variants are widely employed in explaining shares price movements. There are constant efforts from exchange rate economists to come up with an acceptable and sustainable exchange rate model. Through this thesis, the key macroeconomic indicators have already been identified. Those indicators which are ranked high on the list should carry more weights in the eventual exchange rate model. Therefore

we believe this thesis has provided a conducive framework for further research work in this area of interest.

5.4 Chapter Summary

This is the final chapter of the thesis and it is meant to provide an overall conclusion to all the key points raised in the earlier chapters. In the start of this chapter, we provide a recollection of the research problem which is related to the inconclusive evidence with regards to the foreign exchange markets efficiency. The research problem is clearly set out in the first chapter and this thesis is formulated to provide a resolution to this problem. We have succinctly stated the research problem in a compact statement which is given in the beginning of this chapter. In order to solve the research problem, three research objectives have been identified and these objectives are achieved through the five research hypotheses as mentioned in the earlier chapters. Through a comprehensive literature review, the research gap is recognized and subsequently addressed by the findings from this thesis. We have employed some of the more established techniques such as Fama regression, Johansen cointegration and event-study analysis to test the research hypotheses. The applications of these and other techniques have been comprehensively outlined in Chapter Three. The empirical research findings and discussions are revealed in the ensuing chapter.

Overall, the results are supportive of foreign exchange markets efficiency. In addition to Pilbeam & Olmo (2011), the forward bias puzzle is once again proven as a statistical artifact. Even though the foreign exchange markets are by and large efficient, there are signs that market efficiency may be disrupted during the crisis subsample periods. In comparison between the two key crises within the whole sample period, the AFC is found to be a more disturbing event than the GFC in terms of impact to the foreign

exchange market efficiency. From the event-study analysis, we have also found that exchange rates react almost equally strongly to local and U.S. macroeconomic surprises. A ranking list of the impact of the macroeconomic surprises to the exchange rates is also provided and this is a useful guide to various parties who are interested in the foreign exchange markets analysis. All in all, we have identified at least seven significant contributions from this thesis. These contributions are reemphasized in this chapter.

Besides that, we have also discussed the implications of this thesis to three key interested parties namely the: (i) researchers, (ii) policy makers and (iii) market participants. Finally, we discuss some of the potential improvements which could be introduced into this thesis. For example, the partitioning of the whole sample period into several subsample periods could be done through a more objective method. Upon careful deliberations, we still believe all the existing techniques and methods employed in this thesis are the most appropriate and provide the optimum results in achieving the research objectives. We end this thesis by proposing three related topics for future research. The proposed research topics could be seen as some sort of natural and convenient extension of this thesis. There may be some important and interesting insights which could be reaped from the proposed research topics. We seek to actively continue to expand the frontier of knowledge in the research area related to foreign exchange markets.

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