CURRENCY ORDER FLOW, EXCHANGE RATE DYNAMICS AND MARKET INTERVENTION: EMPIRICAL EVIDENCE FROM ASEAN-5 FOREIGN EXCHANGE MARKETS

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ABSTRACT

The microstructure approach in determining exchange rate movements has attracted special attention of academics and practitioners. This approach emphasizes the role of net demand pressure captured by currency order flow in determining exchange rate. This thesis examines the relationship between currency order flow and exchange rate of ASEAN-5 countries namely Indonesia, Malaysia, Philippines, Singapore and Thailand over a 6-year period (2010 – 2015). This study attempts to address three research objectives: (1) To examine the role of currency order flow in determining exchange rates movements against USD(2) To determine the short-run and long-run interaction between micro-macroeconomic variables and exchange rates, and (3) To test the effectiveness of central bank intervention in the foreign exchange markets through the behavior of currency order flow. Therefore, the focus on ASEAN-5 countries is for two reasons; first, these five countries have undergone rapid financial market liberalization, which have made them among the most important markets in the world. Second, these countries mainly practice manage-float exchange rate regime. The aforementioned reason is deemed as an avenue to determine whether the findings and explanations provided in the free-floating exchange rate regime are more widely applicable, or are limited to those markets. Using the portfolio shift model, this illustrates that exchange rates at short horizons are driven by currency order flow. The model of fifteen-minute (high frequency) currency order flow produces R^2 statistics between 6 percent (Philippines) and 19 percent (Singapore). These relatively low R^2's are due to manage-float exchange rate regime practiced by the sample countries. The vector autoregressive model (VAR), vector error correction model (VECM) and forecast error variance decomposition (FEVD) are used to determine the interaction between micro-macroeconomic variables (such as currency order flow, interest rate, country's risk premium) and exchange rate. The thesis identifies

that currency order flow and risk premium of the country are the only two influential determinants of exchange rate for ASEAN-5 countries. To address the final objective of study, the behavior of end-user currency order flow is used to capture the intervention of the central bank in the foreign exchange markets. The findings indicate that the exchange rates of ASEAN-5 countries are sensitive to central bank intervention. The findings also suggest that the central bank intervention will only become effective if the country has a sound monetary and fiscal policy. This thesis is among the first to test simultaneously the behavior of ASEAN-5 countries' exchange rates using market microstructure approach. Furthermore, this study also examines the exchange rate movements of manage-float exchange rate regime using a dataset of fifteen-minute currency order flow. Therefore, this thesis provides more information to the monetary authorities, market dealers and market players on the importance of employing market microstructure approach to determine exchange rate movements in the emerging markets.

ABSTRAK

Pendekatan mikrostruktur dalam menentukan pergerakan kadar pertukaran mata wang telah menarik perhatian ahli akademik dan juga pengamal pasaran. Pendekatan ini memberi tumpuan kepada peranan tekanan permintaan bersih yang terhasil dari aliran pesanan dalam menentukan kadar pertukaran mata wang. Tesis ini mengkaji hubungan yang wujud di antara aliran pesanan dan kadar pertukaran mata wang bagi negara ASEAN-5 iaitu Indonesia, Malaysia, Filipina, Singapura dan Thailand untuk tempoh 6 tahun (2010 - 2015). Tesis ini cuba menangani tiga objektif penyelidikan. Pertamanya ialah mengkaji peranan aliran pesanan dalam menentukan pergerakan kadar tukaran mata wang negara-negara yang dinyatakan berbanding USD. Keduanya ialah menentukan interaksi jangka pendek dan panjang di antara pembolehubah mikro dan makroekonomi ke atas kadar pertukaran mata wang. Dan ketiganya ialah menguji keberkesanan campur-tangan bank pusat dalam pasaran pertukaran mata wang asing melalui tingkah laku aliran pesanan mata wang. Tesis ini memberi tumpuan kepada negara ASEAN-5 kerana dua sebab. Pertama, lima negara ini telah mengalami liberalisasi pasaran kewangan yang pesat, dan ini telah menjadikan negara-negara ini di antara pasaran yang terpenting di dunia. Kedua, negara-negara ini secara amnya mengamalkan rejim kadar pertukaran mata wang apungan terurus (manage-float), oleh yang demikian, ia memberi peluang kepada tesis ini untuk menguji sama ada penemuan dan penjelasan sebelum ini ke atas rejim kadar pertukaran mata wang terapung bebas (free-floating) adalah sama dan boleh diaplikasikan ke regim yang lain, atau terhad kepada regim mereka sahaja. Dengan menggunakan model peralihan portfolio, tesis ini menemui bukti yang kadar pertukaran jangka pendek adalah didorong oleh aliran pesanan mata wang. Model yang menggunakan aliran pesanan mata wang bertempoh lima belas minit ini menghasilkan statistik R^2 di antara 6 peratus (Filipina) dan 19 peratus (Singapura). R^2 yang agak rendah ini disebabkan oleh rejim kadar pertukaran mata wang apungan terurus yang diamalkan oleh negara-negara tersebut. Model autoregressive vektor (VAR), model pembetulan ralat vektor (VECM) dan ramalan penguraian varians ralat (FEVD) digunakan untuk menentukan interaksi di antara kadar pertukaran, aliran pesanan mata wang, kadar faedah dan premium risiko negara. Tesis ini mendapati dua penentu sahaja yang mempengaruhi nilai tukaran mata wang negara ASEAN-5 iaitu aliran pesanan mata wang dan premium risiko negara. Untuk menangani objektif terakhir tesis, tingkah laku aliran pesanan mata wang pengguna akhir digunakan bagi mengenalpasti campur tangan bank pusat dalam pasaran pertukaran mata wang asing. Tesis ini mendapati bahawa kadar pertukaran mata wang negara ASEAN-5 adalah sensitif kepada campur tangan bank pusat. Tesis ini turut

mencadangkan bahawa campur tangan bank pusat hanya akan berkesan jika sesebuah negara mempunyai dasar monetari dan fiskal yang kukuh. Tesis ini adalah yang pertama menguji tingkah laku kadar pertukaran mata wang negara ASEAN-5 secara serentak dengan menggunakan pendekatan mikrostruktur pasaran. Tambahan pula, ia adalah yang pertama menguji pergerakan rejim kadar pertukaran mata wang apungan terurus dengan menggunakan satu set data yang baru iaitu aliran pesanan mata wang bertempoh lima belas minit. Tesis ini memberi pencerahan kepada pihak berkuasa kewangan, peniaga pasaran serta peserta pasaran mengenai kepentingan menggunakan pendekatan mikrostruktur dalam menentukan pergerakan kadar pertukaran mata wang di pasaran-pasaran membangun.

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LIST OF SYMBOLS AND ABBREVIATIONS

ASEAN	:	Association of Southeast Asian Nations
ADF	:	Augmented Dickey fuller
AIC	:	Akaike information criteria
ARDL	:	Autoregressive Distribution Lag
AUD	:	Australian dollar
BI	:	Bank Indonesia
BI-RTGS	:	Bank Indonesia real time gross settlements
BIS	:	Bank of international settlements
BNM	:	Bank Negara Malaysia
BOT	:	Bank of Thailand
BSP	:	Bangko sentral ny pilipinas
CAPS	:	Clearing and payment services
CB	:	Central bank
CHF	:	Swiss franc
CIP	:	Covered interest parity
CLS	:	Continuous linked settlement
CND	:	Canadian dollar
COF	:	Currency order flow
CP-SIPS	:	Core principles for systematically important payment system
DK	:	Devisa Kredit
DM	:	Deutsche mark
DPrice	:	Differenced price
DU	:	Devisa umum
ECM	:	Error Correction Modeling

EU	:	European union
EUR	:	European euro
FDI	:	Foreign direct investment
FM-OLS	:	Fully modified ordinary least square
FDI	:	Foreign direct investment
FX	:	Foreign exchange
GBP	:	Great British pound sterling
GDP	:	Gross domestic product
GMT	:	Greenwich meridian time
HVPS	:	High value payment system
IDR	:	Indonesia rupiah
IMF	:	International monetary fund
INT	:	Intervention
IPS	:	Institute of policy studies
JB	:	Jarque bera
JPY	:	Japanese yen
LVPS	:	Large value payment system
MAS	:	Monetary Authority of Singapore
MEPS+	:	New monetary authority of Singapore electronic payment system
MYR	:	Malaysia ringgit
OLS	:	Ordinary least square
PDDTS	:	Philippine domestic dollar transfer system
PDEx	:	Philippine dealing and Exchange Corporation
PDR	:	People democratic republic
PDS	:	Philippine dealing system
Philpass	:	Philippine payments and settlements system

PHP	:	Philippine peso
PLR	:	Prime lending rate
PV	:	Probability value
PVAR	:	Parsimonious Vector Autoregression
PVP	:	Payment verse payment
RENTAS	:	Real time electronic transfer of funds and securities
RMB	:	Renminbi
RTGS	:	Real time gross settlements
SIC	:	Schwarz information criteria
SC	:	Success criteria
SE	:	Standard error
SGD	:	Singapore dollar
SIPS	:	Systematically important payment system
TB	:	Treasury bill
TETFUND	:	Tertiary Education Trust Fund
THB	:	Thailand baht
UIP	:	Uncovered interest parity
USA	:	United States of America
USD	:	United States dollar
VAR	:	Vector Autoregression
VECM	:	Vector Error Correction Modeling

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CHAPTER 1: INTRODUCTION

In the recent past, the dwindling foreign exchange reserves, subsequent depreciation of currency and consequent market intervention in the foreign exchange market of ASEAN-5 (Indonesia, Malaysia, Philippines, Singapore and Thailand) countries have posed a great challenge on their exchange rate policy (ADB, 2012; 2015; BIS, 2015). It may not be because of monetary policy failure in most cases or ineffective fiscal policy as it may. However, this may be due to inadequate attention of the monetary authorities to one of the major microeconomic variables (currency order flow) on the important role it plays in the determination of exchange rate in the foreign exchange markets (Cerrato, M., Sarantis, N., and Saunders, A., 2011). It is desirable yet challenging to achieve a better understanding of how the value of ASEAN-5 currencies are determined in the long-run, and to identify the dynamics of the group currencies movement against the US dollar in the short-run specifically withthe of the ASEAN-5 countries' economies.

Furthermore, currency depreciation may force the central bank to sell foreign exchange reserves (market intervention) in order to prevent further depreciation. However, at some stage, the depleting foreign exchange reserves will inevitably make interest rate to increase, as the exchange rate and the monetary authority cannot indefinitely control the money market rate (Mundell, 1968). Thus, the likely consequences of foreign exchange market intervention and its effects on the monetary policy objectives may be severe. Hence, the effectiveness of market intervention as a policy tool to influence the future direction of exchange rate can be investigated.

Therefore, this thesis aims to improve the understanding of the exchange rate policy from a market microstructure perspective of the ASEAN-5 countries. To achieve this, the thesis examines the role of currency order flow in determining exchange rates movements of ASEAN-5 countries' currencies against US dollar. In addition, the short-run and long-

run interaction between micro-macroeconomic variables (such as currency order flow, interest rate and country risk premium) and exchange rates are determined. Finally, the effectiveness of central bank intervention in the foreign exchange markets through the behavior of currency order flow is tested. The selection of these micro-macroeconomic variables are based on the theories of exchange rate determination, and also from the related micro- macrostructure literature (Evans and Lyons, 2002a; 2002b; De-Medeiros, 2004; Wu, 2012; Duffuor, K, Marsh I.W, and Phylaktis, K., 2012; Zhang, Z, Chau, F and Zhang, W. , 2013).

Subsequent to the failure of conventional macroeconomic models to empirically explain and forecast exchange rate movements (Meese and Rogoff, 1983; Frankel and Rose 1995), theoretical and empirical works confirm via market microstructure approach that currency order flow has significant explanatory power for exchange rate movements (Evans and Lyons, 2002a; Evans, 2002; Bacchetta and Wincoop, 2006; Rime, D, Sarno, L and Sojli, E., 2010). Currency order flow is defined as the net of the buyer-initiated and seller-initiated orders in the foreign exchange market (Evans and Lyons, 2002a). Thus, currency order flow corresponds largely to what practitioners might refer to as buying or selling pressure (Evans and Lyons, 2007). From the macroeconomic perspective, interest rate is considered one of the major driver of exchange rate changes and it is available in daily frequency, hence, useful for empirical study. Furthermore, due to major difference in interest rates between the developed and emerging market economies, country risk premium was introduced in the studies of emerging markets (De-Medeiros, 2004; Wu, 2012). This is a variable considered in the literature to have a positive and strong significance in the studies of emerging markets (Zhang et al., 2013; Wu, 2012; Duffuor et al., 2012; De-Medeiros, 2004). Therefore, this thesis incorporates country risk premium as a control variable. Finally, from the market microstructure

perspective, this thesis takes into consideration the existence of foreign exchange market intervention and its impact on the exchange rate dynamics.

This thesis employed various techniques of the market microstructure approach to explore these issues. The thesis first constructs a measure of currency order flow that is based on all tick-by-tick high frequency transaction data of every fifteen-minutes currency order flow from the ASEAN-5 foreign exchange markets, and computes the cumulative daily currency order flow. Focusing on the integrating relationship between cumulative currency order flow and the exchange rate, the thesis found evidence that currency order flow not only Granger causes exchange rate movements, but also a significant determinant of exchange rate in the short-run. In addition, it finds that currency order flow and country risk premium are the only two influential determinants of exchange rate for ASEAN-5 countries.

Based on high frequency data, the thesis adopts some market intervention success criteria and ordinary least square (OLS) approach to explore market intervention and the extent to which this policy tool is effective. Evidence shows that market intervention is effective in influencing both the exchange rate and currency order flow, as the presence of the monetary authorities in the foreign exchange markets affect the correlation between exchange rate and currency order flow. In addition, the monetary authorities mostly intervene to smooth the foreign exchange market, which is more of "*leaning against the wind"* but unable to reverse the trend. Therefore, this shows that the exchange rates of ASEAN-5 countries are sensitive to central bank intervention. However, the thesis suggests that without a sound monetary and fiscal policy, using market intervention to stabilize exchange rate may not work in the long-run.

Therefore, this sheds more light to the monetary authorities, market dealers and market players on the importance of employing market microstructure approach to determine exchange rate movements in the emerging markets.

1.1 Background of the Study and Motivation

In the past decades, the application of conventional macroeconomic models to the study of exchange rates has met with increasing challenges due to poor performance by the models in capturing exchange rate fluctuations at high frequencies (Meese and Rogoff, 1983; Backus, 1984; MacDonald and Taylor, 1994; Frankel and Rose 1995; Isard, 1995). Macroeconomic factors such as liquidity, interest rate and stock return have differential impact on the daily high, low and closing exchange rates. However, following the failure of these conventional macroeconomic models to empirically explain and forecast exchange rate movements, promising evidence has been provided by the market microstructure literature through the research works of Evans and Lyons (2002a).

O'Hara (1995) defines the market microstructure approach as one that studies "the process and outcomes of exchanging assets under explicit trading rules". In turn, the trading process is centered on order flow; hence, order flow becomes the focal point of the microstructure approach (Frankel and Rose, 1995). Thus, order flow corresponds largely to what practitioners might refer to as buying or selling pressure (Evans and Lyons, 2007). Furthermore, by testing its ability to transmit information on price formation, theoretical and empirical works has confirmed that currency order flow has significant explanatory power for exchange rate movements (Evans and Lyons, 2002a, 2005, 2006, 2007; Bacchetta and Wincoop, 2006; Rime et al, 2010). Though, this does not imply that the only fundamental determinant of exchange rate is currency order flow, however, the order flow performs better in estimation (Marsh and O'Rourke, 2005; Killeen, W. P., Lyons, R.K and Moore, M.J. , 2006; Rime et al., 2010).

Previous studies have focused on the major currency pairs of developed market, meanwhile, in the emerging markets; very few studies have investigated the fundamental role of currency order flow in the determination of exchange rate. This therefore motivates to investigate further the importance of this microeconomic variable (currency order flow) together with macroeconomic variables (interest rate and country risk premium) in the determination and forecasting of exchange rate in the emerging markets.

The thesis is also motivated to research into foreign exchange market intervention. Market intervention is a policy tool used by most central banks to influence the future direction of their domestic exchange rate against other foreign currencies. However, there are consequences when market intervention is prolonged, as the monetary objectives may be undermined, the financial stability may be compromised and heavy financing costs may be imposed on the monetary authority (Basu and Varoudakis, 2013). In addition, market intervention usually weakens the domestic macroeconomic performance due to high inflation, financial system distortions, and exchange rate misalignment costs (Adler and Tovar, 2011). Hence, foreign exchange market intervention has direct consequences for the stance of monetary policy, which is a major cause for policy dilemma. Therefore, given the growing economic and financial liberalization, and the likely consequences of market intervention, this thesis is concerned to investigate ASEAN-5 monetary authorities' market intervention and the extent to which this policy tool is effective.

1.2 Economic Growth of ASEAN-5 Countries in Brief

The rapid economic growth of the Association of Southeast Asian Nations (ASEAN) has allowed it to increase its influence in the development of Asia and become one of the important economic associations in the world. ASEAN consists of 10 member states: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the

Philippines, Singapore, Thailand and Vietnam. Bilateral trade between the world major four economies (USA, EU, Japan and China) and ASEAN has grown over the last two decades from US$7 billion in 1990 to US$400 billion in 2012 (Asian Development Bank,2012). Invariably, ASEAN economies contribute over 24% of total trade in 2014 with the trade partner countries, including China, EU-28, Japan and USA. (IMF-World Economic Outlook 2015). In addition, between 2012 and 2014, the total Foreign Direct Investment (FDI) inflow to ASEAN is almost US$370 billion from the eleven selected partner countries including EU-28 (15.7%), Japan (15.3%), USA (8.8%) and China (5.8%) (IMF-world Economic Outlook 2015). The Gross Domestic Product (GDP) of ASEAN has grown from US$ 1.5 trillion in 2009 to over US$ 2.5 trillion in 2014 (IMF-World Economic Outlook 2015). (See Appendix A. Table 1.1, 1.2 and 1.3).

However, among the high performing economies in the region are the five founding members of ASEAN[1] (known as ASEAN-5). ASEAN-5 economies contribute 86.96% and 85.4% to the total trade in 2013 and 2014 with the major four trading partner countries. The group accounted for almost 90% of the total value of FDI inflow to ASEAN between the period 2012 and 2014. In addition, these five countries account for over 80% of the Gross Domestic Product (GDP) within ASEAN between 2009 and 2014. (See Appendix A. Table 1.3, 1.4 and 1.5).

Macroeconomic interdependence within the group has become stronger, as evidenced by a simultaneous contraction of economic activity throughout ASEAN-5 in 2005 and a simultaneous expansion in 2006 and 2007, respectively. The diverse economic relationship with the US, Japan, China and EU, this group economies should be able to achieve a reasonable degree of exchange rate stability. Unfortunately, these economies

[1] ASEAN-5: Indonesia, Malaysia, Philippines, Singapore and Thailand

have experienced a continuous reduction in their foreign exchange reserves, which also led to currency depreciation in the international market, especially against the US dollar. For example, the foreign exchange reserves in Indonesia decreased to US$100.24b in November 2015 from US$112.78b in 2012. While in Malaysia, it decreased to US$94.6b in November 2015 from US$139.66b in 2012. In the Philippines, it decreased to US$80.26b in August 2015 from US$83.83b in 2012. In Singapore, it decreased to US$247.1b in October 2015 from US$259.31b in 2012. Thailand experienced the same scenario; it decreased to US$154.84b in August 2015 from US$181.61b in 2012. (See Appendix A. Table 1.6).

The dwindling foreign exchange reserves position of these countries has led to the depreciation of their currencies against other major international currencies, especially against the US dollar. For example, between year 2010 and 2015, Indonesian Rupiah depreciates against USD (39.24%), while Malaysian Ringgit, Philippine Peso, Singapore Dollar and Thai Baht, also depreciated against USD; 30.8%, 6.4%, 7.8%, and 16.6% respectively (See Appendix A. Table 1.7).

The exchange rate depreciation in ASEAN-5 countries' economies have raised the question of whether the monetary authorities in these countries should act pre-emptively against these rising trends of the depreciation of their currencies, especially against the US dollar. The monetary policy of these five countries is not only important to their economic development, but also increasingly important to the world (ADB, 2015). The successful transition of these five emerging markets to a developed status is important, both to the world and as a model for the other emerging economies (ADB, 2015). Therefore, it is considered necessary but yet challenging to achieve a better understanding of how the value of ASEAN-5 countries' currencies are determined in the long-run, and to identify the dynamics of exchange rate in the short run. Hence, from a microstructure

perspective, this thesis investigates on how the value of ASEAN-5 countries' currencies is determined in the long run, and to identify the dynamics of the currency movements against the US dollar in the short-run.

In addition, currency depreciation may force the monetary authority to sell foreign exchange reserves, and this may lead to currency crisis due to speculative attack. When the monetary authority intervenes to prevent currency depreciation, the limit is often set by the national reserves as well as the contingency credit policies available to such a country. Therefore, at some stage, the depleting reserves will inevitably force interest rate to increase, "the impossible trinity"[2] (Mundell, 1968). Thus, it is essential for the monetary authority to carefully weigh the consequences of foreign exchange policy and its effects on the monetary policy objectives. By this act, high inflation rate, financial system distortions, and exchange rate misalignment costs can be greatly controlled. Therefore, the thesis aims at a better understanding of central bank market intervention and its effectiveness thereof. Hence, from a microstructure perspective, this thesis tests the effectiveness of central bank market intervention in the foreign exchange markets of the ASEAN-5 countries.

[2] "Impossible trinity": the exchange rate and money market rate cannot be indefinitely controlled by the monetary authority.

1.3 Objectives of the study

Specifically, this study is conducted to achieve the below objectives:

(i) To examine the extent to which currency order flow analysis may explain the short- term determination of the exchange rate value of ASEAN -5 countries' currencies against the US dollar.

(ii) To determine the extent of long-run and short-run interaction between micro-macroeconomic variables, such as currency order flow, interest rate, risk premium and exchange rate.

(iii) To investigate market intervention of ASEAN-5 countries' monetary authorities and the extent to which this policy tool is effective in curbing the depreciation of their currencies against the US dollar.

1.4 Research Questions

(i) To what extent can currency order flow analysis explain the short -term determination of the exchange rate value of ASEAN -5 countries' currencies against the US dollar?

(ii) What is the extent of long- run and short-run interaction between micro-macroeconomic variables, such as currency order flow, interest rate, risk premium and exchange rates?

(iii) To what extent is the market intervention of the ASEAN -5 countries' monetary authorities effective in curbing the depreciation of their currencies against the US dollar?

1.5 Scope of the study

This thesis focuses on the ASEAN-5 countries' economies (Indonesia, Malaysia, Philippines, Singapore and Thailand). These countries have a long history of multilateralism among themselves and possess similar contention due to financial/currency crises (Asian Development Bank, 2012). The economic experience of the members of this group had undergone most dramatic situation from growth to crisis over the past 7 years (Asian Development Bank, 2015).

In addition, members of this group mainly practice "managed floating" exchange rate regime, and the foreign exchange market regulations and structure are similar[3]. Therefore, this will provide opportunity to test whether some of the findings and explanations provided in the "free floating" exchange rate regime are more widely applicable, or limited to those markets. Meanwhile, the majority of the countries in Asia (including this group) fixed their exchange rates against US dollar between 1997 and 2005 coupled with the breakout of the global financial crisis circa 2008, and the spillover effect in 2009, which led to low or nil volatility in exchange rates. Therefore, this thesis includes the period, post 2008 global financial crisis from January 4, 2010 to December 31, 2015 in order to measure the flexibility and consequent volatility of exchange rates of ASEAN-5 countries' currencies against the US dollar.

[3] "Managed floating": Indonesia, Malaysia, Singapore and Thailand. "Independently floating": Philippines

1.6 Significance of the study

This study aims to address three research objectives and make theoretical, methodological and empirical contributions to the literature, especially to the market microstructure approach to exchange rate determination. First is to examine the role of currency order flow in determining exchange rates movements of ASEAN-5 countries' currencies against US dollar. Second is to determine the short-run and long-run interaction between micro-macroeconomic variables such as currency order flow, interest rate and country risk premium and exchange rates. Third, to test the effectiveness of central bank intervention in the foreign exchange markets through the behavior of currency order flow.

The market microstructure approach provides and can explore more details, the operating behavior of the ASEAN-5 countries foreign exchange markets. Therefore, the thesis fills this gap by employing market microstructure approach to exchange rate determination with high frequency transaction data of every fifteen-minute currency order flow. Explaining exchange rate fluctuations with high frequency dataset provides understanding impact and persistence effects of currency order flow may have on exchange rate in the emerging markets (Evans, 2010; Osler, 2006; Tanseli, 2011).

In previous studies on the impact of currency order flow on exchange rate determination in the developed market, the findings show that currency order flow is an important determinant of exchange rate dynamics. This microeconomic variable provides significant information in forecasting daily exchange rate movements and that through it, two-third of the total effects of macroeconomic news on exchange rate is transmitted to the market. In addition, currency order flow volatility remains higher, hours, even days, after the macroeconomic news. Therefore, in the models of exchange rate determination, currency order flow matters. However, in the emerging markets, some of the findings

indicate that currency order flow does not have any significant performance in the determination of exchange rate, while some findings confirm that currency order flow explains significant movements in exchange rates (Bjonnes and Rime, 2005; Breedon and Vitale, 2010; Rime et al., 2010; Evans and Lyons, 2008; Dominquez and Panthaki, 2005; Tanseli, 2011; De-Medeiros, 2004; Wu 2012; Duffuor et al., 2012; Zhang et al., 2013).

In addition, some findings on central bank market intervention show that the behavior of exchange rate on intervention days and non-intervention days cannot be statistically distinguished. While some findings indicate that the correlation between currency order flows and exchange rate changes disappear on intervention days, and that central bank market intervention strongly affect the level of exchange rate in the desired direction (Chaboud and Humpage, 2005; Fatum and Hutchinson, 2006; Menkhoff, 2010; Newman, V., Potter, C., and Wright, M., 2011; Marsh, 2011). Therefore, to some extent, findings from the developed market confirm and summarize that currency order flow is a major determinant of exchange rate dynamics.

However, in the emerging markets, with the exception of China, the findings indicate that currency order flow does not have any significant performance in the determination of exchange rate (Zhang et al, 2013; Wu, 2012; Duffuor et al, 2012; De-Medeiros, 2004). This implies that these findings are inconclusive in the emerging markets. Hence, it is considered necessary and unequivocal, using market microstructure approach to further investigate on the important role currency order flow plays in the determination of exchange rate in the emerging markets.

Therefore, this study aims to make some promising contributions to the market microstructure literature. First, while some datasets have been for a relatively short period in previous studies, the dataset used in this thesis is one of the largest and more recent

ever used in the literature to examine the impact of currency order flow on exchange rate determination in the emerging markets. Second, this thesis is one of the first to test simultaneously the behavior of ASEAN-5 countries' currencies exchange rates against the US dollar using market microstructure approach. Third, it is also one of the first to test the exchange rate movements of manage-float exchange rate regime using a new dataset of fifteen-minute currency order flow collected from one data source (Bloomberg).

Fourth, like many other monetary authorities, ASEAN-5 countries monetary authorities have enfolded their foreign exchange market intervention in secrecy. The thesis collect newswires reports on market intervention from one of the world's biggest news databases; Bloomberg. To estimate monetary authorities' market intervention, the thesis also gathers information from the construct of currency order flow measurement and exchange rate. Hence, it presents a rich context for this thesis, which aims at a better understanding of foreign exchange market intervention and the effectiveness of this policy tool in ASEAN-5 countries.

1.7 Organization of the study

This thesis is organized as follows:

Chapter 2: Literature review, this chapter reviews the related literature on market microstructure of exchange rate determination and currency order flow in the developed and emerging markets; exchange rate regimes and foreign exchange market intervention.

Chapter 3: This chapter discusses historical background of ASEAN-5 countries foreign exchange markets and foreign exchange policy; the main theories on exchange rate determination; market intervention channels; currency order flow, information

processing and exchange rates; construction of the measure of currency order flow and development of hypotheses.

Chapter 4: This chapter describes the methodology, sampling, data and data collection method and statistical method employed/model specification: Vector Autoregression (VAR) modeling; Error correction modeling (ECM); Impulse responses (IR); forecast error variance decomposition (FEVD) and foreign exchange market intervention success criteria.

Chapter 5: This chapter comprises the empirical results of the estimations on currency order flow analysis on short- term determination of exchange rate value of the ASEAN - 5 countries' currencies against the US dollar and, the long-run and short –run interaction between micro-macroeconomic variables, such as currency order flow, interest rate, risk premium and exchange rate.

Chapter 6: This chapter presents the empirical results of the estimations on ASEAN-5 countries monetary authorities' market intervention and the extent to which this policy tool is effective in curbing the depreciation of their currencies against the US dollar.

Chapter 7: This chapter concludes the dissertation with the summary of the thesis, research implications, research limitations, and suggestions for further research.

CHAPTER 2: LITERATURE REVIEW

This chapter reviews the related literature on the determination of exchange rate, exchange rate regimes and market intervention from the market microstructure perspectives.

2.1 The Market Microstructure of Exchange Rate and Currency Order Flow

The failure of traditional models of exchange rate determination to empirically explain and forecast movements in exchange rates (Meese and Rogoff, 1983; Frankel and Rose, 1995) has led the financial economists and international finance academia to further research on analytical models that can empirically explain the determination of exchange rate as well as forecast exchange rate movements in the foreign exchange markets (Cheung, Y. W., Chinn, M.D. and Marsh, I. W. , 2005; Engel, C; Mark, N.C and West, K.D., 2008). Based on Engel and West (2005), theoretical results show that exchange rates forecast ability seems impossible using fundamentals within the rational expectations model. However, Engel et al. (2008) found evidence that at long horizons, fundamentals can outperform random walk. The traditional models of exchange rate determination are based on two basic fundamental principles: (i) exchange rate determination is mainly macroeconomic variable occurrence, i.e. changes in macroeconomic variables aggregates exclusively determine exchange rate movements; (ii) exchange rates instantly react to changes in macroeconomic variable aggregates (Meese and Rogoff, 1983). This inferred that changes in public-information variables drive exchange rate without any role for microeconomic variable (for example, currency order flow).

Therefore, promising evidence has been provided by the microstructure literature through the research works of Evans and Lyons (2002a, 2005). Furthermore, the presence of a close link between exchange rate fluctuations and order flow have been theoretically and empirically demonstrated by Evans and Lyons (2002b, 2007); Bacchetta and Wincoop (2006); Rime et al., (2010).

Menkhoff, L; Sarno,L; Schmeling,M and Schrimpf, A., (2016) empirically investigate how informative is order flow in the foreign exchange market among the key players, such as their trading behavior, trading styles, risk exposures as well as risk sharing. Using daily data of customer order flows for the period 2001 to 2011, and with a total of 2664 trading days for fifteen countries' currencies: Australia (AUD), Brazil (BRL), Canada (CAD), Euro (EUR), Hong Kong (HKD), Japan (JPY), Sweden (SEK), Mexico (MXN), New Zealand (NZD), Norway (NOK), Singapore (SGD), South Africa (ZAR), South Korea (KRW), Switzerland (CHF), and the United Kingdom (GBP).

The findings show that customer order flow is highly informative, as its predictive power for exchange rates is very robust, thereby reflecting the ability to process fundamental information. In addition, the trading strategies and hedging demands for customer order flows differ significantly and negatively correlated over longer horizons (Gabaix and Maggiori, 2015; Rossi, 2013).

2.1.1 The Market Microstructure of Exchange Rate Determination and Currency Order Flow in the Developed Markets (Free Floating Markets)

Influential research by Evans and Lyons (2002a) with the application of interdealer order flow for four months transaction data on the exchange rate from Reuter's database analyzed the daily changes of deutschmark and Japanese yen with that of USD. Their results show that currency order flow explains over 60% of daily changes in the US dollar against Deutsche Mark (DM). Evans and Lyons (2002b) in another study, focused on

British pound sterling, Belgian franc, French franc, Swiss franc, Dutch guilder, Italian lira and Swedish Krona, all these currencies against USD. The results show that currency order flow generates an R^2 of 78% daily. Berger, D. W, Chaboud A. P, Chernenko, S. V, Howorka, E and Wright J. H., (2008) examine the relationship between currency order flow and exchange rate of the EUR/USD, using interdealer transaction data over a time period of six-year (1999-2004). The results show that a substantial relationship exists between interdealer currency order flow and exchange rate returns at short horizons. Bacchetta and Wincoop (2006) investigate the implications of information dispersion in the determination of exchange rate; they examine the relationship between exchange rates, fundamentals and currency order flow. The results show that from the short run - to - medium run movements in exchange rate, the explanatory power of the fundamental is very little. In addition, that exchange rate is closely related to currency order flow, and that, exchange rate movements may not be that effective as a predictor of future fundamentals.

Bjonnes and Rime (2005) investigate empirically whether dealers sets prices to guard against private information, and how the dealers control inventory to alter their risk exposure. They employ transactions prices and dealers inventories by using four interbank spot foreign exchange dealers' rates (DM/USD and NOK/DM) for the period March 2-6, 1998. The results provide evidence that in the foreign exchange market, private information is very influential. As currency order flow conveys information to the market, through it, the dealers achieve information-based conjecture. Breedon and Vitale (2010) examine the portfolio balance and information effects of currency order flow on exchange rates. They employ indirect foreign exchange transactions dataset of USD/EUR for the period August 2000 to January 2001. The results show that currency order flow has a sizeable and significant impact on exchange rate. In addition, currency order flow affects exchange rates through the information channel, and affects currency value

through the portfolio balance effect; hence, it is a powerful determinant of exchange rate dynamics.

Rime et al. (2010) examine the linkages between exchange rate movements, currency order flow and expectation of macroeconomic variables using all trades high frequency data in spot exchange rates for the three major currencies: EUR, GBP and JPY, all against USD over a period of one year (February 13, 2004 to February 14, 2005). The results show that current and future macroeconomic fundamentals are related to currency order flow, and that currency order flow can successfully forecast risk-adjusted currency returns. In addition, the findings show that currency order flow provides significant information in forecasting the daily exchange rate movements of USD/EUR, USD/GBP and USD/JPY. Furthermore, Evans and Lyons (2008) examine on how macro news transmitted to exchange rate. They employ tick-by-tick order flow transaction and price data in DM/USD spot foreign exchange market over a four-month period (May 1 to August 31, 1996). The results show that approximately two-third of the total effects of macro news on the DM/USD exchange rate is transmitted through interdealer order flow. Dominquez and Panthaki (2006) incorporate both fundamental related and non-fundamental related news reports to examine the role of news in exchange rate determination. They employ intra-day exchange rate and currency order flow data for the USD/EUR and USD/GBP, covering a ten-month period from October 6, 1999 to July 24, 2000. The results show that in both USD/EUR and USD/GBP exchange rate returns, currency order flow explains substantial fraction of the variations. In addition, fundamental related news, non-fundamental related news and currency order flow matters in the models of exchange rate determination. In addition, Menkhoff and Schmeling (2010) perform a cross-sectional analysis on the impact of order flow on prices using six indicators of information: trade size, trader size, trader proximity to a financial center, time of trade, bid/ask spread and order book volume outstanding. The results show that

there is no linear relation between trade size and price impact as traders who convey most information use medium-sized trades.

Furthermore, Tanseli (2011) investigates the micro effects of macro news using customer price-contingent orders data from a large foreign exchange dealing bank in the USD/GBP market for the period September 9, 1999 to September 20, 2002. The results show that news-induced price contingent on order placements do have significant impact on exchange rates without necessarily conveying incremental information about the state of the macro economy. Likewise, currency order flow volatility remains higher, hours, even days, after the macro news announcements. Osler (2006) summarizes how currency order flow drives exchange rate with the basic explanation of inventory, information and liquidity effects. In order to guide against unwarranted risk, dealers in foreign exchange market try to increase or reduce their price, thereby attracting more buying or selling orders when there is a deviation from their inventory positions which is different from their desired levels. In effect, inventory models can explain temporary exchange rate fluctuations, but not permanent exchange rate movements. However, with the information models, market prices have permanent effect via currency order flow.

Furthermore, Vector Autoregression (VAR) model proposed by Hasbrouck (1991) based on market microstructure was applied by Payne (2003) to investigate for a period of one-week, US dollar against Deutsche mark between 6th October and 10th October, 1997. The results display that there is an explanatory power of order flow, up to 60% fluctuations on currency exchange returns. Similarly, Froot & Ramadorai (2005) employed Vector Autoregression (VAR) model to examine order flow as a major factor of exchange rate fluctuations focusing on the interaction between permanent shock and transitory shock on the exchange rate earnings. The findings show that long-term and values can be explained better with the use of macroeconomic fundamentals, but for

short-term currency returns, a microeconomic variable (currency order flow) is appropriate. Other empirical studies that investigate the explanatory power of order flow on exchange rate in the developed market using VAR model include: Evans and Lyons (2002a; 2002b; 2005; 2007; 2008); Osler (2006); Marsh and O'Rourke (2005); Bjonnes and Rime (2005); Berger et al. (2008); Rime et al. (2010); Evans (2010); Danielson et al. (2012).

2.1.2 The Market Microstructure of Exchange Rate Determination and Currency Order Flow in the Emerging Markets (Managed Floating Markets)

In the study of currency order flow and exchange rate in the emerging markets, De-Medeiros (2004), employ VAR model to empirically investigate the exchange rate between Brazilian Real and US dollar with the application of Evans and Lyons (2002a), model. He incorporates a variable from the international finance field; country risk premium. The findings indicate that amongst the tested variables, the country risk premium, a variable from the international finance field appears statistically significant, though; currency order flow does not have any significant performance. That is, the explanatory power of order flow is weak in the Brazilian foreign exchange market. Also, Wu (2012) employed VAR model to examine the interactions between the commercial customer order flow and financial customer order flow in the Brazilian foreign exchange market (Real/USD), covering a period of four years (July 1, 1999 to June 2003). The results show that there exists a positive relation between financial customer order flow, intervention flows and exchange rate movements. However, there exists a negative relationship between the commercial customer order flow and exchange rate. Also, the results provide empirical evidence that market dealers provide (in US dollar) substantial

amount of foreign exchange liquidity overnight and charge up to 0.35% as premium. Furthermore, Duffuor et al. (2012) employ macro-micro economic variables (exchange rate, interest rate, order flow, and country risk premium) to investigate currency order flow effects on exchange rate fluctuations in the Ghanaian foreign exchange market. They focused on end-user customers currency order flow (CEDI/USD), the unofficial exchange rate market (black market) and the official exchange rate market respectively. The results show that in the unexpected order flow, permanent effect exists in the official market as order flows convey private information. Likewise, with the application of VAR model, Zhang et al. (2013) employ these variables: exchange rate, order flow, short-term interest, long-term interest and risk premium to investigate how order flow influences exchange rates both in the long-term and the short-term in the Chinese foreign exchange market. Focusing on Chinese renminbi (RMB) and the US dollar, findings confirm that currency order flow (microeconomic variable) significantly explains the major movements in the exchange rates between this currency pair.

Other studies that investigate the explanatory power of order flow on exchange rate in the emerging markets include Galati (2000); Gereben et al. (2006); Galac et al. (2006); Rajan et al. (2008).

Therefore, from the market microstructure perspective, to some extent, findings from the developed market confirm and summarize that currency order flow is a major determinant of exchange rate dynamics. However, in the emerging markets, with the exception of China, the findings indicate that currency order flow does not have any significant performance in the determination of exchange rate (Zhang et al., 2013; Wu, 2012; Duffuor et al., 2012; De-Medeiros, 2004). It implies that these findings are inconclusive in the emerging markets.

2.2 Exchange Rate Regimes

With the final breakdown of Bretton Woods's system in 1973, a good number of exchange rate regime classifications have been developed, and each of these classifications rely on actual *de facto* behavior (IMF, 2006; 2008). Therefore, Table 2.1 explains the eight types of International Monetary Fund (IMF) *de facto* exchange rate regimes. These include: exchange arrangements with no separate legal tender; currency board arrangements; other conventional fixed peg arrangements; pegged exchange rates within horizontal bands; crawling pegs; exchange rates within crawling bands; managed floating with no predetermined path for the exchange rate and independently floating (See Table 2.1 for detail description).

Table 2.1: Exchange Rate Regimes – IMF Descriptions

S/No	Type	Description
1	Exchange Arrangements with No Separate Legal Tender	The members of the monetary/currency union share the same legal tender. Therefore, such regimes adoption completely erodes the monetary authorities of their domestic monetary policy independent.
2	Currency Board Arrangements	A fixed exchange rate is adopted against domestic currency and foreign currency with certain legal restrictions placed by the issuing authority. Hence, this type of regime erodes individual member countries central banks of their traditional functions.
3	Other Conventional Fixed Peg Arrangements	A country currency is fixed based on the weight of a basket of currencies of the major trading partners. Although, there may fluctuations of exchange rate in between narrow margins of 1% and 2% within a specified period, usually three months. More so, the monetary authorities retain their traditional central banking functions and may as well infrequently intervene in the market in order to maintain the fixed parity.
4	Pegged Exchange Rates within Horizontal Bands	The same principles apply with the conventional fixed peg arrangement by allowing exchange rate fluctuations in between minimum and maximum narrow margins of 1% and 2% respectively. However, depending on the bandwidth, monetary policy discretion is considerably limited.
5	Crawling Pegs	Adjustment to the currency rate is periodically executed with a fixed small amount as exchange rate can be set to achieve inflation- adjusted as well projected inflation. To maintain a crawling peg, there constraints imposed on monetary policy, and they are similar to that of fixed peg system.
6	Exchange Rates within Crawling Bands	The exchange rate fluctuates in between minimum and maximum narrow margins of 1% and 2%, respectively. However, depending on the bandwidth, monetary policy discretion is considerably limited; adjustment to the currency rate is periodically executed. In addition, to maintain a crawling peg, there constraints imposed on monetary policy.
7	Managed Floating with No Predetermined Path for the Exchange Rate	Here, influencing the exchange rate by the monetary authority is accomplished without any specific exchange rate target. Moreover, managing the exchange rate is somehow judgmental, as the monetary authority does not follow any form of automatic adjustment criteria. In addition, the monetary authority may as well directly/indirectly intervene in the market.
8	Independently Floating	The forces of demand for currency and supply of currency determine the exchange rate, and when there is excessive

		volatility, the monetary authority intervenes to moderate and curb such undue market fluctuations.

Source: IMF's De Facto Classification of Exchange Rate Arrangements and Monetary Framework (IMF 2006; 2008).

However, as alternatives to *de jure* classifications, Levy-Yeyati and Sturzenegger (2003); Reinhart and Rogoff (2004) and Shambaugh (2004) employ different types of exchange rate regime classifications in their research works. For example, Levy-Yeyati and Sturzenegger (2003) classify exchange rate regimes as floating, intermediate (managed float) and fixed, and employ cluster analysis to analyze exchange rate movements and market intervention in the foreign exchange market. Reinhart and Rogoff (2004) classify exchange rate regimes as free floating, managed floating, and pegs, and examine the impact of capital controls on market-determined exchange rates. Meanwhile, Shambaugh (2004) classifies exchange rate regimes as pegged and non-pegged, and that a country exchange rate is pegged, as long as its official exchange rate stays within a small band for a sufficiently long time (Rose, 2011).

Indeed, one prominent and common characteristic of these systems based on *de facto* behavior is that the *de jure* classification is mostly untrustworthy, in the sense that, many countries that state they float actually intervene frequently to smooth the exchange rate ("fear of floating"). In addition, majority of countries that state they peg have high inflation and capital controls, which cause their currencies to trade at deep discounts on the black markets. Thus, the dealers/market makers resolve that *de facto* classifications make more sense than *de jure* ones. More so, when it comes to exchange rate regimes, mostly, the words of countries often do not correspond to their deeds (Rose, 2011).

Importantly, the rapid growth in market capitalization has led Asia's share of world trade to grow significantly, and subsequently placed the region among the economic foremost global players (Sukor, 2014). However, the paradigm of market efficiency is

more resilient under a free float regime than a managed float regime. More so, instead of concentrating on market efficiency, the major concern of the monetary authority should be the overall economic welfare of the state (Ahmad et al., 2012).

Therefore, Asian exchange rate regimes can be broadly classified into two strands following the 1997-1998 Asian financial crisis. One strand has categorized the region currencies to be more flexible, especially against the US dollar. While the other strand categorized Asian exchange rate regimes as *de facto* regime. Meanwhile, Patnaik et al. (2011) argue that during the financial crisis 'fear of floating' caused Asian countries to moderate the flexibility of their exchange rate regimes, but after the crisis, exchange rate flexibility became greater than in the prior period.

2.3 Foreign Exchange Market Intervention

Market intervention is a policy tool used by most central banks to influence the future direction of their domestic exchange rate against other foreign currencies (Dominguez, 2003). This may be refer to official buying and selling of foreign currencies for influencing exchange rates. The decision by the central bank to intervene in the foreign exchange market will be influenced by the reaction of the exchange rate to its trades. Evidently, it is an essential policy instrument used to influence the foreign exchange market by the monetary authorities. Apart from the decision of when and how to intervene, monetary authorities have varied goals for their market intervention operations. According to Dominguez (2003), there are four basic reasons for foreign exchange market interventions: (i) to influence trend movements in exchange rates (ii) calm disorderly markets (iii) rebalance foreign exchange reserve holdings (iv) and to support fellow central banks in their exchange rate operations. However, the monetary authorities may wish to conceal their market intervention operations, as market intervention is designed

to counter large deviations of exchange rate from the central bank's target (leaning-against-the-wind strategy), and sometimes to calm disorderly markets (Ito and Yabu, 2007). Although, monetary authorities may adopt different intervention strategies; however, they have to decide whether to intervene secretly or publicly.

Chang, M; Suardi, S. and Chang, Y., (2017) examine the impact of market interventions on exchange rates during the period of reserves accumulation and the global financial crisis, thereby concentrating on the Asian central banks. Using daily exchange rate data and Reuters news wire reports as a proxy for central bank interventions under four classifications (firm, suspected, supported and neutral), thereby focusing on eight economies in Asia: India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand, for the period 2005 to 2013. The results show that leaning-against-the-wind intervention strategies are effective in all the eight Asian countries during the period of investigation, and that coordinated interventions significantly improve the odds of effective intervention. In addition, that these Asia central banks intervene in the market to smooth the trend of exchange rates as well as to calm disorderly market (Menkhoff et al., 2017; Oliver and Ranciere, 2011; Paolo, 2016; Fatum and Yamamoto, 2014). Though market intervention by the central banks may impede the direction as well as levels of exchange rate movements, however short-term solution to the problem of volatile capital flows is provided (Humpage, 2013; Farnadez et al., 2015).

Fratzscher, M; Gloede, O; Menkhoff, L; Sarno, L; and Stöhr,T., (2017) examine foreign exchange market intervention, using confidential daily data on foreign exchange market intervention, the paper make a broad assessment of intervention effectiveness for 33 central banks for the period, 1995 to 2011. The findings show that intervention is widely used, and is an effective policy tool with a success rate in excess of 80 percent

under some criteria. For the countries with narrow band regimes, the policy works well in smoothing and stabilizing exchange rates.

The effectiveness of market intervention as a policy is highly controversial (BIS, 2013a). The paper presents the criteria by focusing on the most immediate success to that focusing on longer-term oriented success. That is “Event criterion", "direction criterion", "smoothing criterion" and "stabilization criterion".

Foreign exchange market intervention seems to be a contentious policy tool for lack of evidence from the literature that it moves exchange rates in the intended direction. The argument is that the largest financial market in the world by volume is foreign exchange market, and in terms of trading volume in the foreign exchange market, the central banks have become gradually insignificant players (BIS, 2013b). In addition, fundamental news is quickly integrated by the foreign exchange markets, and they are connected to fundamentals in the long-run (Engel et al., 2008; Chen, 2011), which induces the inquiry to what central banks be able to communicate beyond available knowledge. However, contrary to this view, around the world, central banks believe in the usefulness of foreign exchange market intervention as suggested by survey evidence (Neely, 2008; 2011). Likewise, non-secret foreign exchange market intervention is more effective, especially if accompanied by oral intervention.

Ghosh, A.R; Ostry, J.D and Chamon, M., (2016) examine the case for using two instruments: the policy interest rate and sterilized foreign exchange market intervention in emerging market countries to stabilize inflation and output while reducing disequilibrium currency fluctuations. The paper examines the conditions under which inflation targeting is better than discretionary monetary policy, and whether emerging market economies central banks, who are inflation- targeting countries, should intervene in the foreign exchange markets. In the emerging markets, the monetary authorities lack

full policy credibility for achieving success concerning price stability for a long period. In order to avoid potential conflict between price stability and exchange rate objectives, inflation- targeting countries have adopted floating exchange rate regimes. In addition, stabilizing exchange rate around equilibrium value is not conflicting with attaining inflation target, once the central banks have sterilized intervention as a sustainable instrument. Meanwhile, complementing inflation targeting foreign exchange market intervention may improve the plausibility of the central bank's inflation target, as the central banks comes under pressure to react when the exchange rate deviates from intermediate fundamentals.

Daude, C; Levy Yeyati, E and Nagengast, A., (2016) analyze the effectiveness of exchange rate interventions for a panel of 18 emerging market economies for the period, 2003-2011. Using an error correction model approach, the findings indicate that on average, foreign exchange market intervention is effective in moving the real exchange rate in the desired direction. The results show that exchange rate interventions in the emerging markets are mainly effective, as market intervention move the real exchange rate in the desired direction. In addition, the findings show that market interventions are likely to be more effective when the real exchange rate reveals substantial deviations from its long-run equilibrium position. The paper presents evidence that supports the view that in the short-run central bank market intervention can influence the exchange rate (Dominguez, K; Fatum, R and Vacek, P., 2013; Fatum, 2015). Although in the literature this has received partial confirmation, but among the market practitioners, it is widely an accepted view. In addition, the paper finds preliminary evidence that is consistent with both the portfolio and signaling channel (Blanchard et al., 2015; Adler et al., 2015; Levy-Yeyati et al., 2013; Benjamin et al., 2014; Eichengreen, 2013).

Berganza and Broto (2012) analyze empirically the link between exchange rate volatility, inflation targets and foreign exchange market interventions in the emerging economies. The paper is based on the theoretical conditions of "strict inflation targeting", implying a full flexible exchange rate, or operating a "flexible inflation targeting", requiring a managed-floating exchange rate with foreign exchange market interventions to moderate exchange rate volatility. Using a panel data model for 37 countries, the paper evidence that though inflation targeting leads to instability exchange rate than alternative regimes, market interventions in several inflation targeting countries have been more effective in lowering volatility than in non-inflation targeting countries. In addition, the results show that foreign exchange market interventions in inflation targeting countries do play an important role in controlling the exchange rate volatility. Hence, "flexible inflation targeting" regimes sustainability are not only feasible, but also foreign exchange market interventions executed under this scheme are much more effective than those of non-inflation targeting countries in curbing excessive volatility.

Foreign exchange market intervention have to be detected by the market participants for it to be effective, as market intervention works by influencing market participants expectations on the future value of exchange rates (Sarno and Taylor, 2001). Intervention by the monetary authority be it public or secret, is most likely to affect exchange rate in the short-run, because it conveys private information to affect market parameters (Chaboud and Humpage, 2005). Indeed, the impact of market intervention can be significantly influenced by so many factors, amongst which are: exchange rate regime in place; policy action history; foreign exchange market intensity and sophistication, and regulatory controls (Disyatat and Galati 2007). In addition, market intervention may affect the exchange rate by reference to three channels of influence of market intervention operations. The channels include the portfolio balance channel, the signaling channel and the microstructure channel (Pasquariello, 2010).

The portfolio balance channel point of view is that investors are risk averse, therefore, in their portfolio of investment, domestic and foreign bonds are imperfect substitute for each other. Hence, conveying policy intentions via market intervention to the foreign exchange market may influence exchange rates. Meanwhile, the signaling channel can be effective in influencing exchange rate only if market participants adjust their expectations in the foreign exchange markets (Edison, 1993). Furthermore, in line with the market microstructure, the extent to which information embedded in the monetary authority market intervention (with the existence of superior information advantage assumption) reaching the market participants will affect their expectations, and subsequently influence the spot exchange rates (Adler and Tovar, 2011). Likewise, empirical evidence shows that monetary authority market intervention may affect the exchange rate, through the microstructure of the markets where they are traded (Evans and Lyons, 2005; Pasquariello, 2007).

2.3.1 Monetary Authority Market Intervention in the Emerging Markets

Active foreign exchange market intervention in the developed market is hardly visible in the last decade with the exception of Japan (Marsh, 2011). However, foreign exchange market intervention in the emerging markets appears to be a common phenomenon amongst the monetary authorities (BIS, 2015). Although, foreign exchange market is not large enough in the emerging market, and predominantly accommodates relatively small number of market participants, hence, it is unlikely that exchange rate will be volatile. Consequently, the monetary authorities in emerging market perceive market intervention as part of their responsibilities to provide certain regulations and sustenance against exchange rate volatility. Therefore, the monetary authorities in the emerging market

intervened in the foreign exchange markets for certain reasons. These include to reduce the volatility of exchange rate, liquidity supply to the market,foreign reserves influence, maintain international competitiveness, control inflation, prevent disorderly in the market, amongst others.

According to the Bank of International Settlement (BIS, 2005; 2015) survey conducted on foreign exchange market intervention in emerging markets, market intervention has allowed the central bank of Argentina to provide adequate level of liquidity and to meet the monetary authority's target by holding the inflation rate within the estimated band. Therefore, it has assisted the monetary authority of Argentina to curb the excessive volatility in the market.

Also in Chile, market intervention occurs due to uncertainty and volatility in the market, which might have adverse economic effects. Furthermore, option-based market intervention is used by the monetary authority in Colombia to stabilize the value of domestic currency in the foreign exchange market. The use of this option by the monetary of Colombia curbed the severe exchange rate deviations, thereby enhances the market stability. The central bank of Czech Republic intervenes in the foreign exchange market, for the authority view market intervention to be profitable to the economy, which done rarely. However, the monetary authority of Hong Kong intervenes in the foreign exchange market to thwart possible tactical behavior of some colossal market players. The authority acts when t there are speculative pressures or a situations that results exchange rate to rise sharply. This is done to provide an anchor for exchange rate stability.

Furthermore, in Korea, market intervention is used by the monetary authority to achieve market stabilization, mitigate short-term exchange rate volatility and prevent speculative attacks. The authority also plays the role of market maker by providing sufficient liquidity in the market through market intervention. Also in New Zealand, the

monetary authority intervenes when there is an exceptional of high or low exchange rate, and that such exchange rate is not in line with the economic fundamentals. Thus, the authority considered market intervention only when it is appropriate and worthwhile. Likewise, the monetary authority of Peru intervenes for moderating the excessive exchange rate volatility. This is done largely to curb excessive domestic currency depreciation, which appears to be extremely risky for the economy to be tolerated. Therefore, it may be concluded that the level of financial and economic development of emerging economies operating in the emerging markets are the major reasons for their recurrence foreign exchange market intervention.

2.3.2 The Consequences of the Monetary Authority Market Intervention

The reasons or arguments that support to some extent, the monetary authority intervention in the foreign exchange market include that (i) market intervention is an appropriate policy tool that can be used to smooth the essential economic adjustments;(ii) market intervention is necessary to mitigate the costs of exchange rate "overshooting", and (iii) the monetary authority is better informed than the market to choose an exchange rate that is more in line with economic fundamentals (Pilbeam et al., 2015). However, there are consequences when market intervention is prolonged. These include: (i) the monetary objectives may be undermined; (ii) the financial stability may be compromised (iii) and heavy financing costs may be imposed on the monetary authority (Basu and Varoudakis, 2013). Furthermore, market intervention by the monetary authority usually weakens the domestic macroeconomic performance due to high inflation, financial system distortions, and exchange rate misalignment costs (Adler and Tovar, 2011). Hence, foreign exchange market intervention by the monetary authority has direct

consequences for the stance of monetary policy, which is a major cause for policy dilemma.

Mundell (1968) is of opinion that when the monetary authority intervened to prevent currency depreciation, the limit is often set by the national reserves as well as the contingency credit policies available to such a country. Therefore, at some stage, the depleting reserves will inevitably make interest rate to increase, as the monetary authority ("the impossible trinity") cannot indefinitely control both the exchange rate as well as money market rate. Also, Reinhart and Reinhart (1999); Argy and Murray (1985); Frankel (1993); Calvo et al (1993); Velasco and Cabezas (1999) shared the same opinion.

Therefore, it is essential for the monetary authorities to carefully weigh the consequences of foreign exchange policy and its effects on the monetary policy, as criteria for market intervention must be consistent with the monetary policy objectives. By doing this, high inflation rate, financial system distortions, and exchange rate misalignment costs can be greatly controlled.

2.3.3 The Effectiveness of Foreign Exchange Market Intervention

Intervention in the foreign exchange markets by the monetary authorities do vary, as it cut across a number of dimensions. Krugman (1991) asserts that the future expectations of the monetary authority and its actions are sufficient to influence exchange rates. That is, if exchange rate can be unambiguously defined by the central banks, it is most likely to influence exchange rate behavior in such a way that exchange rates remain within the set bands, even without any form of intervention by the central bank. Furthermore, Basu and Varoudakis (2013) and Basu (2012) reveal that only if central bank can adopt a "schedule" intervention strategy, then, it is possible to avoid foreign reserve

accumulation, which may eventually lead to buying or selling of foreign currency to curb excessive volatility, as a result of appreciation or depreciation of local currency beyond the specified levels. In addition, Fatum and King (2005) show that there is no significant evidence expresses that rule-base policies are less important and ineffective than discretionary intervention.

Adler and Tovar (2011) find that for foreign exchange market intervention to be effective, the most important things are – capital account degree of openness, and whether the country's exchange rate is overvalued, not necessarily rules and discretion. Although countries under a managed floating regime mostly adjust their domestic currency value through central bank intervention in order to maintain desired currency value during crisis period, notwithstanding, to stabilize currency value at all time, central bank market intervention may not be sufficient (Zainudin and Phooi M'ng 2014). Therefore, focusing on the exchange rate volatility and market intervention by the policy makers may not lead to currency stability in the long-run, rather, the target of the monetary authority should be on how to improve international trades and economic development (Aftab et al., 2016).

There are diverse stances on the effectiveness of foreign exchange market intervention. Bank of International Settlements (BIS, 2015) survey conducted on central banks, results show that almost 70% of the central banks that participated believed that their market interventions were successful during the period 2005-2012. Similarly, majority of the central banks included in BIS (2005) survey view market intervention to be an effective instrument to allay disorderly foreign exchange markets, adjust exchange rate misalignment and stabilize exchange rates.

Menkhoff's (2010) empirical analysis results show that monetary authority foreign exchange market intervention strongly affect the level of exchange rate in the desired direction. Adler and Tovar (2011) maintain that market intervention is strongly effective

in terms decelerating the speed of exchange rate appreciation, especially, with limited capital account openness. In addition, Newman et al. (2011) find that the effect of market intervention on the exchange rate is momentary when the foreign exchange market is deep and liquid. In addition, Fatum and Hutchinson (2006) employ an event study approach to examine the effectiveness of market intervention by the monetary authority, and the results show that market intervention is effective in the short-term. However, Chaboud and Humpage (2005) show that the behavior of exchange rate on intervention days and non-intervention days cannot be statistically distinguished. More so, Marsh (2011) provide some evidence that the trading activities in the net order flows of corporate customers are in consistent with the possible intentions of the Japanese monetary authority when it intervened in the market. In addition, , the correlation between order flows and exchange rate changes disappear on intervention days. By implication, the presence of monetary authority in the foreign exchange market affects the relationship between order flow and exchange rates.

2.4 The Research Gap

Following the failure of traditional models of exchange rate determination to empirically explain and forecast movements in exchange rates, promising evidence has been provided by the microstructure literature through the research works of Evans and Lyons (2002, 2005, 2007, and 2008). Although previous studies have focus on the major currency pairs of developed markets, but very few studies have investigated the important role currency order flow plays in the determination of exchange rate in the emerging markets.

Therefore, with the application of the microstructure approach to exchange rate determination and forecasting, many essential issues remain unresolved in understanding

exchange rate behavior in the emerging markets. First, microstructure approach to exchange rate determination and forecasting with currency order flow have been primarily on developed markets and world major currency pairs. However, the successful transition of the emerging economies to developed market is of economic importance. Second, employing micro-macroeconomic approach to exchange rate determination and forecasting, very few empirical researches have been done in the emerging markets with inconclusive findings. Third, the monetary authorities in most developed countries have increasingly shield away from market intervention with the exception of Japan (Marsh, 2011). Nonetheless, market intervention has become a common phenomenon in the emerging markets in an attempt to influence exchange rate movements and manage currency value, especially against the US dollar (BIS, 2005; 2015). However, research on whether market intervention is successful in influencing exchange rates and how it affects volatility is scarce in the emerging markets, especially from the market microstructure perspective.

Therefore, this thesis aims to address three research objectives and make theoretical, methodological and empirical contributions to the literature, especially to the market microstructure approach to exchange rate determination. First is to examine the role of currency order flow in determining exchange rates movements of ASEAN-5 countries' currencies against US dollar. Second is to determine the short-run and long-run interaction between micro-macroeconomic variables (such as currency order flow, interest rate and country risk premium) and exchange rates. Third, to test the effectiveness of central bank intervention in the foreign exchange markets through the behavior of currency order flow.

This thesis aims to make some promising contributions to the market microstructure literature. First, while some datasets have been for a relatively short period in previous

studies, the dataset used in this thesis is one of the largest and more recent period ever used in the literature to examine the impact of currency order flow on exchange rate determination in the emerging markets. Second, this thesis is one of the first to test simultaneously the behavior of ASEAN-5 countries' currencies exchange rates against the US dollar using market microstructure approach. Third, it is also one of the first to test the exchange rate movements of manage-float exchange rate regime using a new dataset of fifteen-minute currency order flow collected from one data source (-Bloomberg).

Fourth, like many other monetary authorities, ASEAN-5 countries monetary authorities have enfolded their foreign exchange market intervention in secrecy. This thesis gather together the newswires reports on market intervention from one of the world's biggest news databases; Bloomberg. To estimate monetary authorities' market intervention, the thesis also gathers information from the construct of currency order flow measurement and exchange rate. Hence, it presents a rich context for this thesis, which aims at a better understanding of foreign exchange market intervention and the effectiveness of this policy tool in ASEAN-5 countries.

2.5 Chapter Summary

Based on the traditional models of exchange rate determination, public information announcement plays no role in the determination of exchange rate. The assumption is that public information is already impounded in price through rational expectations and market efficiency. However, exchange rate studies, which centered on market microstructure analysis consider public information in the determination of exchange rate. Hence, market microstructure analysis points out the part that currency trading plays in price formation through a concept termed "currency order flow". Subsequently, trading

process is centered on currency order flow and it becomes a focal point of the market microstructure approach to exchange rate determination.

Furthermore, a good number of exchange rate regime classification have been developed after the final breakdown of Bretton Woods system in 1973, but then, each of this classification relies on actual *de facto* behavior. The basic reason is that, the *de jure* classification is untrustworthy when it comes to exchange rate regimes, as the words of countries do not correspond to their deeds in most cases. Importantly, during the financial crisis, "fear of floating" caused Asian countries to moderate the flexibility of their exchange rate regimes, but thereafter, exchange rate flexibility became greater than in the prior period.

Market intervention, a policy tool used to influence exchange rate by the monetary authority, fundamentally, is part of the major reasons for market intervention to calm disorderly markets situation and influence trend movements of exchange rate. However, this can be achieved through the portfolio balance channel, the signaling channel and the microstructure channel. Although, monetary authorities in the emerging markets view market intervention as an effective policy tool used to influence the future direction of their domestic exchange rate, nevertheless, employing market intervention in stabilizing exchange rate without a firm monetary and fiscal policy, such currency value may not be sustained for a long time.

CHAPTER 3: HISTORICAL BACKGROUND OF ASEAN-5 FOREIGN EXCHANGE MARKETS, THEORETICAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

This chapter discusses the historical background and current trading system in the ASEAN-5 countries foreign exchange markets, the main theories of exchange rate determination, information processing and construction of the measure of currency order flow as well as the development of hypotheses.

3.1 The Historical Evolution and Current Trading System in the ASEAN-5 Countries Foreign Exchange Markets

The historical evolution of ASEAN-5 countries foreign exchange markets and their current trading system are briefly discussed (See Appendix A for Tables of major events of foreign exchange trading system).

3.1.1 The Historical Background and Current Trading System in the Indonesia Foreign Exchange Market

Indonesia Rupiah (IDR) is the currency of Indonesia. Bank Indonesia (BI) takes the sole responsibility of administering all the foreign exchange and trade controls of the nation with cooperation from the finance, trade and cooperatives ministry, accredited banks and custom authorities (Bank Indonesia, 2015). The country adopted a simplified multiple exchange rate structure in 1970, amongst which include: exchange rate with flexible feature (DU), credit foreign exchange rate (DK) and export rate. However, the free floating of US dollar led to devaluation of IDR in the international market during this

period. Therefore, credit foreign exchange rate was abolished in 1978 and the bank introduced an “effective rate” having control and floating features.

The country adopted managed float policy after taken into consideration a broader selection of currencies in 1983. However, in 1989, the monetary authority reviewed the exchange rate system. Subsequently, as the economic and financial situation demands, the monetary authority from time to time revised the exchange rate policy in line with the fundamentals.

Foreign exchange trading activity in Indonesia is consummated between the hour of 10.00am and 4.00pm Jakarta time. However, in order to mitigate risk in the financial market, Bank Indonesia developed a system known as “Bank Indonesia Real Time Gross Settlement (BI- RTGS)” in November 17, 2000. The market participants, most especially banks can use this electronic fund transfer for the processing and settlement of their real-time financial transactions. This system is designed to process high value and urgent financial transactions (i.e. High Value Payment System (HVPS)), as this is considered to be a Systemically Important Payment System (SIPS) in Indonesia.

BI- RTGS deemed as an efficient, secured and reliable fund transfer facility. It is also considered as an effective means of liquidity management for both the monetary operations and banking supervision, being a centralized system. The system provides the market participants the opportunity to manage their liquidity prudently for all financial transactions, especially for prompt settlement among the members. Indeed, only members account having sufficient funds can guarantee settlements in BI- RTGS transactions (“no money no game” rule).

Bank Indonesia ensures that BI- RTGS system of operation complies with the principle of “10 Core Principles for Systemically Important Payment System" (CP-SIPS) emanated

from the Bank of International Settlement. The BI-RTGS participants comprise banks and non-bank financial institutions, with direct and indirect participant membership categorization. The direct participants can use their own identity to consummate RTGS transactions. Meanwhile, indirect participants have to use the identity of direct participants to submit RTGS transactions for subsequent execution by the direct participants on their behalf (Bank Indonesia, 2015). Though, the exchange rate of Rupiah is determined by the forces of the market demand and supply, however, when it appears there is an excessive fluctuations of Rupiah against other major currencies, especially US dollar, Bank Indonesia intervenes to curb such excesses in the foreign exchange market.

3.1.2 The Historical Background and Current Trading System in the Malaysia Foreign Exchange Market

Malaysia Ringgit (MYR) is the currency of Malaysia, previously known as the Malaysian Dollar (M$). In 1967, June precisely, a unit of Malaysian dollar was created to replace the old sterling-linked Malaysian/Straits dollar. The Bank Negara Malaysia (Central Bank of Malaysia) administers foreign exchange controls on behalf of the Malaysian Government with specific authorities delegated to the authorized banks. Malaysian Government placed the effective rate for her currency on a controlled and fluctuating basis in June 1973. The managed floating system of exchange rate determination was sustained until 1997. However, due to Asian financial crisis occurrence in 1997, the monetary authority reverts to fixed exchange rate system, thereby pegged the Ringgit against the US dollar at a fixed exchange rate of USD/RM3.80. The Ringgit pegged to the USD in 1997 was replaced with a managed float system in July, 2005. The primary motivation for the policy shift was to position Malaysia to respond and benefit from the structural changes occurring in the region and in the international environs (Bank Negara Malaysia, 2015).

Malaysian foreign exchange trading starts on Monday morning and ends on Saturday morning, Malaysian time (GMT+8). Only authorized dealers are permitted to trade in the foreign exchange market in Malaysia pursuant to Section 2 of the Exchange Control Act of 1953. Spot trading is conducted on 27 currencies including the world major currencies: US dollar (USD), European Euro (EUR), British pound sterling (GBP), Japanese yen (JPY), Australian dollar (AUD), Swiss Franc (CHF) and Canadian dollar (CND). Spot trading in these currencies starts from 0900 to 1700 with four trading sessions (i.e. 0900, 1130, 1200 and 1700). The trading periods are in Malaysian time and usually open for business on Monday morning and closes on Saturday morning, excluding public holidays, and the settlement period for foreign exchange transaction is set at T+2 (i.e. two days after the transaction day).

Remarkably, the introduction of Large Value Payment System (LVPS) into the foreign exchange market by the Malaysian Government actually made the transaction of high-value and real-time easy to process. In addition, Real Time Electronic Transfer of funds and Securities (RENTAS) are the only LVPS for high-value and time critical payments acceptable in the country, and this system operates under Real Time Gross Settlements (RTGS). The main objective is to improve the overall efficiency of large value payment system. RENTAS participants stand at 69 among which are Commercial Banks, Islamic Banks, Investment Banks and Development financial institutions classified as active players in the money market. In 2006, Bank Negara Malaysia collaborates with Hong-Kong Monetary Authority to implement Payment Verse Payment (PVP) infrastructure for settling inter-bank Ringgit-US dollar trade transactions during Malaysian business hours. The purpose is to eliminate foreign exchange settlement risk for Ringgit and US dollar foreign exchange transactions. Also in March 2012, Bank Negara Malaysia includes renminbi (RMB) settlements to improve and enhance the capability of RENTAS in cross-border payments and settlements (Bank Negara Malaysia, 2015).

Although, the forces of the market demand and supply determine the exchange rate of Ringgit, however, Bank Negara Malaysia intervenes as the need arises in order to maintain and sustain orderly market conditions mostly to circumvent too many variations in the value of Ringgit against the currencies of major trading partners.

3.1.3 The Historical Background and Current Trading System in the Philippines Foreign Exchange Market

In Philippines, Peso (PHP) is the official currency of the country. The Philippines Central Bank (Bangko Sentral ny Pilipinas (BSP)) manages the country foreign exchange controls. Between 1970 and 1984, the country had experienced multiple exchange rate structure for all the foreign exchange transactions based on a daily "Guided Rate". The economy of the country was opened from its highly protected economic regimes due to economic launch of Asia-Pacific area in 1980. However, the multiple exchange rate structure was abolished due to 1983 financial crisis. a reference rate for USD/PHP conversion rate was allowed for the purpose of customs valuation and import duties computation by the country's Bankers Association.

Peso/US dollar (PHP/USD) foreign exchange trading among the Bankers Association of the Philippines (BAP) and the Philippines Central Bank are mostly effected through the Philippines Dealing System (PDS). The majority of the Philippines member- banks perform their financial transactions through an electronic platform known as Philippine Dealing and Exchange Corporation (PDEx) for all spot trading in USD/PHP. This platform (PDEx) allows immediate transmission of price information and trade confirmations amongst the BAP member-banks. Foreign exchange trading in Philippines usually starts at 9.00am and ends at 4.00pm, and a lunch break is observed between the hour of 12.00 noon and 2.00pm.

With the help of this system (PDS), final settlement of trade transactions among foreign exchange dealers on the same day is feasible, as the system has on-line, real time and net transfer capability of batching end-of-day financial transactions. In Philippines, most of the commercial banks are permitted to participate in foreign exchange trading at spot, outright forward as well as swap transactions in PHP/USD. However, third currency transactions are effected through the Reuters and Bloomberg trading platforms. In addition, the member-banks can as well deal through foreign exchange brokers, majorly: ICAP Philippines Incorporation; AFS Philippines Incorporation; Tulett Prebon Philippines Incorporation and Traditional Financial Services Philippines Incorporation.

Furthermore, Payment verse Payment (PvP) electronic system is used for the PDS transactions in settlement of USD/PHP local interbank spot and forward deals. This electronic system (PvP) provides a link that is connected to two real-time gross settlements, which is, the BSP's Philippine Payments and Settlement System (PhilPass) for all the local transactions in Peso, and the Philippine Domestic Dollar Transfer System (PDDTS) for the foreign currency transactions, especially USD. The PDDTS provides the banking institutions, especially the BAP commercial banks, a platform to transfer USD funds from one Philippine bank to another within the same day without necessarily passing through US correspondence banks (Bangko Sentral ny Pilipinas, the Philippines Central Bank, 2015).

In Philippines, the monetary authority permits the forces of demand and supply to determine the exchange rate of Peso against other major trading partners' currencies in the international market. Nevertheless, the monetary authority participates (intervenes) in the foreign exchange market to curb excessive volatility, maintain orderly market conditions and provide liquidity to the market when the need arises.

3.1.4 The Historical Background and Current Trading System in the Singapore Foreign Exchange Market

In Singapore, the country's currency is Singapore dollar (SGD). The currency was initially linked to United Kingdom Great Britain Pound Sterling (GBP), but when the Sterling area was disassembled in 1970, the currency, for a short period was linked to United States of American dollar (USD). Between 1973 and 1985, Singapore dollar (SGD) was pegged to an undisclosed trade-weighted basket of currencies. The Monetary Authority of Singapore (MAS) administers all exchange control affairs, and with close monitoring by the authority, Singapore dollar was allowed to float against the major trading partners and competitors currencies in the international market. Hence, the country foreign exchange regime may be described as a "Monitoring Band" exchange regime. Furthermore, the country central parity rate and bandwidth are computed around an undisclosed target band, though, subject to periodical review in line with economic fundamentals and market conditions. To maintain price stability within the economy as well as to export competitively in the international market, this exchange regime may be classified as an effective exchange regime for the country. As in time of great economic fluctuations, it has a large degree of flexibility, as the country's currency was allowed to depreciate by 20% during the height of East Asian crisis.

In Singapore, the foreign exchange markets official time is set to open from 5.00am on Monday morning Sydney time and close at 5.00pm Friday New York time, all year round. It implies that, the opening time for spot foreign exchange trading in Singapore starts from 1700 to 1659 (24 hours), and the settlement period is set at T+2 (two days after the transaction day). However, not a large number of major organizations are responsible for the cardinal payments and clearing functions in Singapore. The financial operations are implemented under the New MAS Electronic Payment System (MEPS+) for large-value settlements. In addition, Continuous Linked Settlement (CLS) system is

in operation for the settlement of major currencies on a payment versus payment in the foreign exchange market. This settlement system (CLS) eliminates foreign exchange settlement risk that may arise due to delay in payment, as it is a real-time as well as global settlement system linked to the Singapore Real Time Gross Settlement (RTGS) system. Furthermore, it operates on netted values of foreign exchange trades, thereby leading to efficient liquidity management and costs minimization to banks. Three of the operating local banks in Singapore are authorized by the Monetary Authority of Singapore (MAS) to connect to Continuous Linked Settlement (CLS) Bank via Clearing and Payment Services Pte Limited (CAPS) for achieving advancement in efficiency and economies of scale among the participating banks (Monetary Authority of Singapore, 2015).

Although the Monetary Authority of Singapore permits the country's currency to fluctuate in the foreign exchange market within an undisclosed band, but when it appears, there is excessive volatility and disorderly in the market, the authority intervenes to curb such excessive volatility and maintain orderly market conditions.

3.1.5 The Historical Background and Current Trading System in the Thailand Foreign Exchange Market

Thai-Baht (THB) is the currency of Thailand. The Bank of Thailand (BOT) administers the country exchange controls. Before 1963, the country adopted a floating exchange rate regime but terminated in October 1963, and subsequently linked to US dollar at a rate of USD/THB 20.80. Thereafter, the monetary authority introduced in May 1972, a 4.5% fluctuation ranged between the domestic currency and US dollar, and then revalued the exchange rate in July 1973 (USD/THB 20.00). The country currency was pegged to a weighted basket of major trading partners' currencies in March 1978, and it was later allowed to float within a specified range. Between 1984 and 1997, the monetary authority, in line with the pegged exchange rate regime, introduced some financial and

monetary measures to defend THB against USD in the international market through "Exchange Equalization Fund". Since the adoption of managed float exchange rate regime in July1997, the market forces determines THB exchange rate. W situation arises, the monetary authority may intervene to curb excessive volatility and maintain orderly market conditions. Through this exchange regime, flexibility is enhanced, efficiency in monetary policy implementation is achieved, and domestic and foreign investors' confidence is maintained.

The foreign exchange market is the ambit for a country's currency in exchange for another. This market can be described as the leading financial market in the world, as it accommodates a daily trading volume of an equivalent of over 4 trillion US dollars. This is three times over and above the total aggregate amount of transactions on the United States equity and Treasury market combined. A spot-on 24-hour market opens each trading in Sydney, then shifts as the business day commences in other financial center- from Sydney to Tokyo; Tokyo to London; London to New York, and New York to Frankfurt. However, a time comes where two trading sessions are open at the same time. This is described as overlapping trading sessions. In this situation, there is a tendency for more volume to be traded, as all the market participants are "wheel-in" and "deal-in"[4].

In Thailand, in relative terms the forces of demand and supply do determine the exchange rate to an extent. Even though, such forces of demand for currency and supply of currency are derived from international trade value, international capital flows and market expectations amongst other factors. In July 2 1997, the country adopted a managed-float exchange rate regime, which made the Bank to implement foreign exchange rate management structure with the intention to maintain currency stability.

[4] "Wheel-in" and "deal-in": More money is transferring hands among the market participants in the foreign exchange market.

The attention of the Bank is channel towards monitoring and supervision of the exchange rate fluctuations in line with the economic fundamentals.

One of the major reasons for adopting a managed floating regime is for the monetary policy implementation for flexibility and efficiency, and to increase domestic and foreign investors' confidence in the market. The Ministry of Finance specifically assigns the responsibility of foreign exchange administration to the Bank of Thailand. Foreign exchange transactions in Thailand must be carried-out through authorized commercial banks and authorized non-banks, which include: authorized moneychangers, authorized money transfer agents, and authorized companies that are granted licenses by the Ministry of Finance to officially carry-out foreign exchange transaction (Bank of Thailand, 2015). Currently, only few major currencies, for example US dollar, Euro and Japanese yen are used for international trade and service settlement. As international trade relationship with China plays an important role at global and regional level, which made the Chinese authority announced the Renminbi (RMB) internationalization policy in 2009 to promote the use of RMB as the international currency. The supportiveness of this policy by the Bank of Thailand allows the use of RMB for the settlement of international trade has made it possible to reduce foreign exchange risks. The importance of using RMB as a means of payment for international trade transactions made Bank of Thailand to collaborate with three Thai commercial banks to ease RMB/THB foreign exchange transactions/settlements. Although the forces of demand and supply determine the exchange rate in Thailand, but then, when situation arises, the monetary authority intervenes to curb excessive volatility and maintain orderly market conditions.

3.2 International Monetary Fund (IMF) Exchange Rate Classifications-*De facto*

According to International Monetary Fund (IMF 2008) *de facto* classification of exchange rate arrangements and monetary frameworks, ASEAN-5 countries operate "managed floating" exchange rate regime with the exception of the Philippines that operates "independently floating" exchange rate regime. However, their foreign exchange market regulations and structure are similar. Thus, Table 3.1 presents the ASEAN-5 exchange rate classifications in line with the International Monetary Fund (IMF) *de facto* classification of exchange rate arrangements and monetary frameworks.

Table 3.1: **ASEAN-5 Countries *de facto* IMF Exchange Rate Classifications**

S/No	Country	Type
1	Indonesia	Managed floating with no pre-determined path for the exchange rate.
2	Malaysia	Managed floating with no pre-determined path for the exchange rate.
3	Philippines	Independently floating.
4	Singapore	Managed floating with no pre-determined path for the exchange rate.
5	Thailand	Managed floating with no pre-determined path for the exchange rate.

Source: IMF De Facto Classification of Exchange Rate Arrangements and Monetary Frameworks (IMF 2008).

Therefore, in order to confirm the flexibility, volatility and subsequent depreciation of ASEAN-5 countries' currencies exchange rates against the US dollar, Figure 1 presents the Indonesian Rupiah, Malaysian ringgit, Philippine Peso, Singapore dollar and Thai Baht exchange rates, all per US dollar.

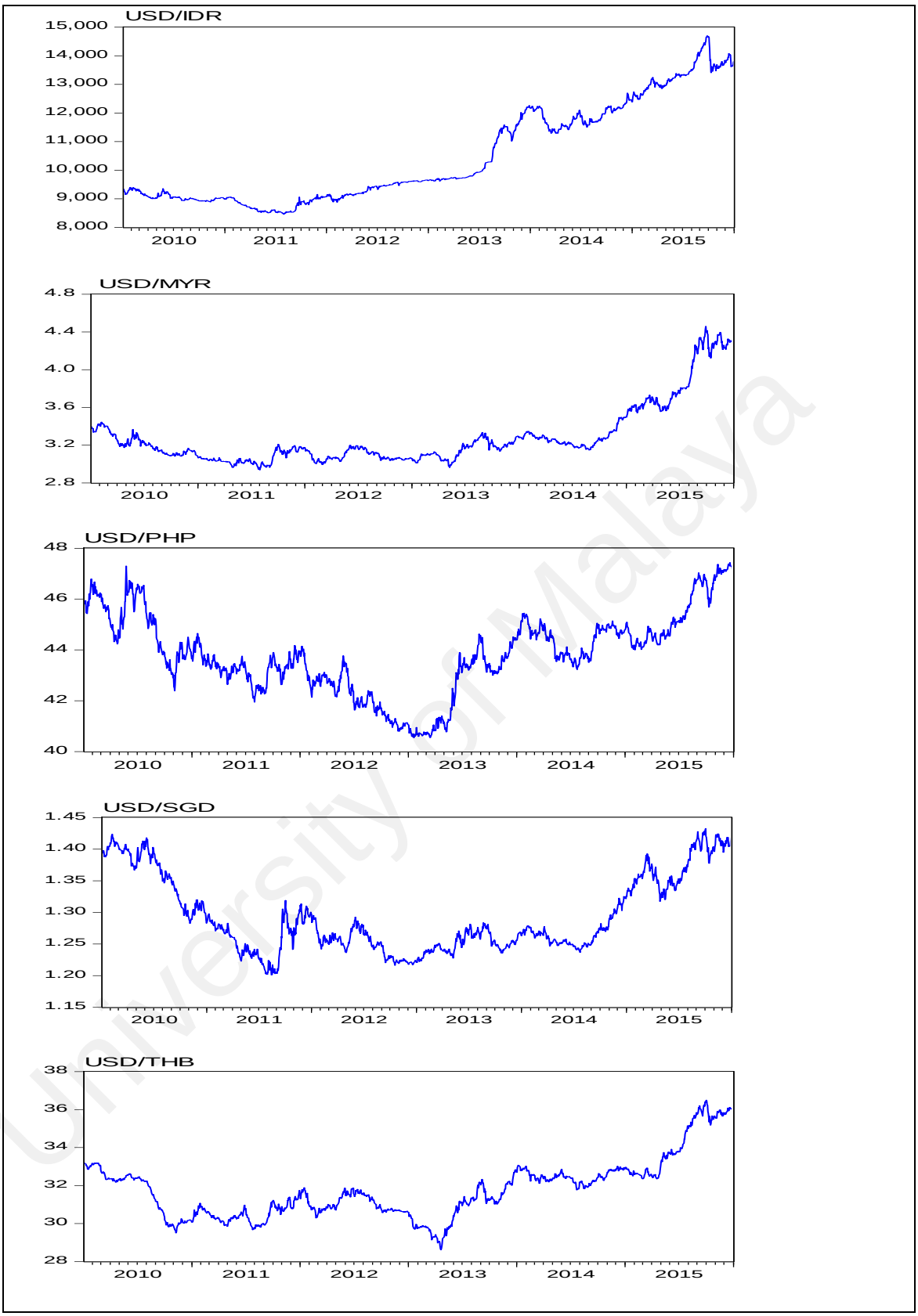


Figure 1: Exchange Rate of IDR; MYR; PHP; SGD and THB per US dollar (04/01/2010 – 31/12/2015)

Furthermore, Figure 2 shows the correlation between the USD/IDR; USD/MYR; USD/PHP; USD/SGD; USD/THB and currency order flow for the countries in the sample. However, currency order flows are constant between January 2012 and September 2014 in Indonesia foreign exchange markets and constant between January 2013 and July 2015 in Malaysia foreign exchange market. In the Philippines foreign exchange market, currency order flows are constant between January 2011 and July 2013: September 2013 and July 2015 respectively. In the Singapore foreign exchange market, currency order flows are constant between January 2010 and July 2013. Likewise, between January 2012 and July 2013; September 2013 and July 2015, currency order flows are constant in the Thailand foreign exchange markets. This particular phenomenon furthers the investigation to what could have been the cause.

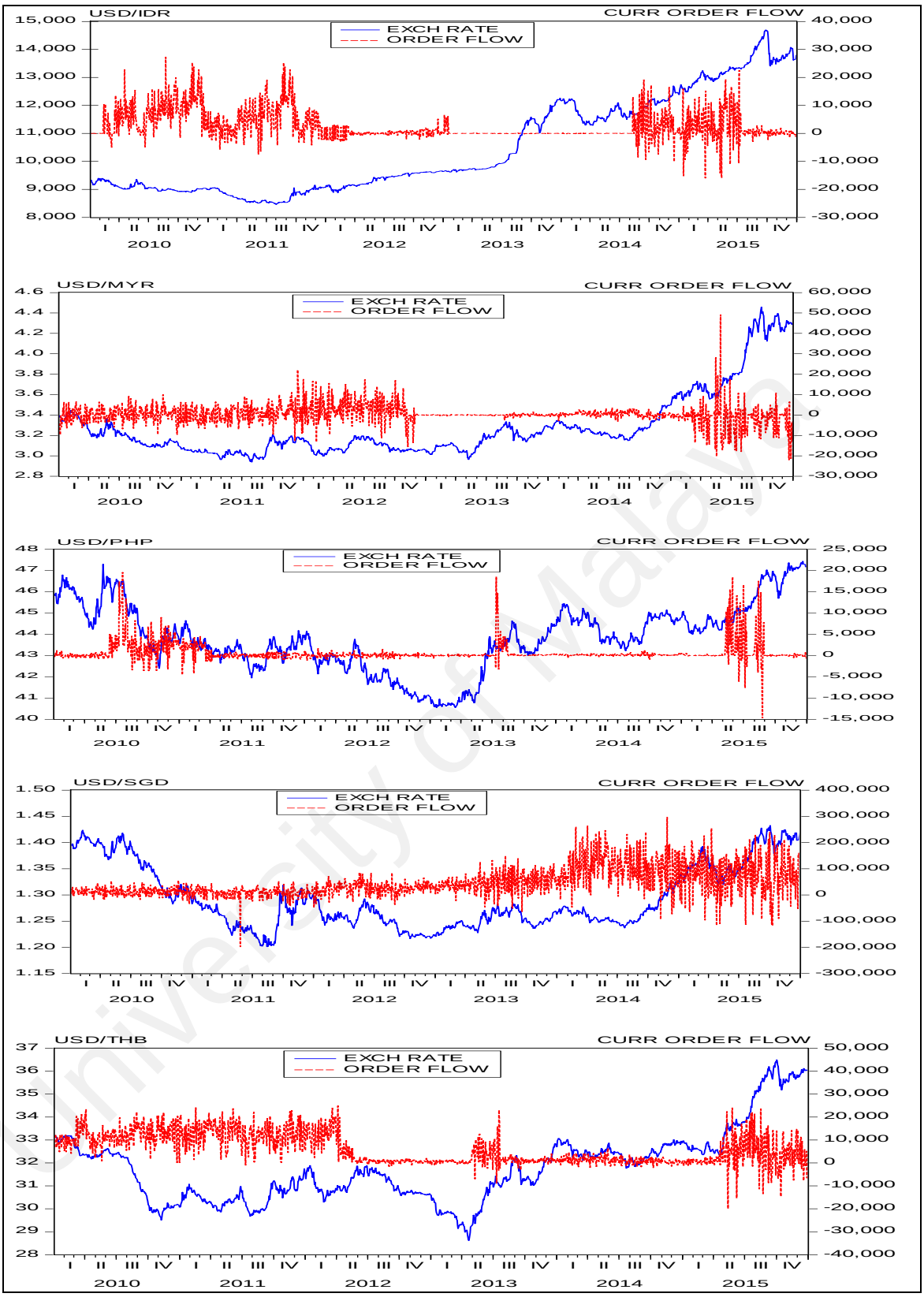


Figure 2: Exchange Rate of USD/IDR; MYR; PHP; SGD; THB and Currency Order Flow (04/01/2010 – 31/12/2015)

Although, majority of the emerging economies do not operate free floating rather managed floating exchange rate regime, and this may lead to frequent occurrence of market intervention by the monetary authorities. This is done mostly to maintain and sustain orderly market conditions, and to prevent excessive volatility in the value of their currencies against the currencies of their major trading partners, especially the US dollar.

The results show that the monetary authorities of these countries consistently intervene to curtail the depreciation of their domestic currencies against the US dollar during these periods. Therefore, this may be one of the major reasons for the currency order flows to remain constant for some periods under consideration. The results of foreign exchange market intervention by the ASEAN-5 countries monetary authorities are presented in chapter six.

3.3 Determination of Exchange Rates: The Main Theories

The high volatility of the major currencies (USD, DM, JPY and GBP) after the final breakdown of Bretton woods system in 1973 led Frenkel (1976) proposed a monetary approach (Flexible price model) to exchange rate determination. In the same period, Dornbush (1976) introduced sticky price monetary model to explain exchange rate fluctuations. In likewise manner, and during the same period, Kouri (1976) proposed portfolio balance approach (portfolio balance model) to exchange rate determination. These models, known as the traditional macroeconomic models, required macroeconomic variables such as interest rate, inflation rate, growth rate, current account balances, money supplies, gross domestic products and government budget deficits to determine exchange rates. Then, the classical research work of Meese and Rogoff (1983) reveal that macroeconomic fundamental models have failed to justify reason(s) for exchange rates movements. More so, Meese (1990) summarizes that "the proportion of (monthly or

quarterly) exchange rate changes that these macroeconomic models can explain is essentially zero". Since then, both the financial economists and international finance economists have done vast research to resolve a great number of issues in the foreign exchange markets, but then, the issues remain unresolved (Macdonald and Taylor, 1994).

The earlier notable contributions to the literature on exchange rate determination have made noble impart to the body of knowledge. These include Mundell (1968); Frenkel and Johnson (1978); Eaton and Turnovsky (1983); Backus (1984); Allen and Taylor (1990); Macdonald and Taylor (1994); Frankel and Rose (1995); Isard (1995) and Taylor (1995). In addition, a significant number of surveys on the various types of models and theories on the determination of exchange rates have been conducted by various authors. The most popular models of exchange rate determination include the flexible price model, the sticky price model and the portfolio balance model.

3.3.1 Flexible Price Model

The flexible price model (proposed by Frenkel, 1976) dwells on the view that purchasing power parity exists, and that domestic and foreign currencies demand are stable in both the domestic and the foreign economies. By definition, the variability of real exchange rate is impossible. Therefore, this led to the development and subsequent introduction of the sticky price model by Dornbusch in 1976.

3.3.2 Sticky Price Model

The sticky price model (proposed by Dornbusch, 1976) provides variability of interest rates and exchange rates with the recognition that the changes in the real exchange rate and nominal exchange rate will compensate for other variables of low flexibility, especially the price of goods.

3.3.3 Portfolio Balance Model

The portfolio balance model of exchange rate determination (proposed by Kouri, 1976) dwells on the fact that, there must be relative supplies of domestic bonds and foreign bonds in order to have an effective exchange rate. In essence, portfolio balance models assume imperfect substitutability of domestic bonds with foreign bonds. Therefore, portfolio balance models incorporate risk premiums in the forward exchange rate, which is a function of relative asset supplies.

The traditional macroeconomic models (the flexible price model, the sticky price model and the portfolio balance model) rely exclusively on public information to determine exchange rate. These macroeconomic models of exchange rate determination are deficient using high frequency data (intraday), and more so, their explanatory power is almost nil (Meese and Rogoff, 1983; Backus, 1984; MacDonald and Taylor, 1994; Frankel and Rose, 1995; Isard, 1995; Rime, 2000). Furthermore, these models have completely made currency trading irrelevant by focusing only on the asset aspect of currency than the international trade aspect (Lyons, 2001). Therefore, the deficiency of using high frequency data to determine exchange rate with macroeconomic models has led to the theory of market microstructure. As enormous trading volumes and high volatility can be addressed with microstructure approach, this appears to be a very difficult task within the macroeconomic approach (Lyons, 2001).

With all these empirical limitations of the traditional models of exchange rate determination, Evans and Lyons (2002a) proposed a "*portfolio shift*" model of exchange rate determination that incorporates both macroeconomic information and information based on microeconomic (order flow), in an attempt to resolve the challenges posed by the macroeconomic models of exchange rate determination. Importantly, Public macroeconomic information is difficult to detect in intraday studies, which is the largest

part of the microstructure studies. Therefore, market microstructure theory has made some significant improvement in the explanation of short-term fundamentals of the foreign exchange market. In microstructure models, order flow conveys information and this leads to an aggregation of private information into exchange rates (Evans and Lyons, 2002b). Although microstructure approach to exchange rate determination is considered to be a complementary approach to macroeconomic models of exchange rate determination (Rime et al, 2010).

3.4 Foreign Exchange Market Intervention Channels

Foreign exchange market intervention a policy tool used by monetary authorities, especially in the emerging markets to influence the future direction of their domestic exchange rate against other major trading partners' currencies in the international market (BIS, 2015). This policy tool may affect the exchange rate by reference to three major channels of influence of foreign exchange market intervention operations. These include the portfolio balance channel, the signaling channel and the microstructure channel (Pasquariello, 2010).

3.4.1 The Portfolio Balance Channel

The effect of monetary authorities' foreign exchange market intervention via the portfolio balance channel can be explained with the portfolio balance model of exchange rate determination in which investors review their portfolio of investment relative to expected returns from their financial assets. Once the monetary authority buys or sells domestic assets, the composition of investors' portfolios will be altered, as the domestic value of foreign bonds spot rate will shift, likewise the expected returns for holding these financial instruments. Therefore, investors will either buy or sell foreign assets in order

to rebalance their portfolios. Through this process, in theory, market intervention influences exchange rate via the portfolio balance channel (Sarno and Taylor, 2001).

3.4.2 The Signaling Channel

The signaling channel posits that market intervention influences exchange rates by supplying the foreign exchange market with new and important information, with the understanding that the monetary authorities possess superior information. Therefore, the authorities are ready to divulge this new and vital information via their actions (market interventions) in the foreign exchange market (Sarno and Taylor, 2001).

3.4.3 The Market Microstructure Channel

In line with the market microstructure, the extent to which information embedded in the monetary authority market intervention (with the existence of superior information advantage assumption) reaching the market participants will affect their expectations, and subsequently influence the spot exchange rates (Adler and Tovar, 2011). Empirical evidence shows that market intervention may affect the exchange rate through the microstructure of the markets where they are traded (Evans and Lyons, 2005; Pasquariello, 2007).

However, the extent to which the portfolio balance channel, the signaling channel and the microstructure channel operate in practice still an issue yet to be resolved in the literature.

3.5 Currency Order Flow, Information Processing and Exchange Rates

Microstructure model focuses attention on new variables (order flow and bid-ask spreads) in the determination of exchange rates (Evans and Lyons, 2002a). These two variables play no role in the macrostructure models of exchange rate determination. However, the more important of these variables is order flow, because it carries more news than the bid-ask spreads (Evans and Lyons, 2002a). Furthermore, order flow conveys information about economic fundamentals as it includes the trades of those who usually analyze economic fundamentals (Evans and Lyons, 2002a).

Currency order flow is defined as the net balance of buyer-initiated and seller-initiated currency order transactions (Evans and Lyons, 2002a). Therefore, it can be interpreted to be a diffusion link between information and exchange rates, which market participants have to aggregate and impound in currency values. Currency order flow can take positive values as well as negative values, in as much that, the counterparty either purchases (+) at the dealer's offer or sells (-) at the dealer's bid. Figure 3 present's information processing stages before foreign exchange trading activity is consummated by the market dealers. As non-dealers of foreign exchange learn about economic fundamentals from direct sources, such fundamentals are disseminated to the market dealers through currency order flow. Through this process, market dealers learn about fundamentals from the customer's order flow and determine the exchange rate (dealing price).

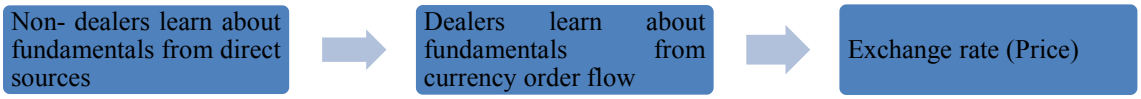


Figure 3: Information Processing Stage

Source: Lyons, 2001.

Evans and Lyons (2007) validate the concept that currency order flow transmits fundamental information regarding exchange rates in the foreign exchange markets. Currency order flow may be referred to be a channel for aggregating the differences arising from the interpretation of news and changes that occur because of heterogeneous expectations of the markets (Evans and Lyons, 2008). Dominquez and Panthaki (2006) confirm that "news" not only affects exchange rates directly, but also influences exchange rates through order flow. In addition, Berger et al. (2008) confirm that order flows convey fundamental information through liquidity effects, and that there exists a strong relationship between exchange rate returns and interdealer order flow. Likewise, Rime et al. (2010) provide evidence that, via macroeconomic news, a significant proportion of order flow fluctuations can be explained. Other empirical studies on currency order flow connectivity to news include Evans and Lyons (2005); Love and Payne (2008).

3.6 Construction of the Measure of Currency Order Flow

The two main techniques of conjecturing currency trade direction amongst others include the Tick-test approach by Sias and Starks (1997) and the Lee and Ready (1991) approach.

However, using these methods of trade classifications algorithm, Theissen (2001) analyze the accuracy of both the Lee & Ready method and the tick test using data of 15 stocks for the period of 21 trading days (September 26 to October 25 1996) from the Frankfurt Stock Exchange. The findings show that though the tick-test uses only transaction data, while the Lee and ready method is based on both transaction and quote data. The tick test performs really well in classifying transactions at the quote midpoint

that occurred on an uptick or a downtick. Also that, the accuracy of the Lee and Ready trade classification method is limited, at least for the German stock market. The results document that details of the microstructure may have an important impact on the accuracy of the trade classification. These dependencies suggest that there are large differences in the performance of trade classification algorithms across markets. As inaccurate trade classification may systematically be bias towards the results of empirical microstructure research. Given the appropriate relative performance of the tick-test, the paper analyze whether spread estimates obtained from a simple regression model using transaction data provide accurate estimates of the effective bid–ask spread. The results show that the estimates are upward biased, but provide a reasonably exact representation of the relative liquidity of the sample stocks. The research suggests that researchers should be cautious when applying the Lee and Ready trade classification method. As there is the possibility of a bias when interpreting empirical results based on that method.

Lee and Ready (1991) compare exchange rates with dealers' quotes. Here, the bid-ask exchange rates are essential in order to determine the midpoint exchange rate. Exchange rates higher or lower than the midpoint exchange rate are classified as purchases or sales. The current exchange rate S_t is first compared with the midpoint exchange rate, $1/2(S_t^A+S_t^B)$. However, if the initiator of the trade cannot be identified by applying this method, as $S_t = 1/2(S_t^A+S_t^B)$, then, tick-test approach can be employed to classify the trade.

Rules applied to identify whether the buyer initiates the trade or the seller are stated in Table 3.2

Table 3.2: Identification Algorithms

Specification	Conjecture for trade at t
$S_t > {}^1/_2(S_t^A + S_t^B)$	Buyer-Initiated
$S_t < {}^1/_2(S_t^A + S_t^B)$	Seller-Initiated
$S_t = {}^1/_2(S_t^A + S_t^B)$ *and* $S_t > S_{t-1}$	Buyer-Initiated
$S_t = {}^1/_2(S_t^A + S_t^B)$ *and* $S_t < S_{t-1}$	Seller-Initiated

Source: Lee and Ready, (1991).

On the other hand, Tick-test applies changes in exchange rates to infer trade direction by comparing previous exchange rate with current exchange rate. If the transaction occurs at an exchange rate higher than the previous rate (up-tick), this is classified as a buy. If otherwise (down-tick), it is classified as a sell. However, when there are no changes between the transaction rates (zero-tick), thus, the deal is classified by considering the last exchange rate different from the current exchange rate.

The rules applied to identify whether the buyer initiates the trade or the seller are stated in Table 3.3

Table 3.3: Identification Algorithms: Tick Test

Specification	Conjecture for trade at t
$S_t > S_{t-1}$	Buyer-Initiated
$S_t < S_{t-1}$	Seller-Initiated
$S_t = S_{t-1}$	Refer to previous rate differs from current rate

Source: Sias and Starks, (1997).

Therefore, this thesis applies the tick-test method, as it is more applicable and current for this study. The currency order flow is signed +1 if the dealer buys and -1 if the dealer sells. The sums of the trades' signs constitute net currency order flow for the day.

3.7 Theoretical Framework and Hypotheses Development

As mentioned earlier, the traditional macroeconomic models rely exclusively on public information to determine exchange rate. These macroeconomic models of exchange rate determination are deficient using high frequency data (intraday), and their explanatory power is almost nil. Moreover, these models have completely made currency trading irrelevant by focusing only on the asset aspect of currency than the international trade aspect (Lyons, 2001).

However, because of all these empirical limitations of the traditional models of exchange rate determination, Evans and Lyons (2002a) proposed a "*portfolio shift*" model of exchange rate determination that incorporates both macroeconomic information and information based on microeconomic (currency order flow), in an attempt to resolve the challenges posed by these macroeconomic models.

Therefore, Table 3.4 presents the assets of approach/portfolio balance and portfolio shift models of exchange rate determination. The exchange rate determination within the assets approach as stated in model (3.1), where ΔP_t represents change in the nominal exchange rate for a time period, usually a month. The controlling variables in the function $f(i, m, z)$ comprise current and previous values of domestic and foreign nominal interest rates i, money supply m, and z representing other macro determinants. However, these macro determinants accounts for only a small portion (less than 10%) of the variation in the floating exchange rates (Frankel and Ross, 1995; Isard,1995). It inferred that changes in public-information variables drive price without any role for currency order flow. This led to the development of hybrid model (*portfolio shift*) of exchange rate determination by Evans and Lyons (2002a).

Table 3.4: Traditional Theories/Models of Exchange Rate Determination

Authors	Models	Parameters
Kouri (1976)	Assets Approach/ Portfolio balance model	$\Delta P_t = f(\ i,\ m, z) + \epsilon_t$ (3.1)
Evans and Lyons (2002a)	Portfolio Shift model	$\Delta P_t = \Delta m_t\ + \lambda \Delta X_t$ (3.2a) $\Delta P_t = \alpha \cdot \Delta(i_t - i_{tf}) + \beta \cdot \Delta X_t + e_t$ (3.2b)
Zhang et al (2013)	Portfolio Shift model(extended)	$\Delta P_t = \alpha \cdot \Delta(i_t - i_{tf}) + \Delta(l_t - l_{tf}) + \Delta(R_t - R_{tf}) + \beta \cdot \Delta X_t + e_t$ (3.3)

The exchange rate determination within the *portfolio shift* as stated in model (3.2a) where ΔP_t represents changes in spot exchange rate; Δm_t represents macroeconomic information innovations (for example, changes in interest rate differential); λ represents positive constant; ΔX_t is daily accumulated net order flows. The model (3.2a) was modified to model (3.2b). Where ΔP_t represent changes in the log of spot exchange rate between the domestic and the foreign currency; the macroeconomic Δm_t in equation (3.2a) has been substituted with $\Delta(i_t - i_{tf})$, represent changes in interest rate differential between the domestic and foreign country; ΔX_t is daily accumulated order flows; β is the coefficient; α is constant and e_t is the error term.

However, due to major difference in interest rates between the developed market economies and the emerging market economies, Zhang et al. (2013) introduced an additional variable, country risk premium, which is not present in the original portfolio shift model of Evans and Lyons (2002a). This variable appears important in the studies of emerging markets. This is a variable considered in the literature to have a positive and

strong significance in the studies of emerging markets (Wu, 2012; Duffuor et al., 2012; De-Medeiros, 2004).

The extended portfolio shift model was employed by Zhang et al. (2013) to investigate the exchange rate dynamics of the Chinese foreign exchange market as stated in model (3.3). Whereby, ΔP_t represent changes in the log of spot exchange rate between the domestic and the foreign currency; $\Delta(i_t - i_{tf})$ represent changes in short term interest rate differential between the domestic and the foreign country; $\Delta(l_t - l_{tf})$ represent changes in long term interest rate differential between the domestic and the foreign country; $\Delta(R_t - R_{tf})$ represent changes in difference in the country risk premium between the domestic and the foreign country; ΔX_t is daily accumulated net order flows; α and β represent constant and coefficient; e_t is the error term. The country's daily risk premium R_t is defined as the difference between the prime lending rate and three months Treasury bill rate. Therefore, the difference between the countries risk premium is given as $(R_t - R_{tf})$, the domestic country's risk premium minus the foreign country's risk premium. Likewise, the short-term interest rate differential $(i_t - i_{tf})$ is defined as domestic country's overnight interest rate minus foreign country's overnight interest rate. Also, long term interest rate differential $(l_t - l_{tf})$ is defined as domestic country's one year daily inter-bank lending rate minus foreign country's one year daily inter-bank lending rate.

Therefore, this portfolio shift model by Evans and Lyons (2002a), extended by Zhang et al. (2013) is applied to the ASEAN-5 countries' foreign exchange market to analyze dataset of every fifteen-minute currency order flow and exchange rate movements. This thesis constructs a measure of cumulative currency order flow in the ASEAN-5 countries foreign exchange market context that centered on every fifteen-minute currency transaction data to reflect excess demand pressure.

Therefore, to achieve the main objectives of this study, the research questions and the hypotheses development are hereby presented.

Research Question 1: To what extent can currency order flow analysis explain the short -term determination of the exchange rate value of ASEAN -5 countries' currencies against the US dollar?

Hypothesis 1:

$\boldsymbol{H_0}$**:** The currency order flow analysis does not influence the short-term determination of the exchange rate value of the ASEAN -5 countries' currencies against the US dollar.

$\boldsymbol{H_1}$**:** The currency order flow analysis influence the short- term determination of the exchange rate value of the ASEAN -5 countries' currencies against the US dollar.

Research Question 2: To what extent is the long-run and short-run interaction between micro-macroeconomic variables, such as currency order flow, interest rate, risk premium and exchange rates?

Hypothesis 2:

$\boldsymbol{H_0}$**:** There is no long-run and short-run interaction between micro-macroeconomic variables, such as currency order flow, interest rate, risk premium and exchange rates.

$\boldsymbol{H_1}$**:** There is a long-run and short-run interaction between micro-macroeconomic variables, such as currency order flow, interest rate, risk premium and exchange rates.

With the application of Vector Autoregression (VAR) model, this thesis examines the cointegrating relationship between cumulative currency order flow and movements in

exchange rate in the ASEAN-5 countries' foreign exchange markets for these two research questions/objectives.

To answer the third and final research question/ objective, this thesis adopts some market intervention success criteria and ordinary least square (OLS) approach to explore market intervention and the extent to which this policy tool is effective. This thesis adopts (five out of nine criteria as applicable to the emerging market studies) some of the tools and methods of success criteria employed by Marsh (2011) for assessing the success (or otherwise) of ASEAN-5 countries' foreign exchange market interventions.

Research Question 3: To what extent is the monetary authorities' market intervention of the ASEAN -5 countries is effective in curbing the depreciation of their currencies against the US dollar?

Hypothesis 3:

$\boldsymbol{H_0}$**:** The monetary authorities' market intervention of the ASEAN-5 countries is not effective in curbing the depreciation of their currencies against the US dollar.

$\boldsymbol{H_1}$**:** The monetary authorities' market intervention of the ASEAN -5 countries is effective in curbing the depreciation of their currencies against the US dollar.

In an analysis done by Marsh (2011), the Bank of Japan only acted to limit the appreciation of Japanese yen against the US dollar. The Bank of Japan intervenes to sell yen against the US dollar in the foreign exchange market. However, in the emerging markets, majority of the monetary authorities (including the ASEAN-5 countries)

intervene to limit the depreciation of their domestic currencies against the major currencies of their trading partners, especially against US dollar. Thus, the study by Marsh (2011) is based on limiting the appreciation of Japanese yen (developed market currency) against the US dollar. However, this study is based on limiting the depreciation of ASEAN-5 countries' currencies (emerging market currencies) against the US dollar.

Therefore, the analysis is in one direction, since ASEAN-5 countries' monetary authorities mainly take action to limit the depreciation of their currencies against US dollar. Hence, this thesis evaluates the success criterion for the sale of US dollars in each case, using four major criteria and an aggregate criterion that incorporates the first four criteria (*Reducing the net currency order flow out of dollar; Reversing the direction of the net currency order flow; Accentuating the net currency order flow; Moderating the net currency order flow* and *General success criterion for net currency order flows*).

3.8 Chapter Summary

The ASEAN-5 countries exchange rate regimes, foreign exchange markets and trading system are similar in nature. According to IMF *de facto* classification of exchange rate arrangements and monetary frameworks, ASEAN-5 countries operate "managed floating" exchange rate regime with the exception of the Philippines that operates "independently floating" exchange rate regime. However, their foreign exchange market regulations and structures are similar.

The monetary authorities of these five countries (ASEAN-5) are responsible for administering all the foreign exchange and trade control matters with specific authorities designated to accredited banks. Though the forces of demand and supply determines the exchange rate in ASEAN-5 countries foreign exchange markets, however, when situation

arises, the monetary authorities intervene to curb excessive volatility and maintain orderly market conditions; and also to sustain the value of their currencies against the currencies of their major trading partners, especially the US dollar. Furthermore, in ASEAN-5 countries foreign exchange markets, foreign exchange trading activities are conducted between the hour of 09.00am and 5.00pm daily with the exception of Singapore and Thailand that operate 24hr foreign exchange trading, all year round.

Following the failure of traditional macroeconomic models (the flexible price model, the sticky price model and the portfolio balance model) of exchange rate determination, Evans and Lyons proposed a "*portfolio shift*" model of exchange rate determination that incorporates both macroeconomic information and information based on microeconomic (currency order flow), in an attempt to resolve the challenges posed by these macroeconomic models. Currency order flow conveys private information that dealers/market participants aggregate into exchange rates. Therefore, currency order flow implies net balance of buyer-initiated and seller-initiated currency order transactions.

The two main techniques of conjecturing currency trade direction are the Tick-test approach by Sias and Starks (1997), and Lee and Ready (1991) approach. This thesis applies the tick-test method as it is more applicable and current for this study. This thesis constructs a measure of cumulative currency order flow in the ASEAN-5 foreign exchange market context that centered on every fifteen-minute currency transaction data to reflect excess demand pressure. The currency order flow is signed +1 if the dealer buys and -1 if the dealer sells. The sum of the trade signs constitutes net currency order flow for the day. The *portfolio shift model* by Evans and Lyons (2002a), extended by Zhang et al (2013) and VAR model is applied to the ASEAN-5 countries' foreign exchange market to analyze dataset of every fifteen-minute currency order flow and exchange rate

movements for the group currency pair against the US dollar from January 2010 through December 2015.

Market intervention is a policy tool used by most central banks to influence the future direction of their domestic exchange rate against other foreign currencies. However, the extent to which market intervention influences the exchange rate, and the effectiveness of this policy tool remains an issue yet to be resolved in the literature.

Therefore, this thesis adopts some of the tools and methods of success criteria used by Marsh (2011) for assessing the success (or otherwise) of the ASEAN-5 countries' monetary authorities market intervention in the foreign exchange markets.

CHAPTER 4: METHODOLOGY

This chapter describes the methodology, sampling, data and data collection method, measurement of variables and statistical method employed. These include the unit root test, Granger causality test, Vector Autoregression (VAR) modeling, error correction modeling (ECM), impulse responses (IR) and forecast error variance decomposition (FEVD).

4.1 Sample, Data Collection and Variables Construction

4.1.1 Sample selection

As mentioned in the scope of the study that among the high performing economies in the ASEAN region is the five founding members (known as ASEAN-5: Indonesia, Malaysia, Philippines, Singapore and Thailand). These countries have a long history of multilateralism among themselves and they possess similar contention due to financial/currency crises (Asian Development Bank, 2012). Macroeconomic interdependence within the group has developed greatly, as shown by a simultaneous ellipsis of economic activity all over the ASEAN-5 countries in 2005 and a simultaneous economic growth in 2006-2007. The economic experience of the members of this group had undergone most dramatic situation from growth to crisis over the past seven years (Asian Development Bank, 2015). In addition, members of this group operate "managed floating" exchange rate regime, and the foreign exchange market regulations and structure are similar. Therefore, this thesis focuses on the ASEAN-5 countries' economies.

4.1.2 Data collection

The data for this study are sourced from Reuters and Bloomberg. These databases provide tick-by-tick trading prices data for spot transactions in the foreign exchange

markets. The tick-by-tick trading prices data and market intervention newswire reports were sourced from Bloomberg, while Reuters provide daily exchange rate, interest rate and risk premium data for this study. The data is huge to be effectively reproduced in this thesis (but is available on request).

This thesis covers the period, post 2008 global financial crisis (January 4, 2010 to December 31, 2015) in order to measure the flexibility and consequent volatility of exchange rates of ASEAN-5 countries' currencies against the US dollar. In addition, after the New Year break, effective currency trading in the foreign exchange market starts on Monday January 4, 2010.

A total sample of 1564 trading days is for each of the countries in the sample with the exception of Malaysia. This study excludes weekends and public holidays from the sample as foreign currency trading activity during these periods are of unusually very light trading volume. Among them, New Year, January 1 and Christmas day, December 25. However, for Malaysia, a total sample of 1497 trading days excluding weekends, general public holidays and Malaysian Public holidays were employed. In addition to very light trading volume, foreign exchange trading data were not available for some of these periods in the Malaysian foreign exchange market, which are New Year (January 1), Christmas day (December 25), Labour Day, Chinese New Year, National day, Malaysian day, Hari Raya, Deepavali, Awal Muharam and Maulidur rasul.

Furthermore, trading in the spot foreign exchange market is conducted on a 24-hour basis in Singapore and Thailand (1700hr to 1659hr). However, in Indonesia, Malaysia and the Philippines, spot currency trading activity usually opens on Monday morning and closes on Friday evening. The opening time for spot currency trading in Indonesia and the Philippines starts from 1000hr and ends at 1700hr, while in Malaysia it starts from 0900hr and ends at 1700hr (GMT+8). In addition, foreign currency transaction settlement

period in Indonesia, Malaysia, Singapore and Thailand is set at T+2 (i.e. two days after the transaction day), while in the Philippines, it is set at T+1 (i.e. one day after the transaction day).

4.1.3 Measurement of Variables

The portfolio shift model by Evans and Lyons (2002a), extended by Zhang et al. (2013) is applied to analyze dataset of every fifteen-minute currency order flow and exchange rate movements in the ASEAN-5 countries foreign exchange markets. The extended portfolio shift model is presented as follow:

$$\Delta P_t = \alpha \cdot \Delta(i_t - i_{tf}) + \Delta(l_t - l_{tf}) + \Delta(R_t - R_{tf}) + \beta \cdot \Delta X_t + e_t$$

Measurements of the variables are in this order; P_t represents the log of each working day closing exchange rate transaction price, X_t is daily accumulated (net) currency order flow, $(i_t - i_{tf})$ represents the differential in interest rate for short-term period between the domestic and the foreign country, $(l_t - l_{tf})$ represents the differential in interest rate for long-term period between the domestic and the foreign country and $(R_t - R_{tf})$ represents the difference in the country risk premium between the domestic and the foreign country. α and β represents constant and coefficient; e_t is the error term.

Evans and Lyons (2002a) show that the daily currency order flows X_t represent the net position between the buyer and the seller initiated currency order flow per transaction day. The differential in the interest rate for short-term period $(i_t - i_{tf})$ represent the domestic interest rate daily overnight period minus the foreign interest rate daily overnight period. The differential in the interest rate for long-term period $(l_t - l_{tf})$ represents the domestic inter-bank daily lending rate for one year minus the foreign inter-bank daily lending rate for one year. A country's daily risk premium R_t represents the

difference between the prime lending rate and the three months Treasury bill rate. Therefore, the difference between the two countries risk premium is given as $(R_t - R_{tf})$ the domestic risk premium minus that of the foreign risk premium. The interest rate data is expressed on an annual basis.

Trade direction and the sum of transaction volume are the two major important elements from the definition of currency order flow. Thus, the major task is to determine the trade direction and sum-up the tick trading direction of the fifteen-minute intraday data. In addition, measure of spot currency order flow is constructed by assigning values to trade i.e. assigned value to every single buying and selling trade, +1 and -1. Therefore, the summation of these trade signs is equal to one-day spot currency order flow over the entire trading period (Evans and Lyons, 2002a).

Generally, running a unit root test is to verify series possibility at $I(1)$ process, in order to be conscious of spurious regression. Augmented Dickey-Fuller (ADF) test is employed to test the stationary and non-stationary of the time series data. That is, $I(1)$ versus $I(0)$ variables. In addition, Granger causality tests of the key variables are performed in order to confirm unidirectional/bidirectional causality of the variables. The restricted and unrestricted models are compared to identify whether currency order flow (X_t) Granger-causes exchange rate (P_t) and vice-versa. This is achieved via Wald tests.

Vector Autoregression modelling (VAR), Error correction model (ECM) and forecast error variance decomposition (FEVD) are some of the models employed by this thesis to determine the long-run and short-run interaction between micro-macroeconomic variables, such as currency order flow, interest rate, country's risk premium and exchange rate.

The methodology and models are hereby described in detail.

4.2 Vector Autoregression (VAR) Modeling

Hasbrouck (1991) proposed microstructure vector autoregression model (VAR) to investigate New York Stock Exchange. VAR model is one of the preferred econometric methods employed to investigate both the long-run as well as short-run relation between currency order flow and exchange rate fluctuations with their feedback effects (Froot and Ramadorai, 2005; Wu, 2012; Duffuor et al., 2012; Zhang et al., 2013). Payne (2003) applies VAR model to examine USD/DM for a period of one week (6^{th} to 10^{th} October, 1997). Froot and Ramadorai (2005) employ the same model (VAR) to investigate the interaction between permanent shock and transitory shock on exchange rate earnings using currency order flow as a main factor of exchange rate fluctuations. Importantly, VAR model considers the currency order flow coefficient on the ordinary least square (OLS) regression with their likely feedback effect (Zhang et al., 2013). In the literature, Vector Autoregression (VAR) has become one of the prevalent methods of time-series modeling, therefore, this thesis adopts VAR model in analyzing the stationary multivariate time series data.

Model Specification and Inference

Let H_t denote attribute vector, D_t the log of each transaction attribute, t is the time event.

The model:

$$H_t = \mathrm{B}D_t + E_t \tag{4.1}$$

and

$$H_t = \begin{pmatrix} P_t \\ X_t \\ (i_t - i_{tf}) \\ (l_t - l_{tf}) \\ (R_t - R_{tf}) \end{pmatrix} ; \mathrm{B} = \begin{bmatrix} \beta_{1,1} & R & \beta_{1,5l} \\ \vdots & \vdots & \vdots \\ N & O & N \\ \\ \vdots & \vdots & \vdots \\ \beta_{5,1} & U & \beta_{5,5l} \end{bmatrix} ; D_t = \begin{pmatrix} P_{t-1} \\ \vdots \\ L \\ \vdots \\ R_{t-1} \end{pmatrix} ; E_t = \begin{pmatrix} \varepsilon_{t1} \\ \varepsilon_{t2} \\ \varepsilon_{t3} \\ \varepsilon_{t4} \\ \varepsilon_{t5} \end{pmatrix}$$

$5 \; x \; 1$ $\qquad$ $5 \; x \; 5l$ $\qquad$ $5l \; x \; 1$ $\qquad$ $5 \; x \; 1$

(4.2)

Where P_t represents transaction price, X_t represents daily accumulated currency order flow, $(i_t - i_{tf})$ represents differential in interest rate for short-term period between the domestic and the foreign country, $(l_t - l_{tf})$ represents differential in interest rate for long-term period between the domestic and the foreign country, and $(R_t - R_{tf})$ represents the difference in the country risk premium between the domestic and the foreign country. B represents matrices of coefficients to be estimated (β, R, N, O and U).

Ordinary least square (OLS) with Heteroskedasticity robust standard errors is applied to estimate each vector autoregression equation.

Vector Autoregression (VAR) terms:

$$H_t = \Gamma D_{t-1} + \varepsilon_t \quad (4.3)$$

hence,

$$H_t' = f\,[P_t,\ \ X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,\ \ (R_t - R_{tf})] \quad (4.4)$$

$$H_t' = f\,[P_t,\ \ X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,R_t\ ,\ R_{tf},\ Trend\ ] \quad (4.5)$$

H_t represents the transaction attributes vector, P_t represents the transaction price, X_t represents daily accumulated currency order flow, $(i_t - i_{tf})$ represents differential in interest rate for short-term period between the domestic and the foreign country, $(l_t - l_{tf})$ represents differential in interest rate for long-term period between the domestic and the foreign country and $(R_t - R_{tf})$ represents the difference in the country risk premium between the domestic and the foreign country. The companion matrix Γ and variable P_t are let on uniform crosswise the currencies, and the lags.

The long-run cointegrating relationships tests using hypotheses H_2 to H_6.

Exchange rate and currency order flow:

$$P_t = -X_t \quad (4.6)$$

Interest rate spread:

$$(i_t - i_{tf}) = -\ (l_t - l_{tf}) \quad (4.7)$$

Country risk difference:

$$R_t = -\ R_{tf} \quad (4.8)$$

Quote for all dealers is at USD/IDR; USD/MYR; USD/PHP; USD/SGD and USD/THB, and is given as:

$$P_t = \mathrm{E}\, P_t + (i_t - i_{tf}) - R_t \qquad (4.9)$$

P_t is the transaction price; $(i_t - i_{tf})$ represents differential in interest rate for short-term period; R_t represents country's daily risk premium. That is, the difference between the prime lending rate and the three months Treasury bill rate.

The long-term (l_t) and short-term (i_t) difference represents term spread, given as:

$$(l_t - l_{tf}) - (i_t - i_{tf}) = (R_t - R_{tf}) \qquad (4.10)$$

Therefore, this thesis can equate country's daily risk premium difference to the term spread for the countries in the sample.

The optimal lag length is of automatic specification (fourth order lag structure) based on the Schwarz information criterion (SIC) and the Akaike information criterion (AIC) with maximum lag of 23.

4.3 Error Correction Modeling (ECM)

The series (P_t *and* X_t) are integrated of the same order of $I(1)$ and cointegrated. As changes in P_t relate to changes in X_t , there is an assumption that long-run equilibrium exists. Therefore, a well-structured timeseries model expresses short run dynamics as well as long run equilibrium simultaneously.

Error correction term can be define as:

$$\mathcal{E}_t = \mathcal{M}_t - \beta \mathcal{N}_t \quad (4.11)$$

Where β represent cointegrating coefficient. $\mathcal{E}_t$ error term of $\mathcal{M}_t$ on $\mathcal{N}_t$.

$$\Delta \mathcal{M}_t = \alpha \mathcal{E}_{t-1} + \gamma \Delta \mathcal{N}_t + v_t \quad (4.12)$$

$\Delta \mathcal{M}_{t,}$explains the lagged $\mathcal{E}_{t-1}$ and $\Delta \mathcal{N}_t$. $\mathcal{E}_{t-1,}$ preceding period equilibrium error. α and γ are error correction coefficients. β, long-run parameter. While, α and γ are short-run parameters.

The ECM becomes:

$$\Delta \mathcal{M}_t = - \mathcal{E}_{t-1} + \beta \Delta \mathcal{N}_t + v_t \quad (4.13)$$

4.3.1 Model: Vector Error Correction Modeling Estimates

The formulation and estimation of error correction model via equations (4.11) and (4.12).

$$[\Delta P_t, \quad \Delta X_t, \ \Delta (i_t - i_{tf}), \ \Delta (l_t - l_{tf}), \quad \Delta (R_t - R_{tf})] \quad (4.14)$$

4.3.2 Partial Vector Error Correction Model

The variables considered insignificant in the system were discarded to arrive at most parsimonious model.

$$\Delta P_t, \quad \Delta X_t, \quad \Delta \left(R_t - R_{tf}\right) \quad (4.15)$$

$$\Delta \mathrm{P_t} = \mathcal{U} + \alpha_1 * \Delta \mathrm{P_{t-1}} + \beta_1 * \Delta \mathrm{X_{t-1}} + \beta_2 * \Delta \mathrm{X_{t-2}} + \theta * \mathcal{U}_{ii\, t-1} + \varepsilon_{p,t} \quad (4.15.1)$$

$$\Delta X_t = \mathcal{U} + \alpha_1 * \Delta P_{t-1} + \alpha_2 * \Delta P_{t-2} + \theta * \mathcal{U}_{i\,t-1} + \varepsilon_{X,t} \quad (4.15.2)$$

$$\Delta(R_t - R_{tf}) = \alpha_1 * \Delta P_{t-1} + \alpha_3 * \Delta P_{t-3} + \varphi_3 * \Delta(i_{t-3} - i_{tf-3}) + \lambda_1 * \Delta(l_{t-1} - l_{tf-1})$$
$$+ \lambda_2 * \Delta(l_{t-2} - l_{tf-2}) + \lambda_3 * \Delta(l_{t-3} - l_{tf-3}) + \delta_1 * \Delta(R_{t-1} - R_{tf-1})$$
$$+ \delta_2 * \Delta(R_{t-2} - R_{tf-2}) + \delta_3 * \Delta(R_{t-3} - R_{tf-3}) + \varepsilon_{R,t} \quad (4.15.3)$$

Where ΔP_t is change in spot exchange rate, ΔX_t is change in currency order flow, $\Delta(R_t - R_{tf})$ is change in country's risk premium difference, $\mathcal{U}$ is constant, α is speed of adjustment, β is cointegrating parameter, θ is error correction term, φ is short-term differential coefficient, λ is long-term differential coefficient, δ is country's risk premium difference coefficient and ε is white noise error term.

4.4 Impulse Responses

Using impulse response functions to analyze the random relationship among the main variables, an in-depth understanding can be achieved. Therefore, when cointegrating rank is consistently estimated based on a reduced rank regression, then, the estimated impulse response in a cointegrated VAR is likewise consistent. More so, where the number of cointegrating vectors is provided as component of the specification of the system, it implies that the ECM models are explicit in this regard.

In addition, applying FM-OLS for the reduced rank regression, this method has preference over unrestricted VAR regression the consistent estimates of the impulse responses are clearly delivered.

Therefore, the impulse responses of the variables in the system $[P_t, X_t, (i_t - i_{tf}), (l_t - l_{tf}), (R_t - R_{tf})]$ are based on the unrestricted and restricted VAR as

well as VECM and parsimonious VAR. It is expected that Parsimonious VAR response estimates should have capacity to convey realistic economic information when compared with unrestricted VAR.

4.5 Forecast Error Variance Decomposition

In determining the effects of unanticipated shocks of one variable on other variables, forecast error variance decomposition is used in empirical research for policy analysis purposes. In a stationary VAR, asymptotically, the coefficient estimation errors have no effect in that the feasible as well as optimal predictors lean towards zero as $\eta \longrightarrow \infty$. Therefore, once the VAR of the cointegrating rank is consistently estimated, likewise forecast error variance decomposition.

Therefore, the forecast error variance of each variable into elements is performed in order to account for innovation of the variables. Hence, Cholesky decomposition is applied to decompose exchange rate fluctuations amongst other variables in the specification.

4.6 Foreign Exchange Market Intervention Success Criteria

To address the final objective of this study, this thesis adopts five out of nine criteria as applicable to emerging market studies, *Reducing the net currency order flow out of dollar; Reversing the direction of the net currency order flow; Accentuating the net currency order flow; Moderating the net currency order flow* and *General success criterion for net currency order flows* as proposed by Marsh (2011) for the purpose of assessing the success (or otherwise) of ASEAN-5 countries' foreign exchange market intervention. The thesis therefore investigates the monetary authorities' market

intervention of the ASEAN-5 countries and the extent to which this policy tool is effective in curbing the depreciation of their currencies against the US dollar.

4.7 Data sets

This thesis comprises the period of six 6 years, from January 4, 2010 to December 31, 2015 for a total observation of 1564 trading days for all the countries in the sample with the exception of Malaysia with 1497 trading days. This thesis uses this full period in the analysis, even though; the most intervention took place between January 2012 and September 2014 in the Indonesian foreign exchange market. Likewise, in the Malaysia foreign exchange market, the most intervention took place between January 2013 and July 2015. Furthermore, the most intervention took place between January 2011 and September 2015 in the Philippines foreign exchange market. However, in the Singapore foreign exchange market, the most intervention took place between January 2010 and July 2013. Meanwhile, the most intervention took place between July 2012 and July 2015 in the Thailand foreign exchange market. The use of full period in the analysis is done to compare the behavior of currency order flows on intervention days with those on non-intervention days.

The OLS regression is adopted to analyze the data, based on the literature (Evans and Lyons, 2003; Chaboud and Humpage, 2005; Girardin and Lyons, 2006 and Marsh, 2011).

The model specification and estimation method run to test intervention effectiveness:

$$\Delta X_t = \alpha + INT_{tt} + e_t \quad (4.16)$$

$$\Delta X_t = \alpha + INT_{ts} + e_t \quad (4.17)$$

$$\Delta P_t = \alpha + \beta \cdot \Delta X_t + e_t \quad (4.18)$$

Where ΔX_t is change in currency order flow, ΔP_t is change in spot exchange rate, α is constant, β is regression parameter, INT_{tt} represents total intervention, INT_{ts} represents secret intervention, e_t is white noise error term.

Importantly, this thesis constructs a measure of currency order flow in the ASEAN-5 countries' foreign exchange markets context to reflect the pressure of currency excess demand (See Figure 2 in page 48), which is measured in US dollars.

4.8 Monetary Authority Intervention Data

This thesis was able to determine the periods when the majority of the intervention took place from the construct of the currency order flows and exchange rate fluctuations for the period under consideration, January 4, 2010 through December 31, 2015. In addition, this thesis examines whether the fact that monetary authority intervention is detected/reported or remains secret/unreported matters. The intervention of monetary authority is considered detected/reported if reports of newswires from either Reuters or Bloomberg clearly state that ASEAN-5 countries' monetary authorities were seen to have intervened in the foreign exchange markets. For example, as cited in Bloomberg newswire reports of January 19, 2015 on Malaysia Ringgit affirm, "Bank Negara Malaysia (BNM) sold around US$7.5b in November and US$2.4b in December 2014, respectively after adjusting for foreign exchange valuation effects. Bank Negara Malaysia is expected to continue to actively curb excessive MYR volatility against the US dollar, as there is risk that if currency depreciation is too fast it could become a destabilizing factor".

Therefore, the newswires reports for this thesis were sourced from Bloomberg database. The monetary authorities (central banks) under consideration include Bank Indonesia (BI), Bank Negara Malaysia (BNM), Bangko Sentral ng Pilipinas (BSP), The Monetary Authority of Singapore (MAS), and Bank of Thailand (BOT).

This thesis adopts some market intervention success criteria (Marsh, 2011) for the purpose of assessing the success (or otherwise) of ASEAN-5 countries' foreign exchange market interventions. The thesis evaluates the success criterion for the sale of US dollars in each case, using four major criteria and an aggregate criterion that incorporates the first four. Furthermore, this thesis evaluates the probability of observing a specific number of successes under the assumption that their occurrence is a hypergeometric random variable. The hypergeometric distribution does not require individual events to be independent and does not depend on the presumed probability of an individual success. Thus, the null hypothesis states that the actual number of successes equals the expected (unconditional) number of successes. Therefore, this thesis uses unconditional performance in each case as a benchmark upon which performance under each criterion is judged.

The Success Criteria:

1 Reducing the net currency order flow out of dollar

This success criterion tests whether when the central bank sells US dollars, the net currency order flow in dollars against the domestic currency immediately reduces.

An intervention sale of US dollars against the domestic currency is successful if:

$$SC1_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < 0 \\ 0 \text{ otherwise} \end{cases} \quad (4.19)$$

2 Reversing the direction of the net currency order flow

This is a more stringent subset of the first criterion. It presumes that when the central bank intervenes to sell US dollars, it then changes the direction of net currency order flows.

An intervention for the sale of US dollars against the domestic currency is successful if:

$$SC2_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < 0, \text{and } COF_{t-1} > 0 \\ 0 \text{ otherwise} \end{cases} \quad (4.20)$$

3 Accentuating the net currency order flow

This is also a subset of the first criterion. It tests whether when central bank sells US dollars against the domestic currency, it reduces the value of the net currency order outflow at a faster rate. That is *"leaning with the wind"*.

An intervention would be deemed successful if:

$$SC3_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < COF_{t-1}, \text{and } COF_{t-1} < 0 \\ 0 \text{ otherwise} \end{cases} \quad (4.21)$$

4 Moderating the net currency order flow

This success criterion considers intervention by the central bank to smooth the foreign exchange market, which is *"lean against the wind"*. It tests whether when the central bank sells US dollars against the domestic currency, it reduces the value of the net currency order flows slowly, but does not reverse the position.

An intervention would be deemed successful if:

$$SC4_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < COF_{t-1}, \text{and } COF_t \geq 0, \text{and } COF_{t-1} > 0 \\ 0 \text{ otherwise} \end{cases} \quad (4.22)$$

5 General success criterion for net currency order flows

This success criterion aggregates the first four criteria, as it represents the union of the previous criterion. It tests whether following the central bank intervention operations to sell US dollars against the domestic currency, the net currency order flow moves in the desired target. That is, currency order flows are out of the dollar or, if not, at least not as much as they were in the undesired trend.

An intervention would be deemed successful if:

$$SC5_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < 0 \text{ or } COF_t < COF_{t-1} \\ 0 \text{ otherwise} \end{cases} \quad (4.23)$$

N.B. *SC: Success criteria; COF: currency order flow; INT: Intervention*

4.9 Chapter Summary

This thesis used various techniques of the market microstructure approach to explore the three objectives. The vector autoregressive model (VAR), vector error correction model (VECM) and forecast error variance decomposition (FEVD) are used to determine the interaction between micro-macroeconomic variables such as, currency order flow, interest rate, country's risk premium and exchange rates. The Augmented Dickey-Fuller

(ADF) test is employed to assess the stationary and non-stationary of the time series data and Granger causality test and Wald test were used. Likewise, VAR model and OLS with Heteroskedasticity robust standard errors are employed to estimate each vector autoregression equation.

The hypotheses development for this study is based on Evans and Lyons (2002a) *portfolio shift model* extended by Zhang et al (2013). This model is applied to analyze dataset of every fifteen-minute currency order flow and exchange rate movements for the ASEAN-5 countries' currency pair against the US dollar for the period of six years from January, 2010 to December, 2015. Data for this study are sourced from Reuters and Bloomberg databases, focusing on the spot foreign exchange markets and trades of the ASEAN-5 countries and the USA.

As it is expected that parsimonious VAR response estimates should have capacity to convey realistic economic information when compared with unrestricted VAR, the impulse responses of the variables in the system are based on PVAR. In addition, Cholesky decomposition is employed to decompose exchange rate movements amongst other variables in the specification.

Furthermore, this thesis adopts five out of nine criteria as applicable to the emerging market studies. Some of the tools and methods of success criteria used by Marsh (2011) for assessing the success (or otherwise) of the ASEAN-5 countries foreign exchange market interventions to answer the final objective. This thesis evaluates with the success criterion for the sale of US dollars in each case, as the monetary authorities in these five countries mostly take action to curb the depreciation of their currencies against the US dollar in the sample.

CHAPTER 5: EMPIRICAL RESULTS AND DISCUSSION ON EXCHANGE RATE AND CURRENCY ORDER FLOW ANALYSIS

This chapter reports the estimations of the empirical results that answer the first two objectives of this thesis. The first is to examine the extent to which currency order flow analysis can explain the short-term determination of the exchange rate value of the ASEAN -5 countries' currencies against the US dollar. Second is to determine the extent of long-run and short-run interaction between micro-macroeconomic variables, such as currency order flow, interest rate, risk premium and exchange rate.

5.1 Unit Root Analysis and Descriptive Statistics

The stationarity of the data is checked, and Table 5.1 reports the ADF test results, as all the data series in the system are statistically significant at 1% level, and at $I(1)$ process. This implies that the variables are stationary as $I(1)$ process for all the countries in the sample.

Table 5.1: Summary of Unit Root Analysis

Variables	At 1st difference	
	Intercept	Trend & Intercept
PANEL A: INDONESIA		
(P_t)	-38.4416 (0.0000) ***	-38.5182 (0.0000)***
(X_t)	-26.8741 (0.0000) ***	-26.8672 (0.0000)***
$(i_t - i_{tf})$	-23.3931 (0.0000) ***	-23.4253 (0.0000)***
$(l_t - l_{tf})$	-39.1961 (0.0000) ***	-39.1836 (0.0000)***
$(R_t - R_{tf})$	-39.6471 (0.0000) ***	-39.6444 (0.0000)***
PANEL B: MALAYSIA		
(P_t)	-39.5899 (0.0000) ***	-39.7615 (0.0000)***
(X_t)	-19.7513 (0.0000) ***	-19.7668 (0.0000)***
$(i_t - i_{tf})$	-24.0416 (0.0000) ***	-24.1111 (0.0000)***
$(l_t - l_{tf})$	-46.3009 (0.0001) ***	-46.4507 (0.0000)***
$(R_t - R_{tf})$	-39.7821 (0.0000) ***	-39.7696 (0.0000)***
PANEL C: PHILIPPINES		
(P_t)	-40.7709 (0.0000) ***	-40.8195 (0.0000)***
(X_t)	-21.5071 (0.0000) ***	-21.5006 (0.0000)***
$(i_t - i_{tf})$	-19.0282 (0.0000) ***	-19.0224 (0.0000)***
$(l_t - l_{tf})$	-37.3852 (0.0000) ***	-37.3790 (0.0000)***
$(R_t - R_{tf})$	-27.2822 (0.0000) ***	-27.2964 (0.0000)***

Table 5.1: Summary of Unit Root Analysis Continued		
PANEL D: SINGAPORE		
(P_t)	-41.1871 (0.0000) ***	-41.2826 (0.0000)***
(X_t)	-17.3100 (0.0000) ***	-17.3041 (0.0000)***
$(i_t - i_{tf})$	-17.5651 (0.0000) ***	-17.5665 (0.0000)***
$(l_t - l_{tf})$	-39.9699 (0.0000) ***	-40.0107 (0.0000)***
$(R_t - R_{tf})$	-43.5963 (0.0000) ***	-43.6610 (0.0000)***
PANEL E: THAILAND		
(P_t)	-37.6773 (0.0000)***	-37.8059 (0.0000)***
(X_t)	-18.7022 (0.0000)***	-18.6964 (0.0000)***
$(i_t - i_{tf})$	-31.4174 (0.0000)***	-31.5652 (0.0000)***
$(l_t - l_{tf})$	-25.9245 (0.0000)***	-26.2823 (0.0000)***
$(R_t - R_{tf})$	-40.5452 (0.0000)***	-40.5344 (0.0000)***

1% level is denoted by *** represent the level of statistical significance

Table 5.2 presents the summary of descriptive statistics and the correlation matrix of the major items for all the countries in the sample; P_t transaction price, X_t daily accumulated order flow, $(i_t - i_{tf})$ differential in interest rate for short-term period, $(l_t - l_{tf})$ differential in interest rate for long-term period and $(R_t - R_{tf})$ difference in the country risk premium. The findings indicate that all the variables fail the Jarque-Bera test with the exception of Singapore long-term interest. Meaning that, all the variables (apart from Singapore long-term interest) depart from Normality. The skewness for all the variables is less than 1 for Thailand, less than 2 for Indonesia and Malaysia, less than 4 for Singapore and less than 18 for the Philippines.

Table 5.2: Summary of Descriptive Statistics and the Correlation Matrix

PANEL A: INDONESIA					
Stratum A: Summary Statistics					
	(P_t)	(X_t)	$(i_t - i_{tf})$	$(l_t - l_{tf})$	$(R_t - R_{tf})$
Observations	1564	1564	1564	1564	1564
Mean	.0001	2536.318	5.2499	5.9198	-2.9358
Std. Dev.	.0001	5078.968	0.8368	0.8074	0.7338
Skewness	-0.4262	1.4396	-0.7723	-0.0562	0.0678
Kurtosis	1.6675	5.8799	2.0667	1.5736	1.4952
JB Normality test	163.0554 (0.0000)***	1080.738 (0.0000)***	212.2453 (0.0000)***	133.4056 (0.0000)***	148.7490 (0.0000)***
Stratum B: Correlation Matrix					
(P_t)	1.0000	0.2817	-0.2816	-0.7486	-0.8233
(X_t)	0.2817	1.0000	0.2610	-0.0023	-0.0342
$(i_t - i_{tf})$	-0.2816	0.2610	1.0000	0.7474	0.7207
$(l_t - l_{tf})$	-0.7486	-0.0023	0.7474	1.0000	0.9796
$(R_t - R_{tf})$	-0.8233	-0.0342	0.7207	0.9796	1.0000
Table 5.2: Summary of Descriptive Statistics and the Correlation Matrix Continued					

PANEL B: MALAYSIA					
Stratum A: Summary Statistics					
Observations	1497	1497	1497	1497	1497
Mean	0.3076	408.0541	2.7842	2.7841	0.4424
Std. Dev.	0.0254	4507.573	0.3177	0.3099	0.0915
Skewness	-1.5873	0.7521	-1.4845	-1.4923	1.1532
Kurtosis	5.0037	16.5371	4.8425	4.7430	5.9706
JB Normality test	879.0415 (0.0000)***	1157.50 (0.0000)***	761.5436 (0.0000)***	745.0884 (0.0000)***	882.2813 (0.0000)***
Stratum B: Correlation Matrix					
(P_t)	1.0000	0.1212	-0.3393	-0.2292	0.1094
(X_t)	0.1212	1.0000	-0.0597	-0.0833	0.0389
$(i_t - i_{tf})$	-0.3393	-0.0597	1.0000	0.6994	-0.0666
$(l_t - l_{tf})$	-0.2292	-0.0833	0.6994	1.0000	-0.0755
$(R_t - R_{tf})$	0.1094	0.0389	-0.0666	-0.0755	1.0000
PANEL C: PHILIPPINES					
Stratum A: Summary Statistics					
Observations	1564	1564	1564	1564	1564
Mean	0.0229	-638.8402	1.7608	5.7713	0.7734
Std. Dev.	0.0008	2274.643	4.1454	0.5042	0.7292
Skewness	0.1784	-4.1393	-17.9759	1.4969	0.1941
Kurtosis	2.6520	26.5266	4.0207	4.0225	1.9962
JB Normality test	16.1870 (0.0003)***	40535.77 (0.0000)***	104.6250 (0.0000)***	652.1871 (0.0000)***	75.4872 (0.0000)***
Stratum B: Correlation Matrix					
(P_t)	1.0000	0.1416	-0.1636	-0.2243	0.6909
(X_t)	0.1416	1.0000	0.0096	-0.0962	0.1701
$(i_t - i_{tf})$	-0.1636	0.0096	1.0000	-0.0181	-0.1041
$(l_t - l_{tf})$	-0.2243	-0.0962	-0.0181	1.0000	-0.5563
$(R_t - R_{tf})$	0.6909	0.1701	-0.1041	-0.5563	1.0000
PANEL D: SINGAPORE					
Stratum A: Summary Statistics					
Observations	1564	1564	1564	1564	1564
Mean	0.7746	-16447.30	-0.0491	-0.2294	0.6739
Std. Dev.	0.0351	71045.87	0.1199	0.2588	0.3019
Skewness	-0.6321	-0.5104	3.0477	-0.0237	-1.8059
Kurtosis	2.1505	4.1925	19.4422	3.2011	5.0899
JB Normality test	151.1892 (0.0000)***	160.5860 (0.0000)***	20038.77 (0.0000)***	2.7818 (0.2489)	1134.832 (0.0000)***
Stratum B: Correlation Matrix					
(P_t)	1.0000	0.1558	-0.3013	-0.3255	0.5270
(X_t)	0.1558	1.0000	-0.1377	-0.0802	0.2103
$(i_t - i_{tf})$	-0.3013	-0.1377	1.0000	0.5089	-0.6587
$(l_t - l_{tf})$	-0.3255	-0.0802	0.5089	1.0000	-0.6433
$(R_t - R_{tf})$	0.5270	0.2103	-0.6587	-0.6433	1.0000
PANEL E: THAILAND					
Stratum A: Summary Statistics					
Observations	1564	1564	1564	1564	1564
Mean	0.0315	5968.590	2.0283	1.8890	0.5710
Std. Dev.	0.0015	6707.127	0.6896	0.5895	0.3620
Skewness	-0.6319	0.5803	-0.1782	-0.6090	-0.2129
Kurtosis	3.2438	2.5968	2.0901	2.6745	1.6933
JB Normality test	107.9754 (0.0000)***	98.3938 (0.0000)***	62.2237 (0.0000)***	103.5845 (0.0000)***	123.0695 (0.0000)***
Stratum B: Correlation Matrix					
(P_t)	1.0000	0.2185	0.5721	0.6193	0.3843
(X_t)	0.2185	1.0000	-0.0926	-0.1395	-0.0538
$(i_t - i_{tf})$	0.5721	-0.0926	1.0000	0.9341	0.7641
$(l_t - l_{tf})$	0.6193	-0.1395	0.9341	1.0000	0.6531
$(R_t - R_{tf})$	0.3843	-0.0538	0.7641	0.6531	1.0000

Notes: The table presents the summary of descriptive statistics, then correlation matrix of the major items; P_t transaction price, X_t daily accumulated currency order flow,$(i_t - i_{tf})$ differential in interest rate for short-term period,$(l_t - l_{tf})$ differential in interest rate for long-term period and$(R_t - R_{tf})$ difference in the country risk premium. 1% level is denoted by *** represent the level of statistical significance.

The correlation matrix results show that short-term interest and long-term interest have negative relationship with the exchange rate in Malaysia, Singapore and the Philippines, while, there is a positive relation between exchange rate, currency order flow and country risk difference. In Indonesia, the results show that short-term interest, long-term interest and country risk difference that have negative relationship with the exchange rate, while, there is a positive relation between exchange rate and currency order flow. However, in Thailand, there exists positive relationship between the exchange rate and all the variables in the system. Meaning that, the diffusion progression of the Thailand foreign exchange market and money market is firm. Therefore, the extent to which interaction exists amongst these variables needs further investigation.

5.2 Cointegration Analyses and Granger Causality Test

Table 5.3 reports the results of Johansen cointegration tests for all the countries in the sample. The cointegration rank test namely Trace and maximum eigenvalue statistics that analyze the propositions of at maximum g number of cointegrating relations of the key variables. The subscript g denotes the number of significant cointegrating vectors. The results show that, for all the countries in the sample, two cointegrating relationships exist at 1% level of statistical significance, based on the full sample. Therefore, at 1% significance level, the null hypothesis $L_0: \mathrm{g} \leq \mathrm{II}$ cannot be rejected.

Table **5.3: Cointegration Analyses with Levels (Ranks)**

PANEL A: INDONESIA					
Levels (ranks)	$L_0: \mathrm{g} \leq \mathrm{NIL}$	$L_0: \mathrm{g} \leq \mathrm{I}$	$L_0: \mathrm{g} \leq \mathrm{II}$	$L_0: \mathrm{g} \leq \mathrm{III}$	$L_0: \mathrm{g} \leq \mathrm{IV}$
Eigenvalue	0.0836	0.0286	0.0098	0.0011	0.0003
Log likelihood	14729.15	14752.55	14775.20	14782.95	14783.82
Trace test	198.8695	62.5331	17.2286	1.7403	0.0053
Crit. Value (0.05)	69.8189	47.8561	29.7970	15.4941	3.8414
Probability	(0.0000)***	(0.0012)***	(0.6231)	(0.9976)	(0.9411)
Max-Eigen	136.3363	45.3046	15.4881	1.7350	0.0053
Crit. Value (0.05)	33.8769	27.5843	21.1316	14.2646	3.8414
Probability	(0.0000)***	(0.0001)***	(0.2562)	(0.9955)	(0.9411)
Table 5.3: Cointegration Analyses with Levels (Ranks) Continued					

PANEL B: MALAYSIA					
Eigenvalue	0.1379	0.0211	0.0161	0.0049	0.0003
Log likelihood	2694.781	2710.318	2726.230	2738.344	2742.037
Trace test	285.2089	63.8831	32.0589	7.8313	0.4453
Crit. Value (0.05)	69.8189	47.8561	29.7971	15.4947	3.8415
Probability	(0.0001)***	(0.0008)***	(0.0270)**	(0.4836)	(0.5046)
Max-Eigen	221.3258	31.8243	24.2276	7.3860	0.4453
Crit. Value (0.05)	33.8769	27.5843	21.1316	14.2646	3.8415
Probability	(0.0001)***	(0.0134)***	(0.0177)**	(0.4445)	(0.5046)
PANEL C: PHILIPPINES					
Eigenvalue	0.1000	0.0647	0.0117	0.0061	0.0006
Log likelihood	-642.3083	-619.1307	-566.9707	-557.8355	-553.0887
Trace test	297.3080	132.9948	28.6747	10.4044	0.9107
Crit. Value (0.05)	69.8189	47.8561	29.7971	15.4947	3.8415
Probability	(0.0001)***	(0.0000)***	(0.0669)	(0.2509)	(0.3399)
Max-Eigen	164.3132	104.3201	18.2703	9.4937	0.9107
Crit. Value (0.05)	33.8769	27.5843	21.1316	14.2646	3.8415
Probability	(0.0001)***	(0.0000)***	(0.1201)	(0.2473)	(0.3399)
PANEL D: SINGAPORE					
Eigenvalue	0.1516	0.1120	0.0083	0.0032	0.0011
Log likelihood	-3302.336	-3371.229	-3278.633	-3272.162	-3269.668
Trace test	461.2548	204.8738	19.6819	6.7387	1.7516
Crit. Value (0.05)	69.8189	47.8561	29.7971	15.4947	3.8415
Probability	(0.0001)***	(0.0000)***	(0.4447)	(0.6082)	(0.1857)
Max-Eigen	256.3810	185.1918	12.9432	4.9872	1.7516
Crit. Value (0.05)	33.8769	27.5843	21.1316	14.2646	3.8415
Probability	(0.0001)***	(0.0001)***	(0.4575)	(0.7435)	(0.1857)
PANEL E: THAILAND					
Eigenvalue	0.0599	0.0180	0.0097	0.0084	0.0005
Log likelihood	4118.685	4132.637	4146.870	4154.549	4161.202
Trace test	153.6605	57.2116	28.7464	13.3888	0.0812
Crit. Value (0.05)	69.8189	47.8561	29.7970	15.4947	3.8414
Probability	(0.0000)***	(0.0052)***	(0.0657)	(0.1013)	(0.7756)
Max-Eigen	96.4488	28.4651	15.3575	13.3076	0.0812
Crit. Value (0.05)	33.8769	27.5843	21.1316	14.2646	3.8414
Probability	(0.0000)***	(0.0385)**	(0.2646)	(0.0704)	(0.7756)

Notes: The table reports the result of Johansen cointegration analyses. The cointegration rank test (trace and maximum eigenvalue statistics) analyze the propositions of at maximum *g* number of cointegrating relations of the key variables. *g* denotes the cointegrating vectors number of significance. 5% and 1% level is denoted by ** and *** represent the level of statistical significance.

Table 5.4 shows the results of the uniqueness of the cointegrating relationships of the variable space tested in the VAR specification. i.e. $H_t'=f\,[P_t\,,\quad X_t\,,\,(i_t-i_{tf})\,,\,(l_t-l_{tf})\quad,R_t\,,\,R_{tf},\,Trend\,]$. Among the hypotheses tested, H_1 tests the cointegrating relationships if there exists any trend, but, excluding the trend from the model, the null hypothesis that asserts that there is no cointegrating relationship among the variables in the model is rejected for all the countries in the sample. For example, the p-value of 0.0761 is rejected for Indonesia, p-value of 0.0606 is rejected for Malaysia, the p-value

of 0.0932 is rejected for the Philippines, the p-value of 0.0486 is rejected for Singapore and for Thailand, the p-value of 0.0306 is rejected when the trend is excluded from the model. Therefore, there exists cointegrating relationship among the variables in the model for all the countries' in the sample.

Table 5.4: Cointegrating Equations Restriction Tests

	P_t	X_t	$(i_t - i_{tf})$	$(l_t - l_{tf})$	R_t	R_{tf}	Trend
PANEL A: INDONESIA							
Unrestricted:							
β_1	0.0018	0.0001	-557.514	306.6738	224.1470	170.1429	0.0005
β_2	1.0000	-0.0002	0.0002	0.0003	-0.0002	-0.00014	0.0009
H_1: Trend = 0, χ^2 (2) = 5.1518 [0.0761]*							
β_1	-0.0042	-0.2630	-17.0845	32.1655	22.8851	3.2772	0.00
β_2	1.0000	-0.2629	5.3301	4.2701	-761.732	-105.6557	0.00
H_2: $P_t = -X_t$, χ^2 (2) = 7.9347 [0.0189]**							
β_1	-0.0044	0.0044	-9.3701	-3.1001	5.6401	9.1601	-0.0075
β_2	1.0000	-1.0000	-1.7801	-3.5601	-1.6001	-2.3901	0.0065
H_3: $(i_t - i_{tf}) = -(l_t - l_{tf})$, χ^2 (2) = 19.0020 [0.0008]***							
β_1	-0.0061	1.2301	1.0000	-1.0000	2.1701	-0.00011	0.0031
β_2	1.0000	-0.2813	-238.8896	238.8896	-3.0475	-6.2196	0.0006
H_4: $(i_t - i_{tf}) = -(l_t - l_{tf})$, Trend = 0 χ^2 (4) = 26.7083 [0.0002]***							
β_1	-0.0052	1.1908	1.0000	-1.0000	-1.3842	-5.2786	0.00
β_2	1.0000	-0.2820	-0.0398	0.0398	-1.2270	0.9356	0.00
H_5: $R_t = -R_{tf}$, χ^2 (2) = 7.9047 [0.1951]							
β_1	-0.0071	-0.2833	3.3101	1.3555	1.0000	-1.0000	-0.0016
β_2	1.0000	-0.2782	-0.0411	0.0110	-0.0298	0.0298	0.0001
H_6: $R_t = -R_{tf}$, Trend = 0 χ^2 (4) = 13.0824 [0.0014]***							
β_1	0.0013	1.2801	3.7200	0.0177	1.0000	-1.0000	0.00
β_2	1.0000	-0.2782	0.0619	1.2901	-0.0494	0.0494	0.00
PANEL B: MALAYSIA							
Unrestricted:							
β_1	0.5808	-0.0283	1.0000	6.6361	0.1405	-0.6056	-0.0041
β_2	1.0000	-0.0249	0.0258	-0.2168	-0.3805	-0.0460	0.0015
H_1: Trend = 0, χ^2 (2) = 14.9265 [0.0606]*							
β_1	5.4624	-0.0419	1.0000	8.9061	-0.8289	-0.9066	0.00
β_2	1.0000	-0.0350	-4.1204	-0.4613	-0.9645	3.6627	0.00
H_2: $P_t = -X_t$, χ^2 (2) = 77.9526 [0.0000]***							
β_1	-0.0283	0.0283	1.0000	9.4724	0.8978	0.3361	-0.0051
β_2	1.0000	-1.0000	512.28	-27.969	-787.94	903.20	-0.0828
H_3: $(i_t - i_{tf}) = -(l_t - l_{tf})$, χ^2 (2) = 15.4072[0.0517]**							
β_1	-46.133	0.0481	1.0000	-1.0000	16.277	2.4902	-0.0734
β_2	1.0000	0.0314	-279.69	279.69	22.798	73.463	-0.0920
H_4: $(i_t - i_{tf}) = -(l_t - l_{tf})$, Trend = 0 χ^2 (4) = 24.2126 [0.0027]***							
β_1	3.0611	-0.0152	1.0000	-1.0000	-3.3618	- 0.6070	0.00
β_2	1.0000	-0.0089	-4.1952	4.1952	0.0135	2.0234	0.00
H_5: $R_t = -R_{tf}$, χ^2 (2) = 9.6730 [0.2887]							
β_1	2.9205	-0.0350	6.9462	35.3809	1.0000	-1.0000	-0.0585
β_2	1.0000	-0.0283	-0.3274	0.4724	-0.4902	0.4902	0.0003
H_6: $R_t = -R_{tf}$, Trend = 0 χ^2 (4) = 23.8440[0.0930]*							
β_1	-2.0920	0.0585	9.7631	0.4623	1.0000	-1.0000	0.00
β_2	1.0000	-0.0283	0.4972	3.4519	-0.4248	0.4248	0.00
Table 5.4: Cointegrating Equations Restriction Tests. Continued							
PANEL C: PHILIPPINES							

Unrestricted:							
β_1	0.0423	-0.0595	1.0000	4.3924	0.1842	-1.1103	-0.0078
β_2	1.0000	-0.0416	0.0338	0.0139	-0.4556	-1.0107	0.0010
H_1: Trend = 0, χ^2 (2) = 4.7466 [0.0932]*							
β_1	3.2637	-0.6232	1.0000	5.3095	-1.8068	-1.3732	0.00
β_2	1.0000	-0.4331	-7.0051	-1.9029	-1.1582	0.2286	0.00
H_2: $P_t = -X_t$, χ^2 (2) = 9.9219 [0.0102]***							
β_1	-0.0847	0.0847	1.0000	6.7336	0.6762	0.1648	-0.0097
β_2	1.0000	-1.0000	264.240	-49.760	-1135.038	682.1578	-0.0966
H_3: $(i_t - i_{tf}) = -\ (l_t - l_{tf})$, χ^2 (2) = 18.1364 [0.0045]***							
β_1	-67.0008	0.0304	1.0000	-1.0000	10.5041	1.5461	-0.0846
β_2	1.0000	0.0102	-682.1578	682.1578	13.7867	50.5150	-0.0966
H_4: $(i_t - i_{tf}) = -\ (l_t - l_{tf})$, Trend = 0 χ^2 (4) = 25.2041 [0.0008]***							
β_1	1.6659	-0.0289	1.0000	-1.0000	-5.4243	-1.2807	0.00
β_2	1.0000	-0.0103	-2.9705	2.9705	0.0057	0.3039	0.00
H_5: $R_t = -R_{tf}$, χ^2 (2) = 5.2308 [0.1557]							
β_1	1.4514	-0.0802	4.2985	25.9246	1.0000	-1.0000	-0.0938
β_2	1.0000	-0.0529	-0.5486	0.2620	-1.1374	1.1374	0.0002
H_6: $R_t = -R_{tf}$, Trend = 0 χ^2 (4) = 12.9887 [0.0025]***							
β_1	-5.2299	0.0253	6.7001	0.1895	1.0000	-1.0000	0.00
β_2	1.0000	-0.0765	0.1971	1.9878	-0.7016	0.7016	0.00
PANEL D: SINGAPORE							
Unrestricted:							
β_1	0.2524	-0.0448	1.0000	2.7059	0.0838	-0.2828	-0.0099
β_2	1.0000	-0.0406	0.0124	-0.0342	-0.0466	-0.0230	0.0044
H_1: Trend = 0, χ^2 (2) = 6.0473 [0.0486]**							
β_1	7.2258	-0.0801	1.0000	1.9257	-0.2494	-0.5287	0.00
β_2	1.0000	-0.0664	-2.1798	-0.0896	-0.4337	2.1169	0.00
H_2: $P_t = -X_t$, χ^2 (2) = 56.1098 [0.0000]***							
β_1	-0.0483	0.0483	1.0000	3.1003	0.5073	0.1653	-0.0098
β_2	1.0000	-1.0000	61.5734	-14.4033	-4.5371	-11.0477	-0.0342
H_3: $(i_t - i_{tf}) = -\ (l_t - l_{tf})$, χ^2 (2) = 9.3228 [0.0535]*							
β_1	-24.9467	0.0736	1.0000	-1.0000	3.1054	-5.0755	-0.0447
β_2	1.0000	0.0565	-13.7279	13.7279	2.4829	-3.0961	-0.0512
H_4: $(i_t - i_{tf}) = -\ (l_t - l_{tf})$, Trend = 0 χ^2 (4) = 12.7417 [0.0735]*							
β_1	5.3493	-0.0106	1.0000	-1.0000	-1.4259	-0.0484	0.00
β_2	1.0000	-0.0017	- 1.2843	1.2843	0.0018	1.0627	0.00
H_5: $R_t = -R_{tf}$, χ^2 (2) = 3.4589 [0.1774]							
β_1	4.2484	-0.0828	12.8628	2.2693	1.0000	-1.0000	-0.0332
β_2	1.0000	-0.0552	-1.4478	-1.0683	-2.3724	2.3724	0.0055
H_6: $R_t = -R_{tf}$, Trend = 0 χ^2 (4) = 8.5315 [0.0362]**							
β_1	-4.1784	0.2924	3.7779	0.1169	1.0000	-1.0000	0.00
β_2	1.0000	-0.1279	0.6428	1.6971	- 2.1451	2.1451	0.00
PANEL E: THAILAND							
Unrestricted:							
β_1	0.0293	-0.5517	1.0000	9.1388	0.4277	0.7567	-0.0069
β_2	1.0000	-0.5149	0.0917	0.0132	-0.0927	-0.0163	0.0023
H_1: Trend = 0, χ^2 (2) = 14.9229 [0.0306]**							
β_1	1.8075	-1.1938	1.0000	19.0354	-1.1606	-2.0776	0.00
β_2	1.0000	-1.1185	-9.9121	-0.2688	-2.7837	7.9653	0.00
H_2: $P_t = -X_t$, χ^2 (2) = 105.0275 [0.0000]***							
β_1	-0.5517	0.5517	1.0000	19.1294	1.8543	0.8444	-0.0092
β_2	1.0000	-1.0000	941.0245	-33.1633	-1328.486	1805.02	-0.0305
H_3 : $(i_t - i_{tf}) = -\ (l_t - l_{tf})\chi^2$ (2) = 14.6781 [0.0007]***							
β_1	-73.0535	0.0693	1.0000	-1.0000	28.0038	3.5418	0.0035
β_2	1.0000	0.0599	-429.469	429.469	35.0770	125.170	-0.0019
H_4: $(i_t - i_{tf}) = -\ (l_t - l_{tf})$Trend = 0 χ^2 (4) = 45.4268 [0.0000]***							
β_1	5.3147	-0.0200	1.0000	-1.0000	-5.1972	-1.2204	0.00
β_2	1.0000	-0.0116	-7.2101	7.2101	0.0259	4.3515	0.00
H_5: $R_t = -R_{tf}$, χ^2 (2) = 1.4144 [0.4930]							
β_1	6.7824	-1.1185	11.7625	48.0946	1.0000	-1.0000	-0.0019
β_2	1.0000	-0.5517	-0.6731	0.7561	-0.7898	0.7898	0.0040
Table 5.4: Cointegrating Equations Restriction Tests. Continued							
H_6: $R_t = -R_{tf}$, Trend = 0 χ^2 (4) = 17.4864 [0.0016]***							

β_1	-5.3786	0.0019	17.2705	0.6696	1.0000	-1.0000	0.00
β_2	1.0000	-0.5517	0.7262	6.7386	-0.7469	0.7469	0.00

Notes: The results of cointegrating relationships among of key variables with and without trends. *, **, *** indicate statistical significance at the 10%, 5%, and 1% level.

Furthermore, this thesis tests the long-run cointegrating relationships between exchange rate and currency order flow ($P_t = -X_t$) , interest rate spread $(i_t - i_{tf}) = -(l_t - l_{tf})$, and country risk difference $R_t = - R_{tf}$ using hypotheses H_2 to H_6. For Indonesia, H_5 with p-value of 0.1951 is accepted from the test results. For Malaysia, the p-value of 0.2887 is accepted from the test results. While the p-value of 0.1557 is accepted from the Philippines test results. Likewise, for Singapore, the p-value of 0.1774 is accepted. In Thailand, the p-value of 0.4930 is accepted from the test results. These results show that there exists a relationship between exchange rate and country risk premium (difference) in all the countries in the sample.

The optimal lag length is of automatic specification (fourth order lag structure) based on the Schwarz information criterion (SIC) and the Akaike information criterion (AIC) with maximum lag of 23.

Table 5.5 presents the results of Granger causality tests and long-run weak exogeneity test of the key variables for all the countries in the sample. The results show that exchange rate Granger causes order flow and vice-versa for Malaysia, Singapore and Thailand. This implies that there exists bidirectional causality. However, for Indonesia and the Philippines, currency order flow Granger causes exchange rate, but exchange rate do not Granger causes currency order flow. This shows that there exists unidirectional causality from currency order flow to exchange rate fluctuations of USD/IDR and USD/PHP respectively.

Table 5.5: Granger causality /long-run weak exogeneity test

	P_t	X_t	$(i_t - i_{tf})$	$(l_t - l_{tf})$	$(R_t - R_{tf})$
PANEL A: INDONESIA					
X^2 (4)	24.7288	46.4101	180.3600	40.8304	56.3694
Probability	(0.0748)*	(0.0001)***	(0.0000)***	(0.0006)***	(0.0000)***
PANEL B: MALAYSIA					
X^2 (4)	50.0451	86.3955	24.2127	76.1340	23.8441
Probability	(0.0000)***	(0.0000)***	(0.0850)*	(0.0000)***	(0.0930)*
PANEL C: PHILIPPINES					
X^2 (4)	26.6791	55.5750	65.3056	492.5363	26.7121
Probability	(0.0452)**	(0.0000)***	(0.0000)***	(0.0000)***	(0.0448)**
PANEL D: SINGAPORE					
X^2 (4)	38.7668	66.3071	116.7915	115.8382	37.9501
Probability	(0.0012)***	(0.0000)***	(0.0000)***	(0.0000)***	(0.0015)***
PANEL E: THAILAND					
X^2 (4)	48.2478	82.4138	36.3023	25.2877	37.0779
Probability	(0.0000)***	(0.0000)***	(0.0026)***	(0.0649)*	(0.0020)***

Notes: This table present the results of Granger causality tests and long-run weak exogeneity test of the key variables. 10%, 5% and 1% level is denoted by *, ** and *** represent the level of statistical significance.

Table 5.6 presents the results of hypotheses tests on the cointegrating relationship amongst the variables with their cointegrating coefficients, adjustment coefficients α, and their standard errors. Based on the results of the p-values for the long-run beta, none of the variables appears weak in the model.

Table 5.6: Long-Run Formation

	P_t	X_t	$(i_t - i_{tf})$	$(l_t - l_{tf})$	$(R_t - R_{tf})$
PANEL A: INDONESIA					
Cointegrating vector. β	-2.0261 -1.0000	-0.6302 0.0017	1.0000 2.6774	3.8492 -1.0000	0.6484 1.0000
Feedback coefficients (α) with 2 ranks	0.0229 (0.0256) -0.0519 (0.0256)	815.4988 (107.857) -142.9708 (116.147)	-0.0086 (0.0026) 0.0037 (0.0024)	0.0029 (0.0008) -0.0006 (0.0008)	0.0035 (0.0009) -0.0014 (0.0009)
PANEL B: MALAYSIA					
Cointegrating vector. β	-2.4023 -1.0000	-0.0508 0.0055	1.0000 3.6487	-4.5074 -1.0000	-0.8878 1.0000
Feedback coefficients (α) with 2 ranks	0.0021 (0.0008) -0.0003 (0.0002)	30319.57 (2291.11) -2093.856 (525.556)	-0.0012 (0.0192) -0.0107 (0.0044)	0.0176 (0.0122) -0.0019 (0.0028)	-0.0467 (0.0143) -0.0013 (0.0033)
PANEL C: PHILIPPINES					
Cointegrating vector. β	-6.7001 -1.0000	-0.0745 0.0026	1.0000 4.2552	-1.5142 1.0000	-1.8112 1.0000
Feedback coefficients (α) with 2 ranks	0.0003 (0.0005) -0.0008 (0.0075)	3018.714 (1462.19) -2872.508 (3700.49)	-0.0095 (0.0101) 0.0056 (0.0082)	0.0140 (0.0604) -0.0041 (0.0609)	-0.0807 (0.0267) -0.0026 (0.0034)

Table 5.6: Long-Run Formation. Continued					
PANEL D : SINGAPORE					
Cointegrating vector. β	-1.9145 -1.0000	-0.0114 0.0035	1.0000 1.2438	2.0355 -1.0000	-0.3046 1.0000
Feedback coefficients (α) with 2 ranks	0.0107 (0.0059) -0.0160 (0.0074)	274237.9 (142448) -46453.18 (33396.3)	-0.0044 (0.0141) -0.0160 (0.0074)	0.0271 (0.0141) -0.0034 (0.0079)	-0.0065 (0.0060) -0.0003 (0.0063)
PANEL E: THAILAND					
Cointegrating vector. β	-10.1159 -1.0000	-0.0169 0.0027	1.0000 2.3142	-5.1350 -1.0000	-2.1321 1.0000
Feedback coefficients (α) with 2 ranks	0.0007 (0.0012) -0.0002 (0.0002)	14122.66 (8381.94) -1251.773 (109.258)	-0.0041 (0.0016) 0.0015 (0.0013)	0.0077 (0.0034) -0.0132 (0.0034)	0.0030 (0.0007) 0.0091 (0.0029)

Notes: The table reports the outcome of hypotheses test on the cointegrating relationship amongst the variables. The cointegration coefficients β and adjustment coefficients α with their standard errors in ( ), and consider 1 to 4 lag interval.

Therefore, for each country in the sample, level data can be formulated with the following cointegrating equations:

Indonesia:

$$\mathcal{U}_i = -P_t + 0.0017 * X_t + 2.6774 * (i_t - i_{tf}) - (l_t - l_{tf}) + (R_t - R_{tf}) ; \quad (5.3.1a)$$

$$\mathcal{U}_{ii} = -2.0261 * P_t - 0.6302 * X_t + (i_t - i_{tf}) + 3.8492 * (l_t - l_{tf}) + 0.6484 * (R_t - R_{tf}) \quad (5.3.1b)$$

Malaysia:

$$\mathcal{U}_i = -P_t + 0.0055 * X_t + 3.6487 * (i_t - i_{tf}) - (l_t - l_{tf}) + (R_t - R_{tf}) ; \quad (5.3.2a)$$

$$\mathcal{U}_{ii} = -2.4023 * P_t - 0.0508 * X_t + (i_t - i_{tf}) - 4.5074 * (l_t - l_{tf}) - 0.8878 * (R_t - R_{tf}) \quad (5.3.2b)$$

Philippines:

$$\mathcal{U}_i = -P_t + 0.0026 * X_t + 4.2552 * (i_t - i_{tf}) + (l_t - l_{tf}) + (R_t - R_{tf}); \quad (5.3.3a)$$

$$\mathcal{U}_{ii} = -6.7001 * P_t - 0.0745 * X_t + (i_t - i_{tf}) - 1.5142 * (l_t - l_{tf}) - 1.8112 * (R_t - R_{tf}) \quad (5.3.3b)$$

Singapore:

$$\mathcal{U}_i = -P_t + 0.0035 * X_t + 1.2438 * (i_t - i_{tf}) - (l_t - l_{tf}) + (R_t - R_{tf}) ; \quad (5.3.4a)$$

$$\mathcal{U}_{ii} = -1.9145 * P_t - 0.0114 * X_t + (i_t - i_{tf}) + 2.0355 * (l_t - l_{tf}) - 0.3046 * (R_t - R_{tf}) \quad (5.3.4b)$$

Thailand:

$$\mathcal{U}_i = -P_t + 0.0027 * X_t + 2.3142 * (i_t - i_{tf}) - (l_t - l_{tf}) + (R_t - R_{tf}) ; \quad (5.3.5a)$$

$$\mathcal{U}_{ii} = -10.1159 * P_t - 0.0169 * X_t + (i_t - i_{tf}) - 5.1350 * (l_t - l_{tf}) - 2.1321 * (R_t - R_{tf}) \quad (5.3.5b)$$

The currency order flow is positively significant for all the countries in the sample; implying that there would be higher domestic currency price of IDR, MYR, PHP, SGD and THB against the US dollar once there is a higher imbalance currency position in the net buying activity in the ASEAN-5 countries foreign exchange markets. Likewise, with a beta coefficient of 0.0017 in the USD/IDR; 0.0055 in the USD/MYR; 0.0026 in the USD/PHP; 0.0035 in the USD/SGD and 0.0027 in the USD/THB exchange rate calculations, it connotes that, for every currency order flow increasing at 1%, there would be a corresponding increase within the day transactions, 17 basis points of the IDR price against the US dollar; 55 basis points of the MYR price against the US dollar; 26 basis points of the PHP price against the US dollar; 35 basis points of the SGD price against the US dollar and 27 basis points of the THB price against the US dollar, respectively.

Table 5.7 shows the result of the short-run VECM estimates for ΔP_t , ΔX_t and $\Delta(R_t - R_{tf})$. Insignificant variables were removed from the model, thereby reducing it to partial VECM for all the countries in the sample. The short-term correction results are

negatively significant at 10% level with a coefficient error correction term θ of -0.0625 for Indonesia and the Philippines (-0.0807). However, for Malaysia (-0.0413), Singapore (-0.0232) and Thailand (-0.0330), the short-term correction results are negatively significant at 5% level.

Table 5.7: Error Correction Modeling Estimates

	ΔP_t	ΔX_t	$\Delta(R_t - R_{tf})$
PANEL A: INDONESIA			
Constant	0.0464 (0.0257)	-0.1945 (0.0332)	-
α_1	-0.0209*** (0.0138)	-0.1287** (0.0254)	- 0.0165 (0.0095)
α_2	-	0.2495** (0.0251)	-
α_3	-	-	- 0.0217 (0.0094)
β_1	-0.0721 (0.0365)	-	-
β_2	-0.0433*** (0.0257)	-	-
θ	-0.0625* (0.0039)	-0.4137*** (0.0359)	-
φ_3	-	-	-0.0250** (0.0091)
λ_1	-	-	-7.0988** (3.6648)
λ_2	-	-	-26.5115*** (7.7608)
λ_3	-	-	-25.6851*** (13.5182)
δ_1	-	-	-0.1954*** (0.0332)
δ_2	-	-	-0.0618** (0.0415)
δ_3	-	-	-0.0198** (0.0257)
R^2	0.1177	0.2141	0.2405
PANEL B: MALAYSIA			
Constant	0.0311 (0.0259)	-0.1419 (0.0495)	-
α_1	-0.0912*** (0.0409)	-0.1480** (0.0637)	-0.8780 (0.4389)
α_2	-	0.1442** (0.0601)	-
α_3	-	-	-0.8346 (0.3490)
β_1	-0.5520 (0.1520)	-	-
β_2	-1.0847** (0.3637)	-	-
θ	-0.0413** (0.0014)	-0.5215 *** (0.0361)	-
φ_3	-	-	0.9182*** (0.1534)
λ_1	-	-	-10.2205** (4.8070)
λ_2	-	-	15.6880*** (7.9193)
λ_3	-	-	-44.7526*** (10.6702)
δ_1	-	-	-0.4058*** (0.6661)
δ_2	-	-	-0.3860*** (0.0260)
δ_3	-	-	-0.1558*** (0.0301)
R^2	0.1669	0.3683	0.3773
PANEL C: PHILIPPINES			
Constant	0.0412 (0.0254)	-0.2678 (0.0342)	-
α_1	-0.1017*** (0.0255)	-0.1743** (0.0869)	-0.2266 (0.1009)
α_2	-	0.1739** (0.0869)	-
α_3	-	-	-0.2066 (0.0909)
β_1	-0.9445 (0.2668)	-	-
β_2	-1.3026** (0.4343)	-	-
θ	-0.0807* (0.0267)	-0.8641*** (0.0666)	
φ_3	-	-	0.7646*** (0.0604)
λ_1	-	-	-13.7001** (10.2597)
λ_2	-	-	14.6563*** (10.2872)
λ_3	-	-	-39.5061*** (33.5022)
δ_1	-	-	-0.3352*** (0.6767)
δ_2	-	-	-0.1352*** (0.0087)
δ_3	-	-	-0.1445*** (0.0285)
R^2	0.0546	0.1045	0.1983

Table 5.7: Error Correction Modeling Estimates. Continued

PANEL D: SINGAPORE			
Constant	0.1128 (0.0430)	-0.2074 (1.2082)	-
α_1	-0.0011*** (0.0256)	-0.1092** (0.0482)	-0.0697 (0.0255)
α_2	-	0.1007** (0.0430)	-
α_3	-	-	-0.0761 (0.1925)
β_1	-0.8542 (0.1926)	-	-
β_2	-1.3113** (0.5441)	-	-
θ	-0.0232** (0.0214)	-0.3102*** (0.0568)	-
φ_3	-	-	0.2132*** (0.1926)
λ_1	-	-	-0.1709*** (0.0255)
λ_2	-	-	0.0835* (0.0309)
λ_3	-	-	-0.2874*** (0.1095)
δ_1	-	-	-0.1828*** (0.0601)
δ_2	-	-	-0.1548*** (0.1166)
δ_3	-	-	-0.1283*** (0.0888)
R^2	0.1879	0.3057	0.2765
PANEL E: THAILAND			
Constant	0.0425 (0.0262)	-0.1711 (0.3506)	-
α_1	-0.0564*** (0.0264)	-0.0963*** (0.0208)	-1.9240 (0.3181)
α_2	-	0.1666** (0.0319)	-
α_3	-	-	-1.5819 (0.3400)
β_1	-0.4585 (0.0693)	-	-
β_2	-0.9998 (0.2544)	-	-
θ	-0.0330** (0.0013)	-0.4104*** (0.0264)	-
φ_3	-	-	0.6683*** (0.0294)
λ_1	-	-	-12.0587** (3.3127)
λ_2	-	-	11.6286*** (8.8983)
λ_3	-	-	-51.4493*** (20.0920)
δ_1	-	-	-0.5989*** (0.7286)
δ_2	-	-	-0.3147*** (0.0287)
δ_3	-	-	-0.1774*** (0.0232)
R^2	0.1280	0.2478	0.3044

The table reports the result of the estimates for ΔP_t , ΔX_t and $\Delta(R_t - R_{tf})$ of the short-run vector error correction model.10%, 5% and 1% level is denoted by *, ** and *** represent the level of statistical significance. Standard errors are shown in ( ).

The results indicate that in all the ASEAN-5 countries' foreign exchange markets, currency order flow Granger causes exchange rate fluctuations in the short-term. Likewise, currency order flow speed of adjustment on the long-run relation is negative and significant for all the countries in the sample (Indonesia, -0.0209***; Malaysia, -0.0912***; Philippines, -0.1017***; Singapore, -0.0011***; and Thailand, -0.0564***). This implies that, an important factor influencing exchange rate fluctuations is currency order flow in the ASEAN-5 countries' foreign exchange markets.

The R^2 obtained for all the countries in the sample are relatively low compared with Evans and Lyons (2002a) 0.64 and 0.46. For example, in the Indonesia foreign exchange market, the R^2 obtained is almost 0.12. In Malaysia, the R^2 obtained is approximately

0.17. Likewise, the R^2 obtained is approximately 0.06 in the Philippines; while in Singapore, the R^2 obtained is almost 0.19. Furthermore, in Thailand, the R^2 obtained is 0.13. One of the major reasons for these relatively low $R^{2\prime}s$ is that, the level at which the currencies of emerging economies being traded in the international market are relatively low compared with the world major currencies of the developed markets. In addition, most of the emerging economies (including ASEAN-5 countries) do not operate free-floating rather managed floating exchange rate regime, which may lead to frequent occurrence of market intervention by the monetary authorities. Therefore, these may account for the difference in the results with that of Evans and Lyons (2002a). Nevertheless, the results are in line with other results of developed and emerging markets. For example, De-Medeiros (2004) while analyzing order flow in the Brazilian foreign exchange markets obtained an R^2 of 0.06 on USD/Real. Likewise, Cerrato et al. (2011) when investigated the extent to which customer order flow analysis may explain exchange rate movements over and above the macroeconomic variables. Zhang et al. (2013) when they examine the influential role of currency order flow on exchange rate fluctuations between Chinese RMB and US dollar (USD/RMB), obtained an R^2 of 0.13. Other empirical studies finding in line with these results include Evans and Lyons, (2005),Marsh and Rourke (2005), Sager and Taylor (2008); Evans, (2010); Rime et al., (2010).

5.3 Forecast Error Variance Decomposition

In testing the strength of the relationship at longer horizons, this thesis considers 10 trading days as two weeks, 20 trading days as 4 weeks and 30 trading days as 6 weeks. Therefore, this thesis tests with Cholesky decomposition for a time horizon of 30 trading

days. Table 5.8 reports the results of decomposition of each item forecast error variance in the specification for all the countries in the sample. That is, the variance decomposition of exchange rate fluctuations relative to other items in the specification. The results show that currency order flow is the most exogenous variable relative to other variables in the specification.

Table 5.8: Variance Decomposition of Exchange Rate

Period	Standard error	P_t	X_t	$(i_t - i_{tf})$	$(l_t - l_{tf})$	$(R_t - R_{tf})$
PANEL A: INDONESIA						
10	0.000199	95.9434	5.1352	0.5154	0.8273	3.1498
20	0.000287	92.1171	6.3151	1.3466	0.6297	1.7619
30	0.000357	88.6629	6.6250	2.2249	0.3700	0.6192
PANEL B: MALAYSIA						
10	0.004547	96.1204	13.3680	0.0653	0.1790	5.9001
20	0.005744	94.2066	20.6703	0.2966	0.0929	5.4960
30	0.007843	91.4263	24.2662	0.3250	0.0682	5.3530
PANEL C: PHILIPPINES						
10	0.000242	96.3422	4.0818	1.0199	0.9174	3.8584
20	0.000335	92.8691	5.2327	1.9818	0.4599	2.6807
30	0.000401	89.2584	6.4249	2.9926	0.1440	2.1775
PANEL D: SINGAPORE						
10	0.008352	98.9010	8.1888	0.0367	0.0873	1.7812
20	0.011721	96.7499	14.5033	0.1340	0.0543	1.3269
30	0.014364	92.5738	16.7786	0.1986	0.0117	1.0458
PANEL E: THAILAND						
10	0.003109	97.8298	7.0724	0.0427	0.1174	3.6732
20	0.004410	95.2908	12.8567	0.1102	0.0764	3.4356
30	0.005442	92.3822	15.0243	0.2045	0.0415	3.2023

Notes: The table reports the results of decomposition of each item forecast error variance in the specification, and also use Cholesky decomposition to test for a time period of 30 trading days.

The indicate that in the Indonesia foreign exchange market, approximately 7% of variations in the exchange rate movements are caused by currency order flow. Likewise, 24% of variations in the exchange rate movements are caused by currency order flow in the Malaysia foreign exchange market. Meanwhile, in the Philippines foreign exchange market, 6.4% of variations in the exchange rate movements are caused by currency order flow. In addition, in the Singapore foreign exchange market, approximately 17% of variations in the exchange rate movements are caused by currency order flow; while in the Thailand foreign exchange market, up to 15% of the changes in the exchange rate

fluctuations are caused by the currency order flow. Therefore, currency order flow may account for 7%, 24%, 6.4%, 17% and 15% of exchange rate movements per trading day in the Indonesia, Malaysia, the Philippines, Singapore and Thailand foreign exchange markets, respectively.

Furthermore, short-term and long-term interest as well as country risks premium account for less than 3.3% of exchange rate movements in the Indonesian foreign exchange market. In the Malaysian foreign exchange market, the country risk premium explains 5.4% of exchange rate movements, while short-term interest and long-term interest account for less than 1%. In the Philippines foreign exchange market, short-term interest, long-term interest and country risk premium account for less than 5.4% of exchange rate movements. Meanwhile, short-term interest, long-term interest and country risk premium account for less than 1.3% of exchange rate movements in the Singapore foreign exchange market. Likewise, in the Thailand foreign exchange market, 3.2% of exchange rate fluctuation is brought about by the country risk premium, while less than 1% of exchange rate movement is explained by short-term and long-term interest.

Therefore, currency order flow and country risk premium variables appear as important determinant factors of exchange rate fluctuations in the ASEAN-5 countries foreign exchange markets.

5.4 Impulse Response Functions

Using the exchange rate equation for each country in the sample, this thesis reports one standard error (SE) shocks of impulse responses of each variable in the system. The column represents each of the key variables against the exchange rate equation, while the row represents the plotted impulse response functions: the unrestricted and restricted

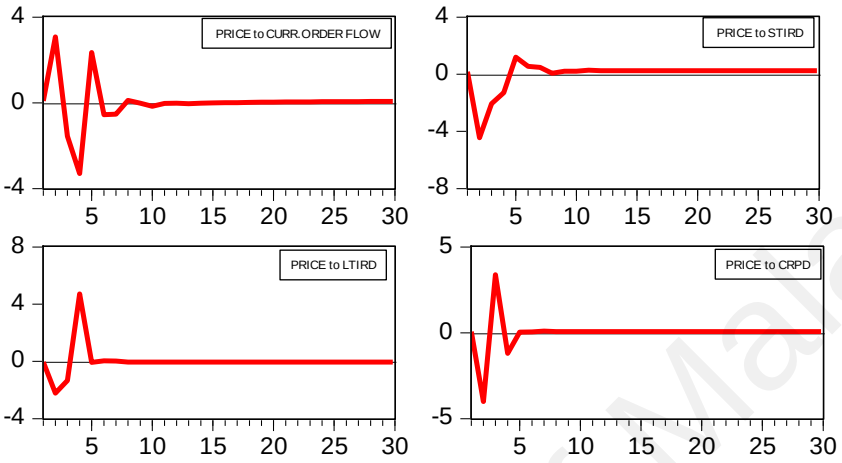
VAR as well as VECM and Parsimonious VAR. It is expected that parsimonious VAR response estimates should have ability to convey realistic economic information when compared with unrestricted VAR. In addition, this thesis reports each variable dynamic simulation results impulse responses for each country in the sample. That is, it reports each variable equation [$(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})$] to one standard error (SE) shocks of the impulse responses. Meanwhile, the Y-axis reports each variable impact, and the X-axis reports the actual number of 30 periods ahead being selected.

The impulse response function for the group needs to be reported separately for each of the countries in the sample. This is done to give clearer picture and overall behavior (various shocks) of the variables in the system in response to external change for the countries in the sample. Figure 4 through Figure 13 depicts the reports of one standard error (SE) shocks of impulse responses of each variable in the system for a time horizon of 30 days for each country. The sequence of report presentations are in this order: Indonesia, Malaysia, the Philippines, Singapore and Thailand.

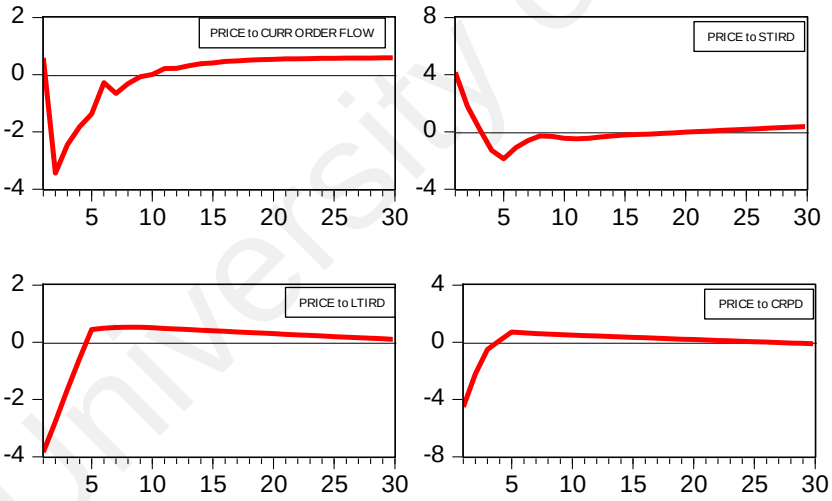
Indonesia

Impulse Responses for Indonesia

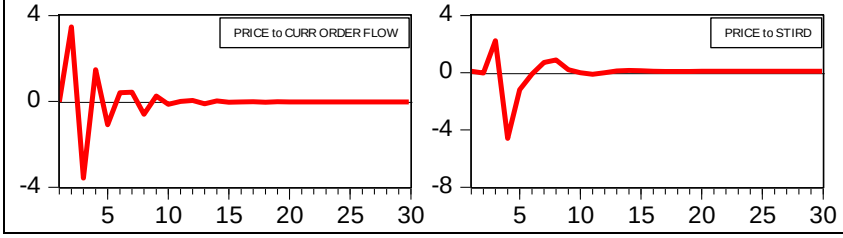
Unrestricted VAR (Price Equation)

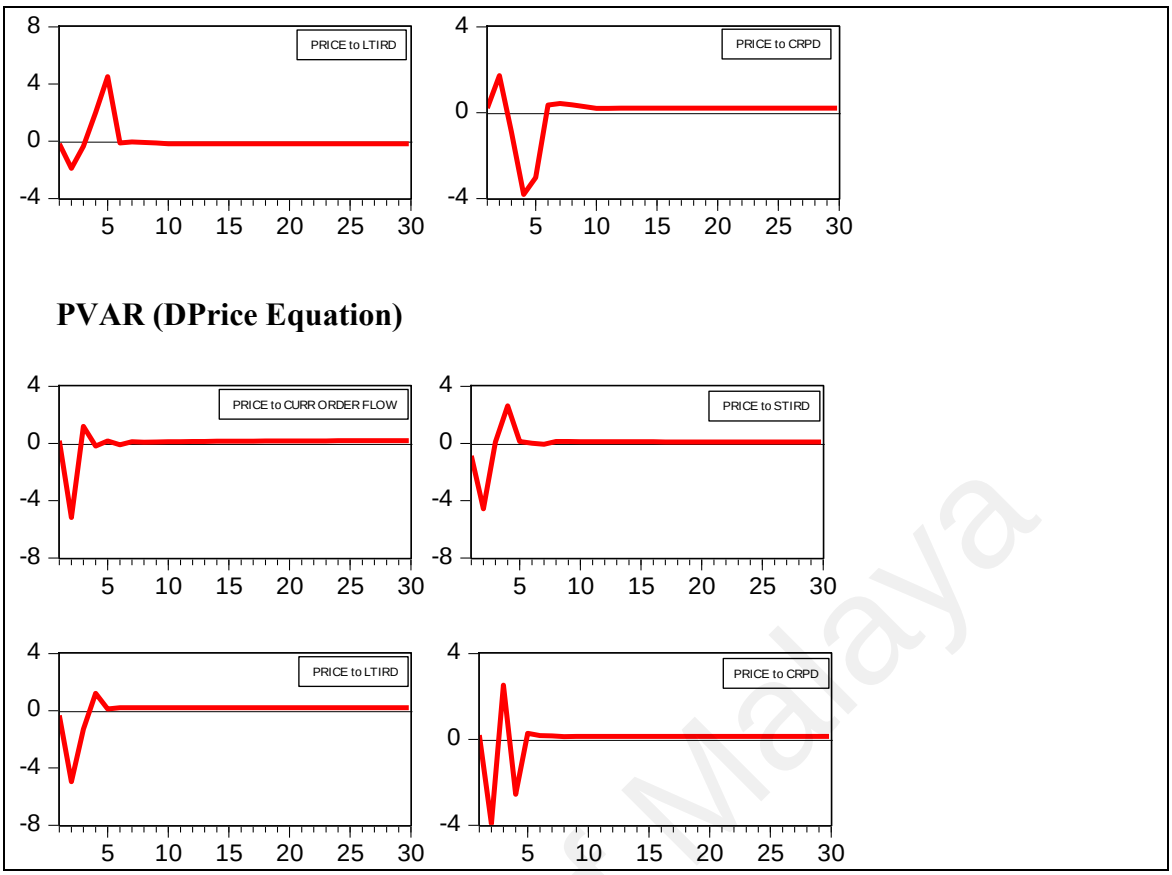


Restricted VAR (Price Equation)



VECM (DPrice Equation)





[5]

Figure 4: Indonesia. The plotted impulse response functions: the unrestricted and restricted VAR, VECM, and Parsimonious VAR

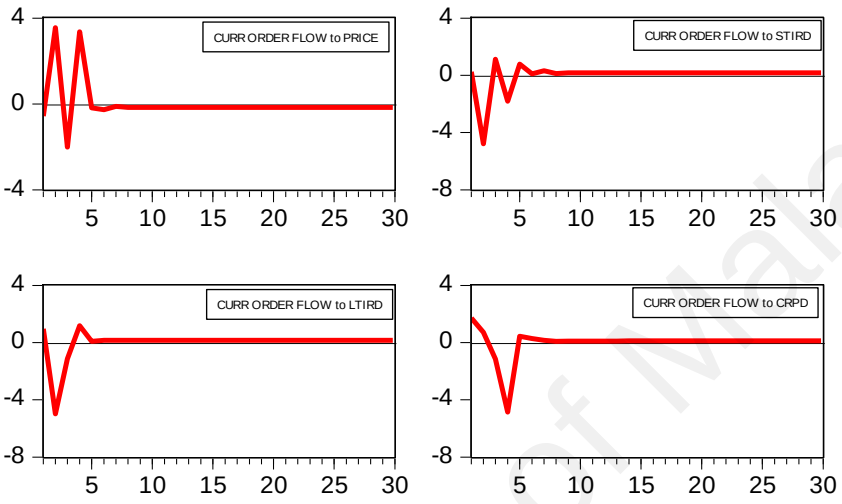
The exchange rate fluctuation occurs immediately and stable in response to various shocks to currency order flow. At the 1st horizon, the shock shows a negative sign and return as positive sign at the 2nd horizon. In a short period, it appears as a feedback effect and turns out to be stable at 11th horizon. The short-term interest differential responds promptly to exchange rate shocks with a negative sign at 1st horizon, but, after the 3rd horizon, the negative signal turns positive thereafter. In likewise manner, other variables

5 Notes: Figure 4 reports the one standard error (SE) shocks of impulse responses of each variable in the system for a time horizon of 30 days[5]. [5]

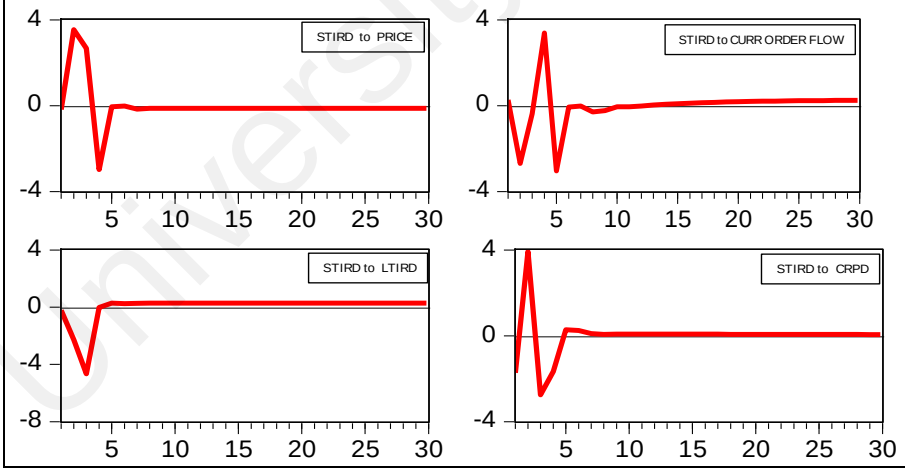
have similar reactions to exchange rate shocks, but not in the same magnitude as with short-term interest rate differential.

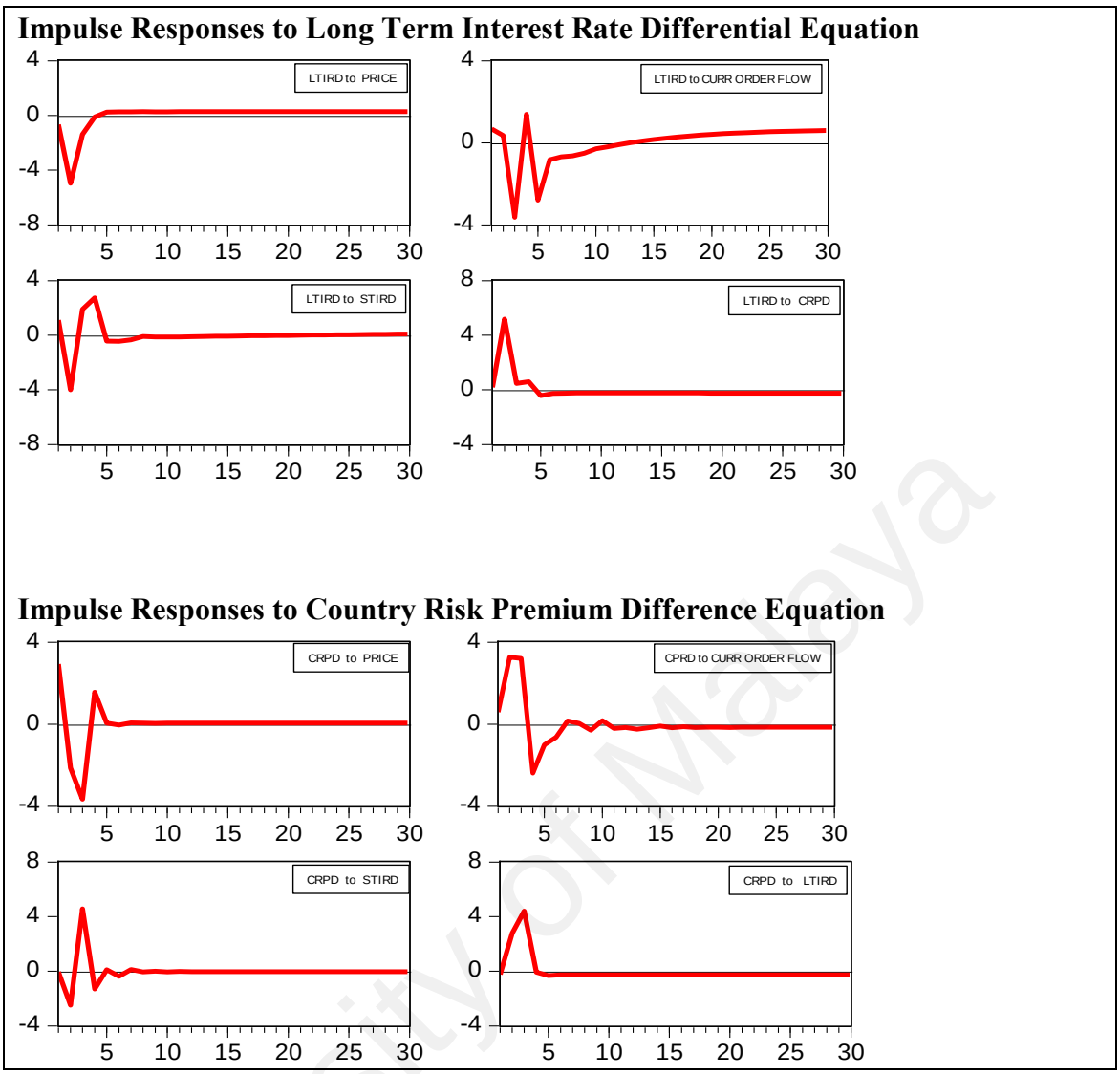
Individual Responses (PVAR) for Indonesia

Impulse Responses to Currency Order Flow Equation



Impulse Responses to Short Term Interest Rate Differential Equation





[6]

~~Figure 5 : Indonesia. Each variable dynamic simulation results of impulse responses~~

Figure 6 reports each variable equations $[(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})]$ to one standard error (SE) shocks of the impulse responses. In the currency order flow

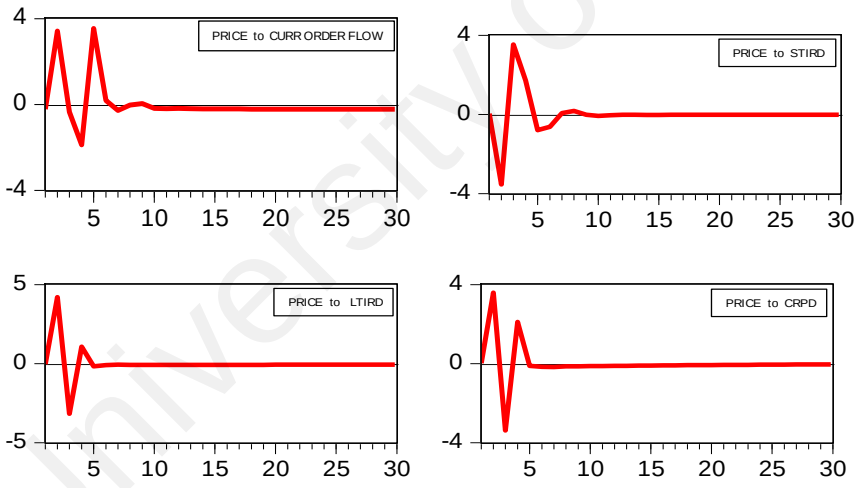
[6] Notes: Figure 5 reports each variable equations $[(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})]$ to one standard error (SE) shocks of the impulse responses for a time horizon of 30 days.[6]

equation, it appears that the exchange rate has a positive influence, while other variables effects are negative. For the short-term interest rate differential equation, the exchange rate, currency order flow, as well as difference in risk premium have both positive and negative impact, while the effects on differential long-term interest rate is negative. Furthermore, the differential in long-term interest rate equation, the exchange rate have negative influence, difference in risk premium have positive impact, while other variables have both positive and negative effects. Meanwhile, for the difference in risk premium equation, the only variable that have positive impact is the differential in long-term interest rate, while other variables have both positive and negative influence.

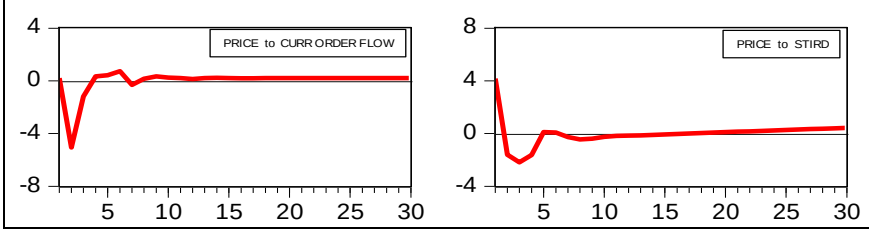
Malaysia

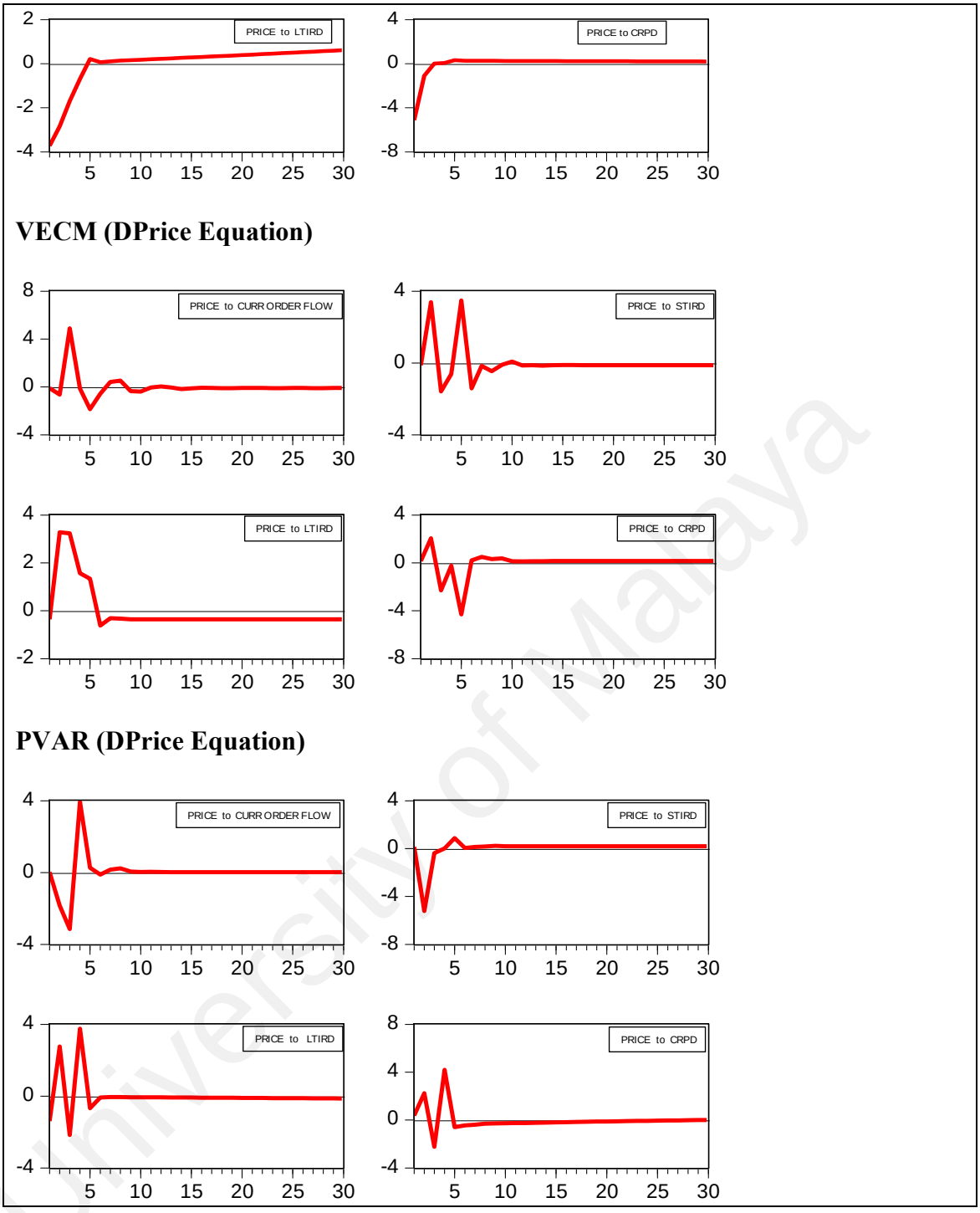
Impulse Responses for Malaysia

Unrestricted VAR (Price Equation)



Restricted VAR (Price Equation)





[7]

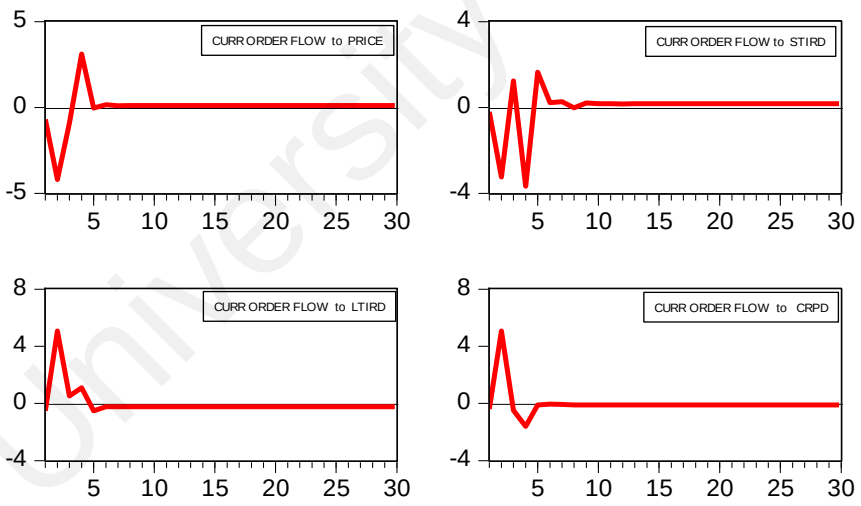
Figure 5~~6~~: Malaysia. The plotted impulse response functions: the unrestricted and restricted VAR, VECM and Parsimonious VAR

[7] Notes: Figure 6 reports the one standard error (SE) shocks of impulse responses of each variable in the system for a time horizon of 30 days.

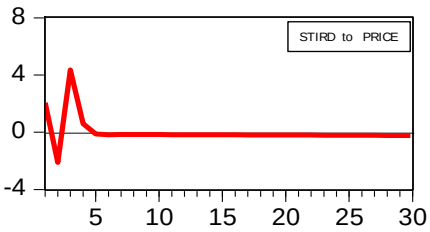
The exchange rate fluctuation occurs immediately and is stable in response to various shocks to currency order flow. At the 1st horizon, the shock shows a negative sign and return as positive sign at the 5th horizon. In a short period, it appears as a feedback effect and turns out to be stable at 9th horizon. The short-term interest differential responds instantly to exchange rate shocks with a negative sign at 1st horizon, but, after the 2nd horizon, the negative signal turns positive thereafter. In likewise manner, differential in long-term interest rate has similar reactions to exchange rate shocks, but decreases with time after the 6th period. Likewise, the country risk premium difference responds promptly to exchange rate shocks with a positive sign at 1st horizon, but, after the 3rd horizon, the positive signal swings to negative signal and becomes stable after the 10th period.

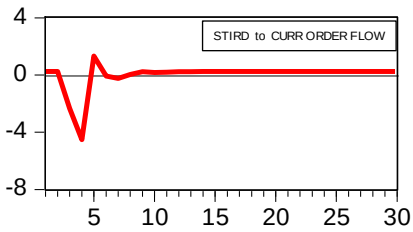
Individual Responses (PVAR) for Malaysia

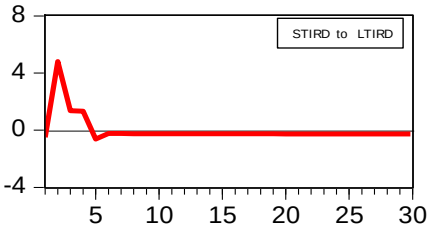
Impulse Responses to Currency Order Flow Equation

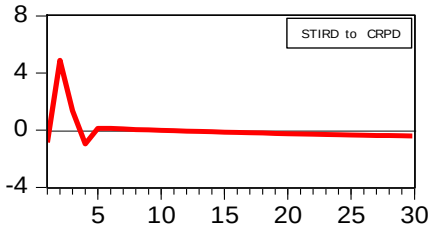


Impulse Responses to Short Term Interest Rate Differential Equation

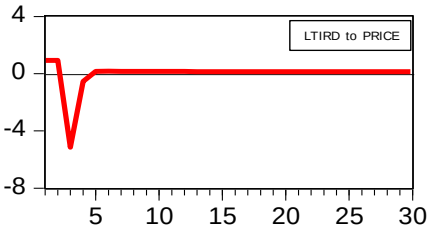


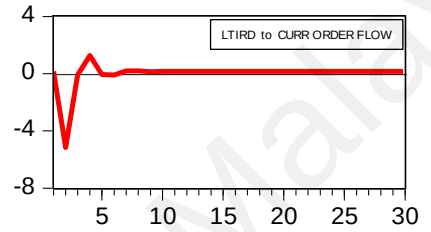


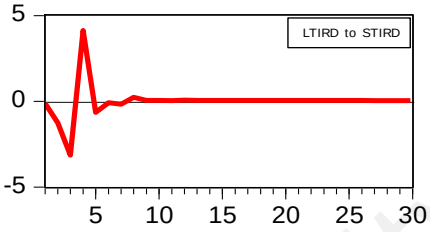


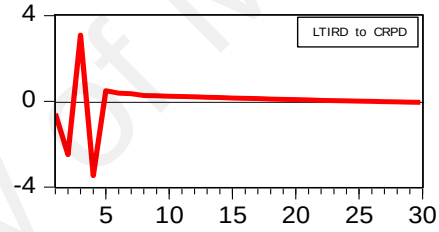


Impulse Responses to Long Term Interest Rate Differential Equation

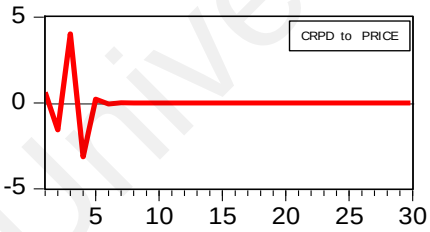


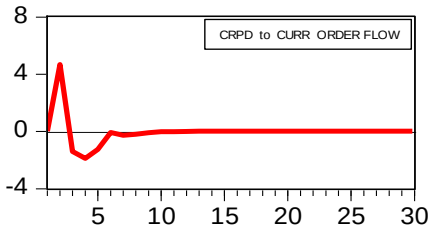


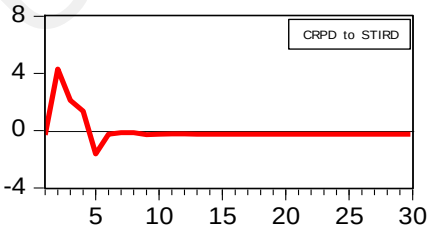


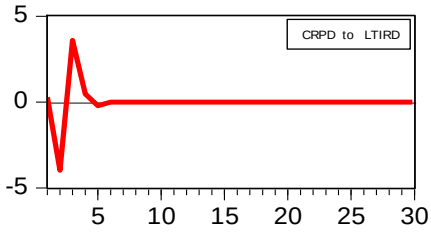


Impulse Responses to Country Risk Premium Difference Equation









[8]

Figure 6~~7~~: Malaysia. Each variable dynamic simulation results of impulse responses

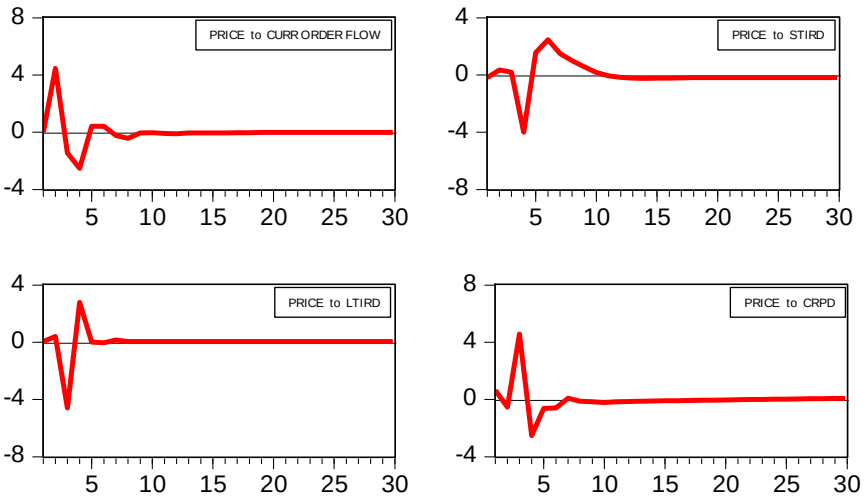
Figure 8 reports each variable equations [$(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})$] to one standard error (SE) shocks of the impulse responses. In the currency order flow equation, it appears that the exchange rate, differential in short-term interest rate and difference in risk premium have both positive and negative influence, while the impact of differential in long-term interest rate is positive. For the differential in short-term interest rate equation, the differential in long-term interest rate and difference in risk premium has positive influence, while other variables have both positive and negative effects. Likewise, for the differential in long-term interest rate equation, the exchange rate and currency order flow have negative impact, while the differential in short-term interest rate and difference in risk premium have both positive and negative effects. Furthermore, for the difference in risk premium difference equation, the exchange rate and the differential in long-term interest rate have both negative and positive impact on country risk premium differential, likewise other variables, but with minimal magnitude.

The Philippines

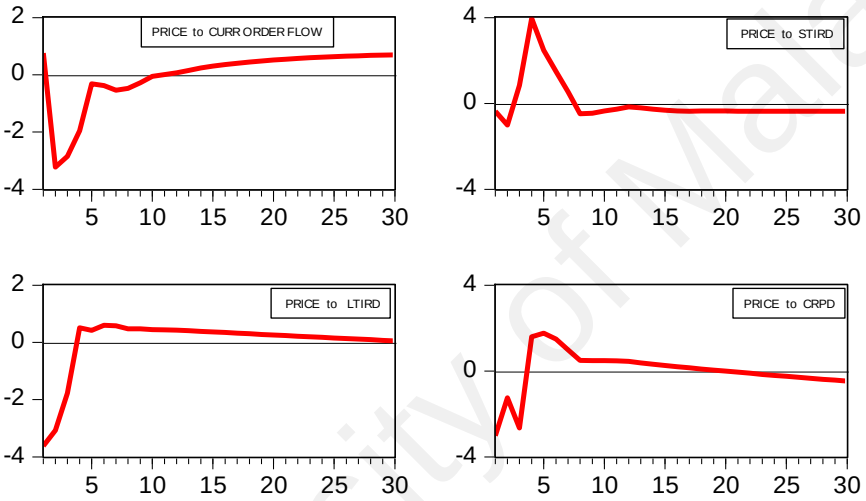
Impulse Responses for the Philippines

Unrestricted VAR (Price Equation)

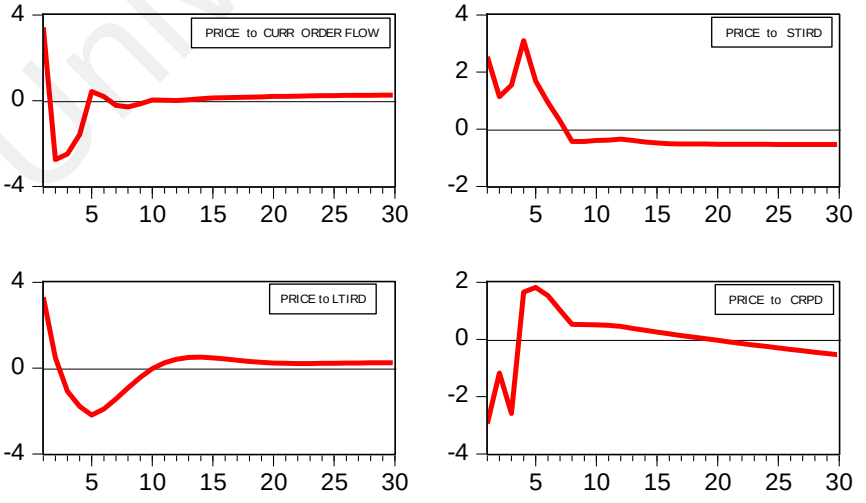
[8] Notes: Figure 7 reports each variable equations [$(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})$] to one standard error (SE) shocks of the impulse responses for a time horizon of 30 days.



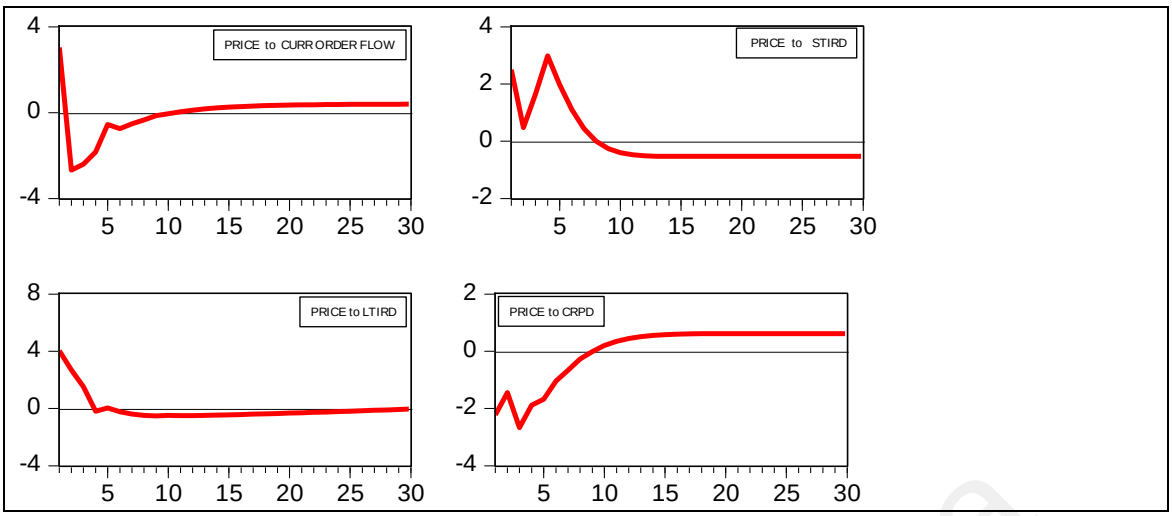
Restricted VAR (Price Equation)



VECM (DPrice Equation)



PVAR (DPrice Equation)



[9]

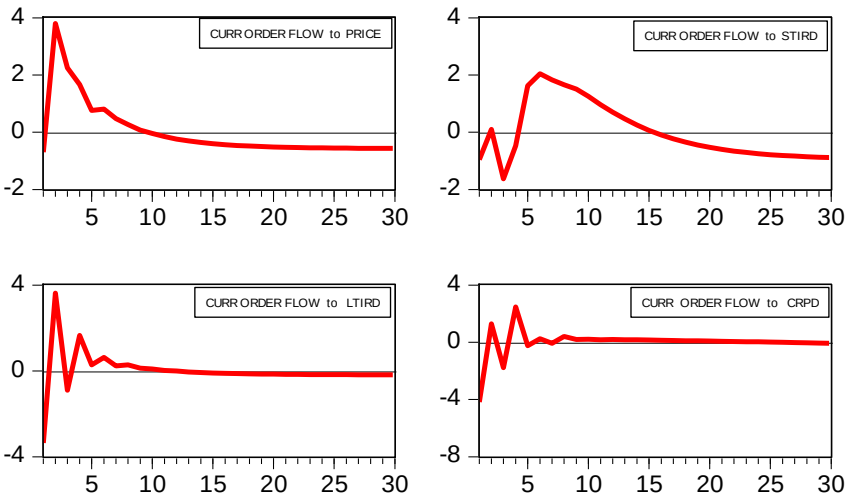
Figure 78: Philippines. The plotted impulse response functions: the unrestricted and restricted VAR, VECM and Parsimonious VAR

The exchange rate fluctuation occurs immediately and stable in response to various shocks to currency order flow. The shock appears as a positive sign at 1st horizon with an immediate negative sign, but, returns to positive sign at 10th period. In a short period, it appears as a feedback effect and turns out to be stable at 10th horizon. The short-term interest differential responds promptly to exchange rate shocks with a positive sign at 1st horizon, but, after the 8th horizon, the positive signal turns negative and becomes steady thereafter., The differential in long-term interest rate responds instantly to exchange rate shocks with a negative sign at 1st horizon, but, after the 13th period, it reverts to positive and increases with time, thereafter. Furthermore, the country risk premium difference responds instantly to exchange rate shocks with a positive sign at 1st horizon, but after the 16th horizon, the positive signal swings to negative signal and becomes stable thereafter.

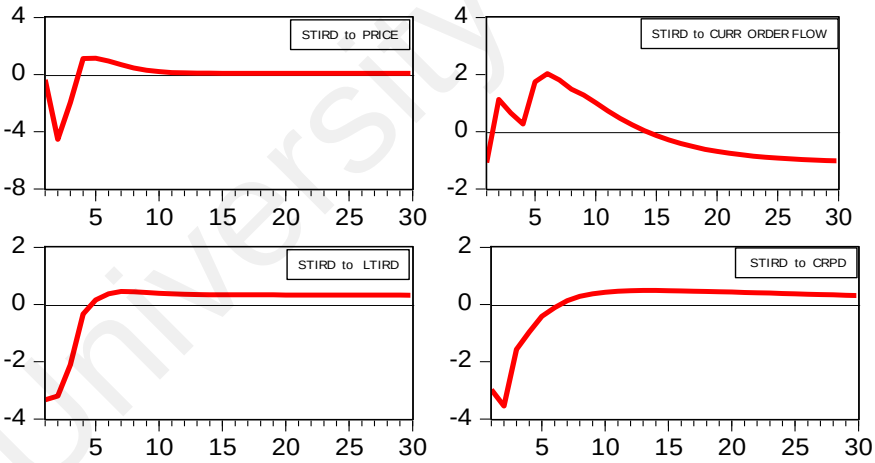
Individual Responses (PVAR) for the Philippines

Impulse Responses to Currency Order Flow Equation

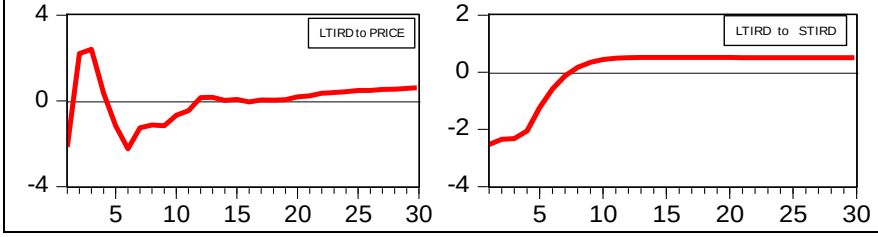
[9] Notes: Figure 8 reports the one standard error (SE) shocks of impulse responses of each variable in the system for a time horizon of 30 days.

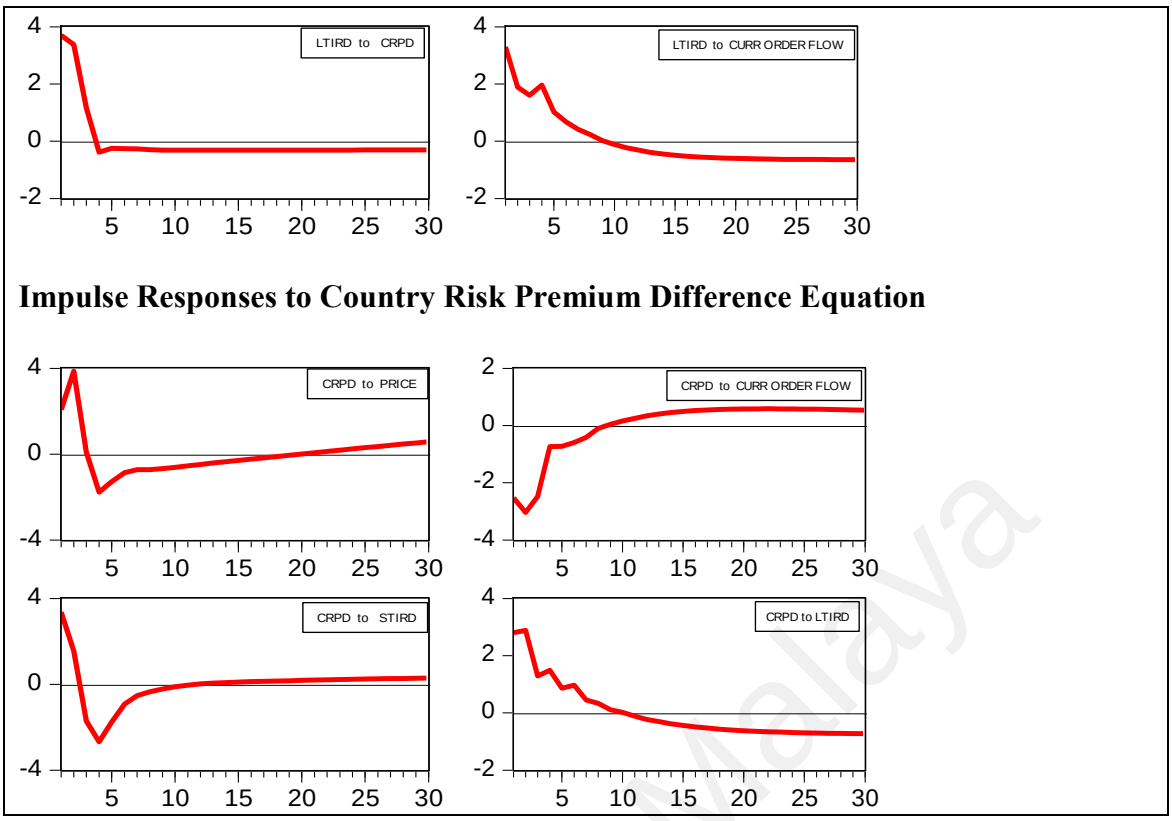


Impulse Responses to Short Term Interest Rate Differential Equation



Impulse Responses to Long Term Interest Rate Differential Equation





10

Figure 8~~9~~: Philippines. Each variable dynamic simulation results of impulse responses.

Figure 10 reports each variable equations $[(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})]$ to one standard error (SE) shocks of the impulse responses. In the currency order flow equation, it appears that the exchange rate, differential in short-term interest rate and difference in risk premium has both positive and negative influence, although, the positive impact of the exchange rate and differential in short-term interest rate on currency order flow are more evident than other variables. For the differential in short-term interest rate equation, the differential in long-term interest rate and difference in risk premium have negative influence, while other variables have both positive and negative effects. Furthermore, for the differential in long-term interest rate equation, the exchange rate,

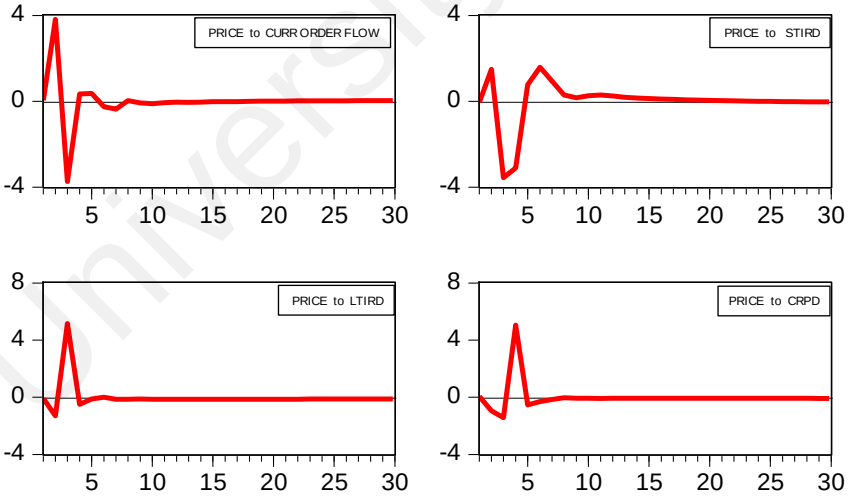
[10] Notes: Figure 9 reports each variable equations $[(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})]$ to one standard error (SE) shocks of the impulse responses for a time horizon of 30 days

differential in short term interest rate, differential in long-term interest rate as well as difference in risk premium have both positive and negative impact on long-term interest rate differential, although the effects of the exchange rate is more evident than other variables. In addition, for the difference in risk premium equation, the differential in short-term interest rate and currency order flow have both positive and negative effect on country risk premium difference, likewise other variables.

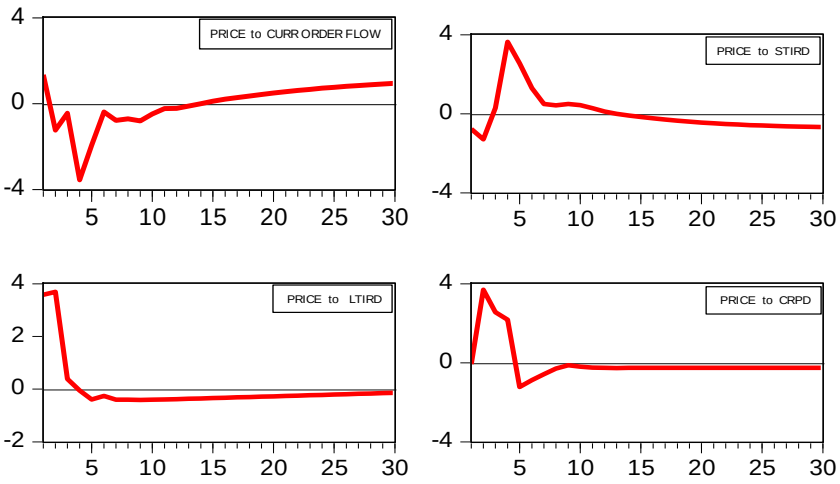
Singapore

Impulse Responses for Singapore

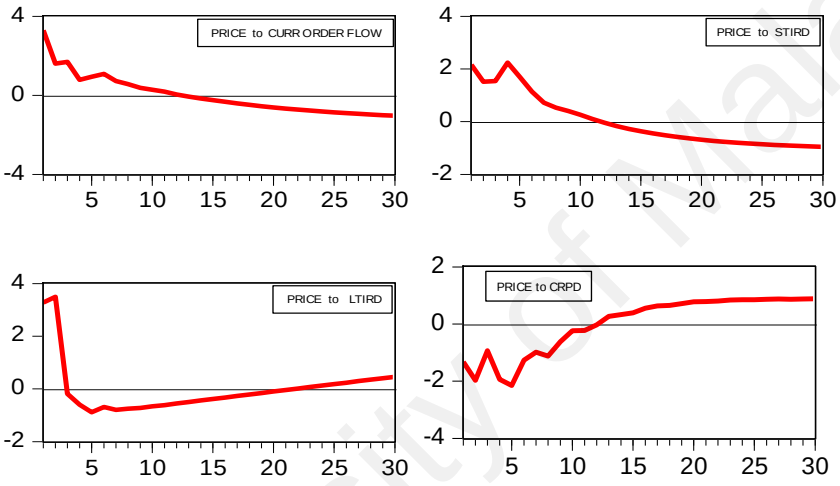
Unrestricted VAR (Price Equation)



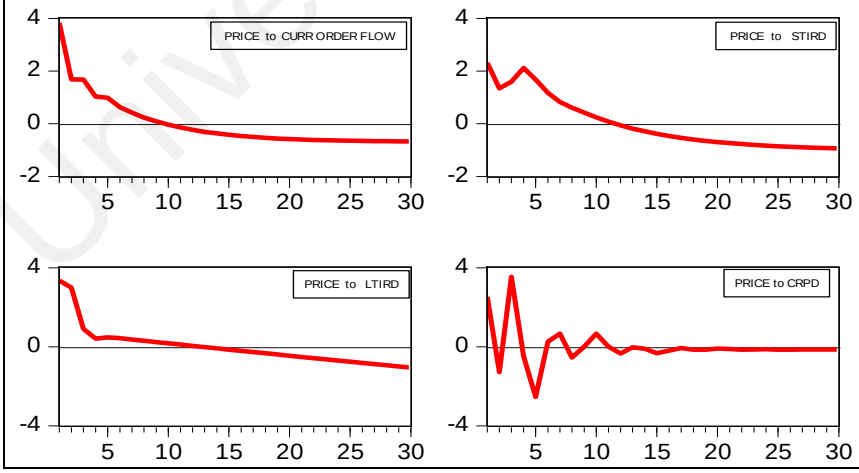
Restricted VAR (Price Equation)



VECM (DPrice Equation)



PVAR (DPrice Equation)

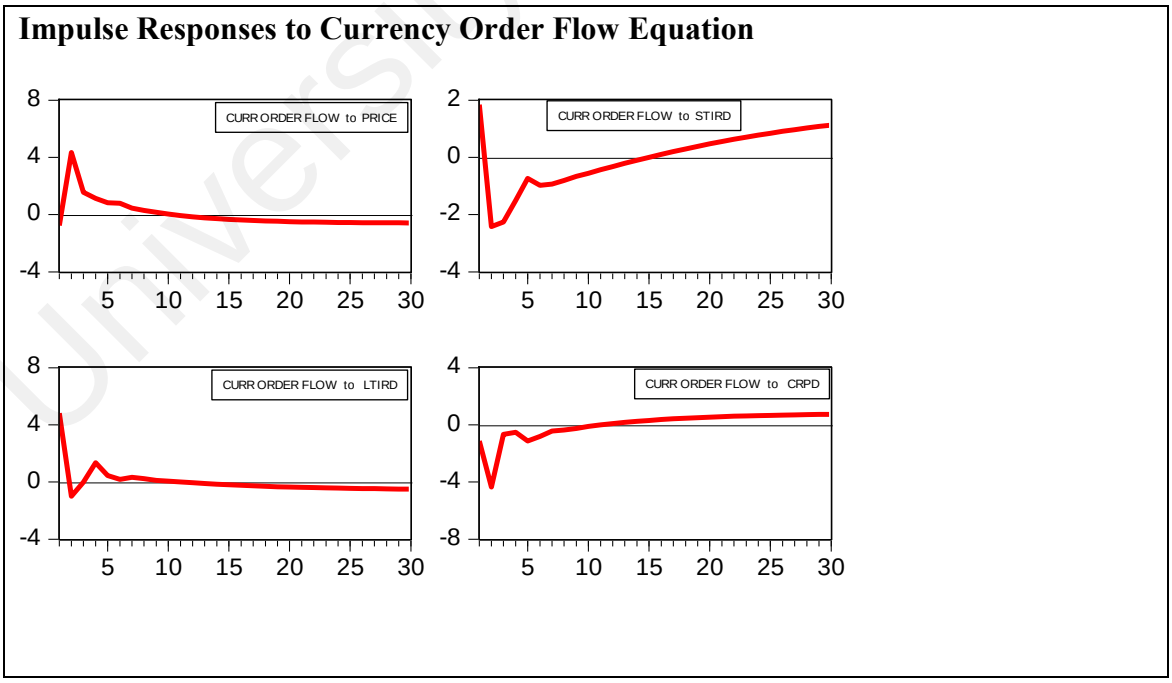


11

Figure 910: Singapore. The plotted impulse response functions: the unrestricted and restricted VAR, VECM and Parsimonious VAR

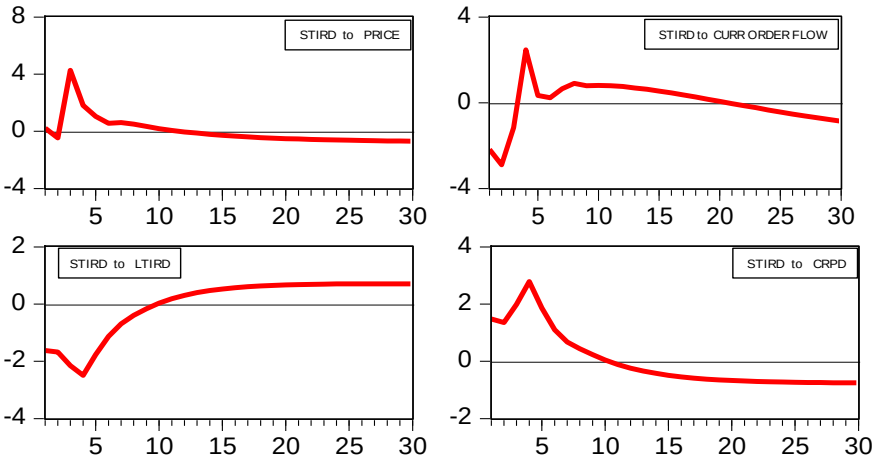
The exchange rate fluctuation occurs immediately and is stable in response to various shocks to currency order flow and differential in short-term interest rate. The shock appears as a positive sign at 1st horizon, until the 9th horizon and returns to a negative sign at 10th horizon. In a short period, it appears as a feedback effect and turns out to be stable at 10th horizon. In likewise manner, the differential in long-term interest rate has similar reactions to exchange rate shocks, but decreases with time after the 15th period. The country risk premium difference responds promptly to exchange rate shocks with a negative sign at 1st horizon, but after the 15th horizon, the negative signal swings to positive signal and increases after the 15th period.

Individual Responses (PVAR) for Singapore

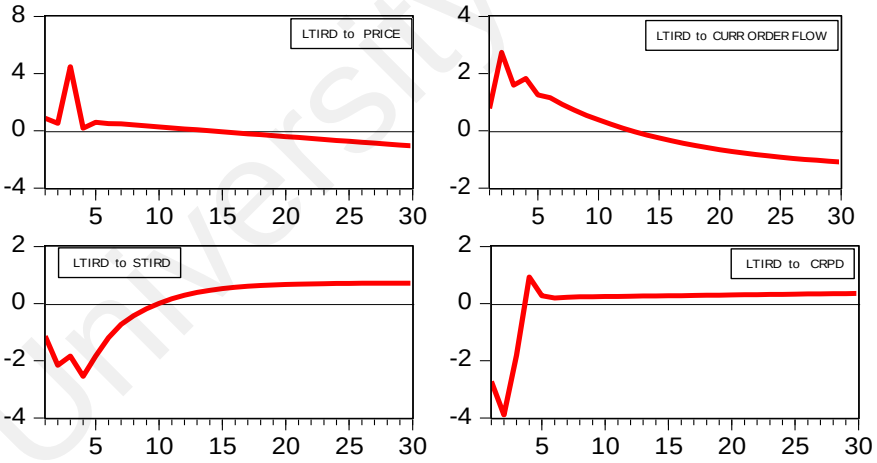


11 Notes: Figure 10 reports the one standard error (SE) shocks of impulse responses of each variable in the system for a time horizon of 30 days.

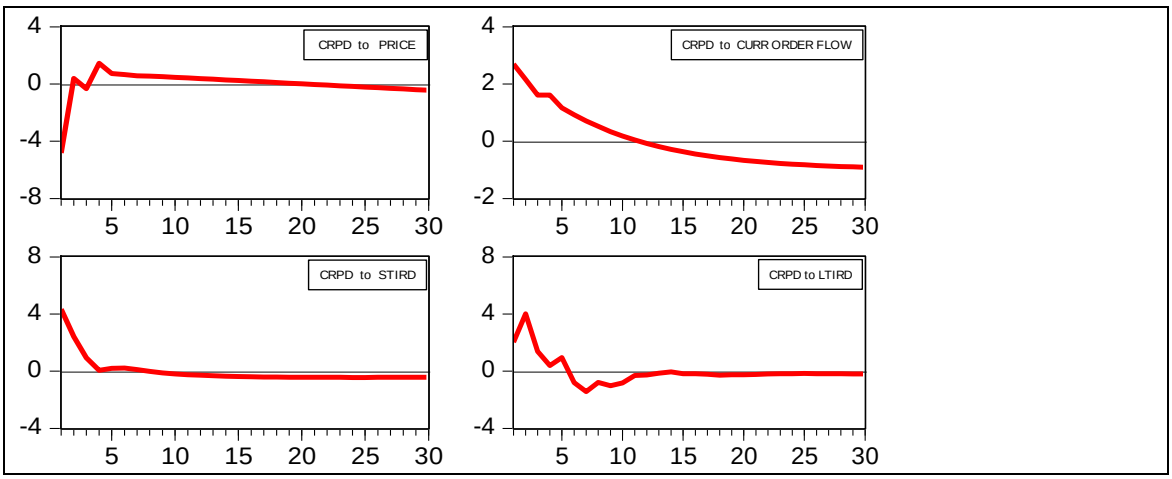
Impulse Responses to Short Term Interest Rate Differential Equation



Impulse Responses to Long Term Interest Rate Differential Equation



Impulse Responses to Country Risk Premium Difference Equation



[12]

Figure 10~~11~~: Singapore. Each variable dynamic simulation results of impulse responses

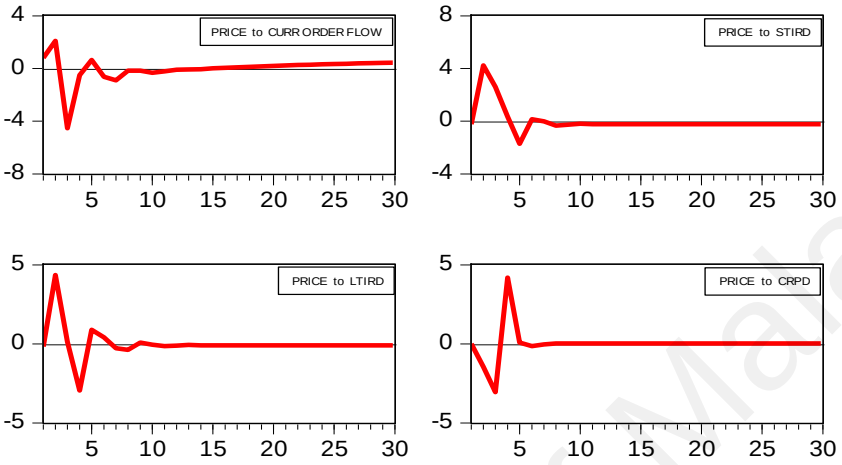
Figure 12 reports each variable equations $[(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})]$ to one standard error (SE) shocks of the impulse responses. In the currency order flow equation, it appears that the exchange rate and differential in long-term interest rate have positive influence, while the differential short-term interest rate and difference risk premium are negative. For the differential in short-term interest rate equation; the exchange rate, currency order flow and difference in risk premium have positive influence, while the effects differential in long-term interest rate is negative. Likewise, for the differential in long-term interest rate equation, the exchange rate and currency order flow have positive influence, while differential in short-term interest rate and difference in risk premium have negative effects. Furthermore, for the difference in risk premium equation; the differential in short-term interest rate, differential in long-term interest rate and currency order flow have positive influence, while the exchange rate effect is negative.

[12] Notes: Figure 11 reports each variable equations $[(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})]$ to one standard error (SE) shocks of the impulse responses for a time horizon of 30 days.

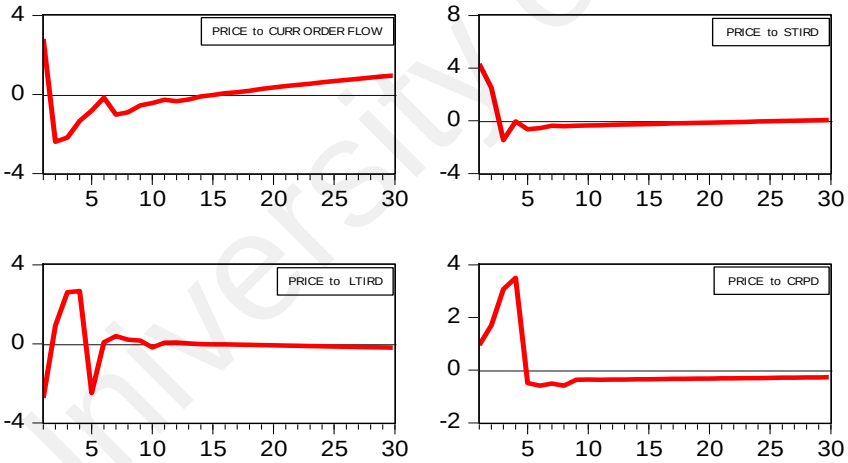
Thailand

Impulse Responses for Thailand

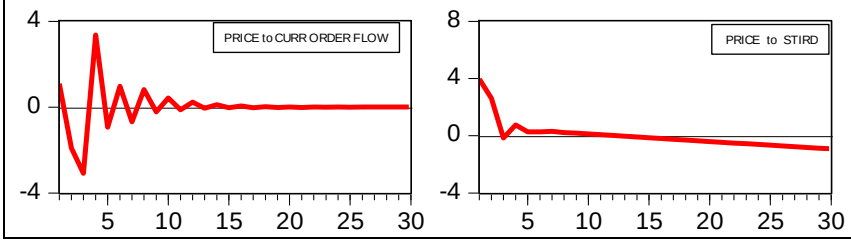
Unrestricted VAR (Price Equation)

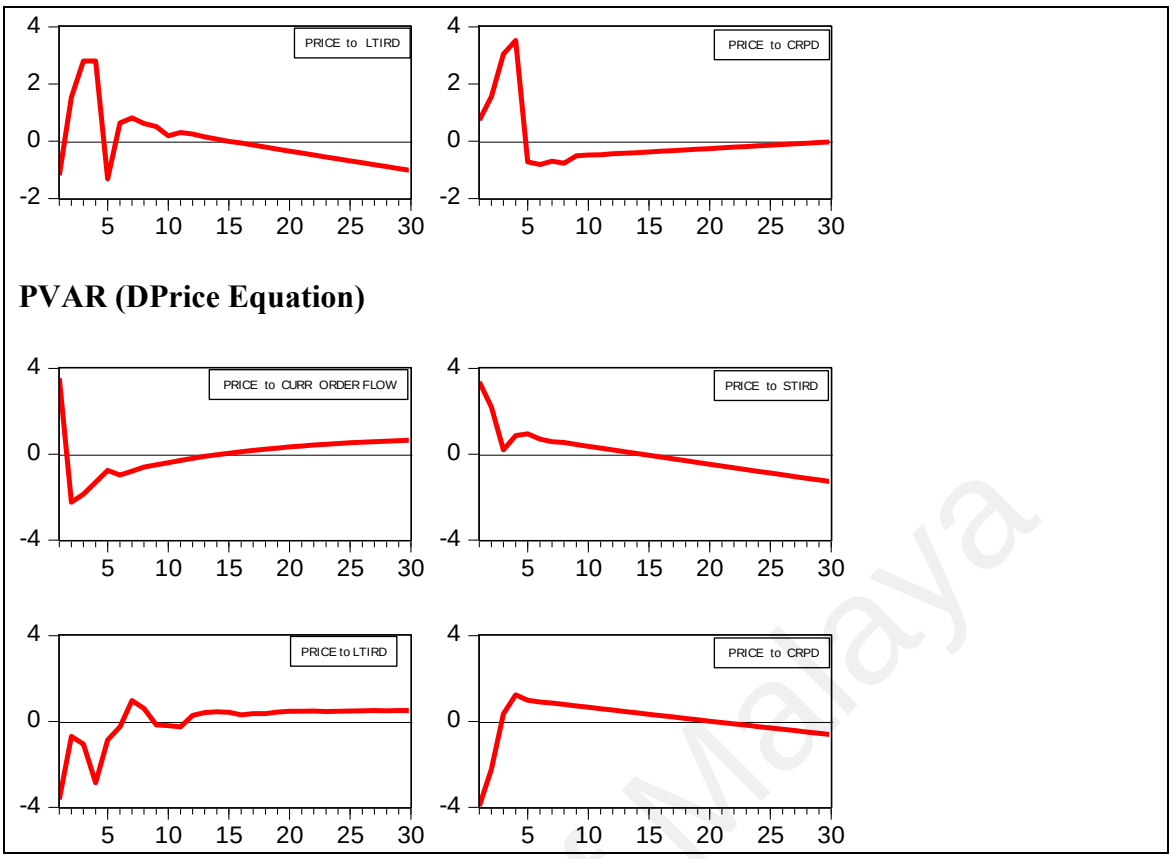


Restricted VAR (Price Equation)



VECM (DPrice Equation)





[13]

Figure 11~~12~~: Thailand. The plotted impulse response functions: the unrestricted and restricted VAR, VECM and Parsimonious VAR

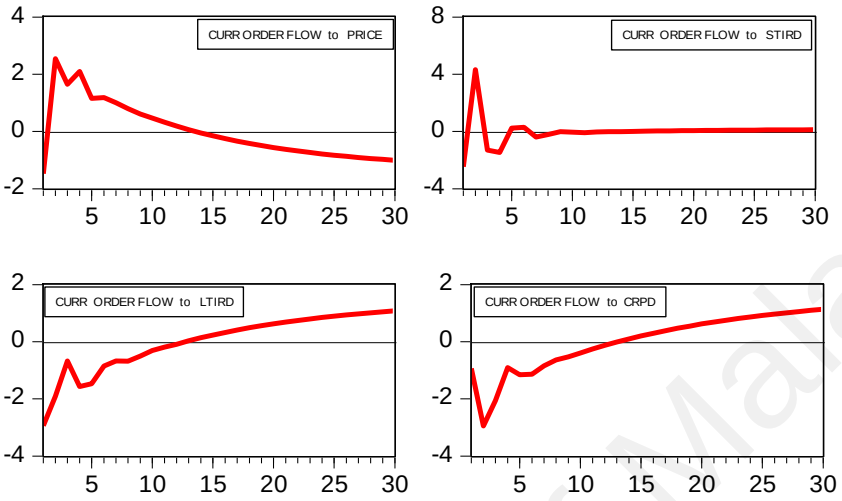
The exchange rate fluctuation occurs immediately and stable in response to various shocks to currency order flow and differential in short-term interest rate respectively. The shock appears as a positive sign at 1st horizon, but the currency order flow positive sign returns immediately to a negative sign, until the 15th horizon, thereby returns to positive sign. The differential in short-term interest rate reacted in likewise manner. In a short period, it appears as a feedback effect and turns out to be stable at the 15th horizon. The differential in long-term interest rate and the difference in risk premium respond promptly

[13] Notes: Figure 12 reports the one standard error (SE) shocks of impulse responses of each variable in the system for a time horizon of 30 days.

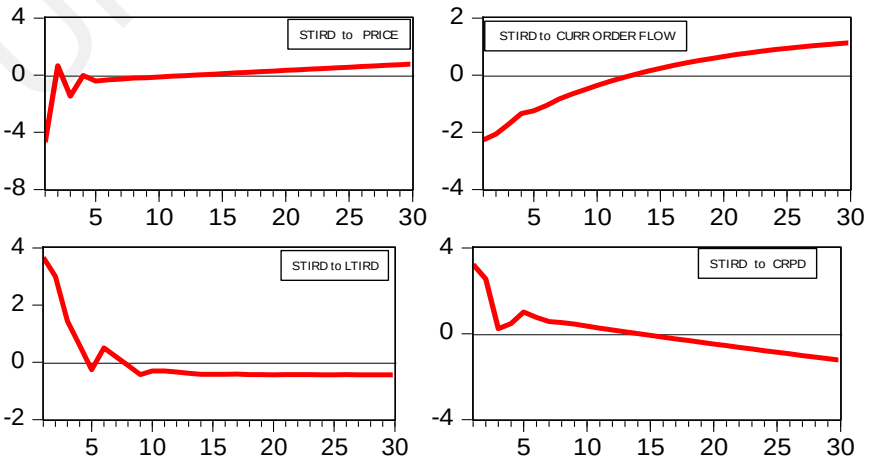
to exchange rate shocks with a negative sign at 1st horizon, but, after the 2nd horizon, the negative signal swings to positive signal at the 17th period and becomes stable thereafter.

Individual Responses (PVAR) for Thailand

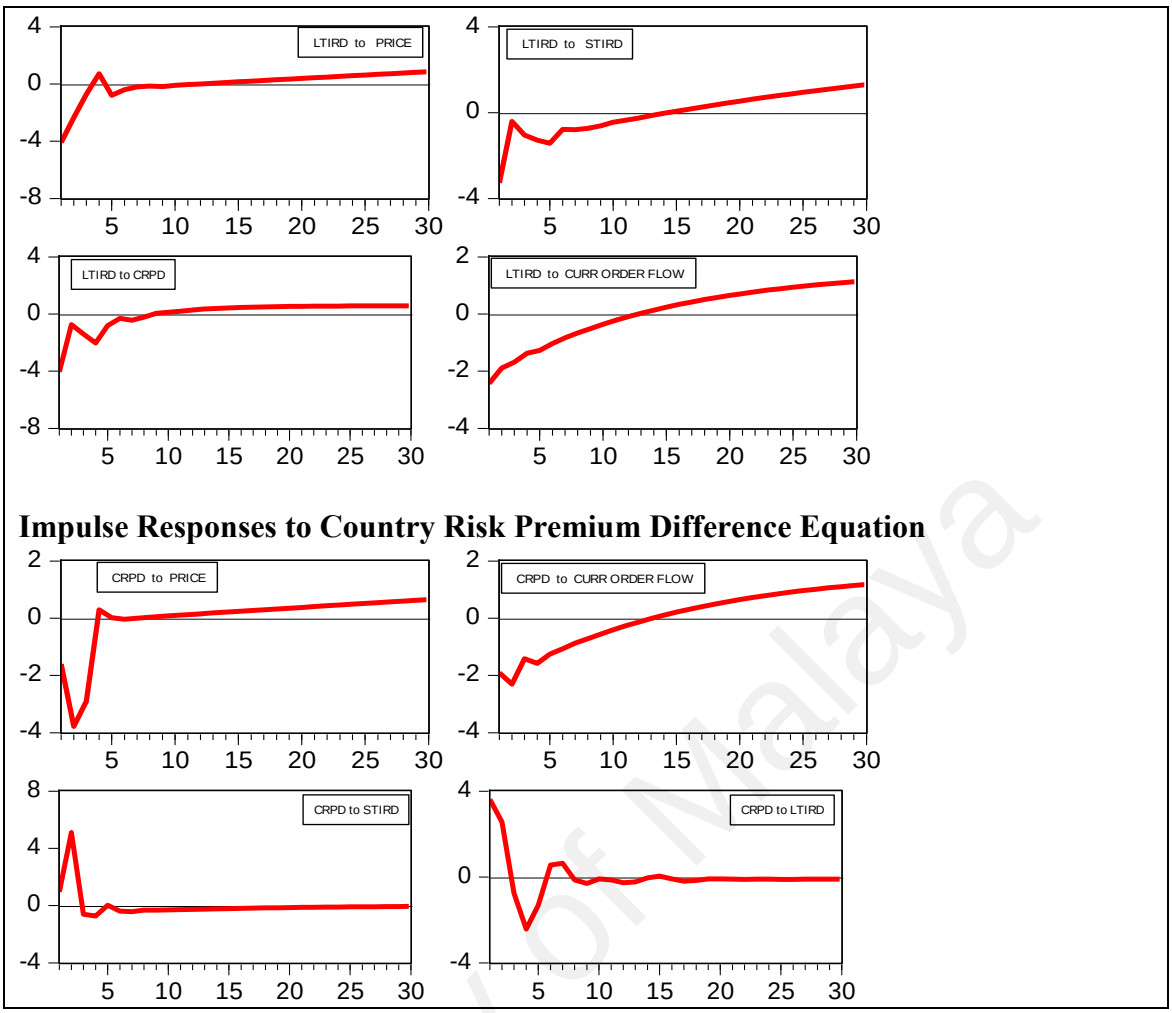
Impulse Responses to Currency Order Flow Equation



Impulse Responses to Short Term Interest Rate Differential Equation



Impulse Responses to Long Term Interest Rate Differential Equation



14

Figure 12~~13~~: Thailand. Each variable dynamic simulation results of impulse responses

Figure 14 reports each variable equations $[(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})]$ to one standard error (SE) shocks of the impulse responses. In the currency order flow equation, it appears that the exchange rate and differential in short-term interest rate have positive influence, while the differential in long-term interest rate and difference in risk premium are negative. For the differential in short-term interest rate equation; the exchange rate, currency order flow and differential in long-term interest rate have

[14] Notes: Figure 13 reports each variable equations $[(X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ ,(R_t - R_{tf})]$ to one standard error (SE) shocks of the impulse responses for a time horizon of 30 days.

negative influence, while, the effects difference in risk premium is positive. Likewise, for the differential in long-term interest rate equation; the exchange rate, differential in short term interest rate and currency order flow have negative influence, while difference in risk premium have positive effects.

Furthermore, for the difference in risk premium equation; the differential in short-term interest rate, differential in long-term interest rate, currency order flow and exchange rate have negative impact on country risk premium difference.

Therefore, with the positive shock on exchange rate and interest rate, if the monetary authorities of ASEAN-5 countries increase their interest rate strictly in line with their monetary policy objective(s), the authorities should have similar sign. Likewise, the country risk premium indicates a comparable trend, appears to be more flexible. The decision by the monetary authority to increase the interest rate may attract domestic investments, foreign investments as well as market speculators. However, with the thin nature of the market of these five countries, as a control measure, the monetary authority may have to intervene in the market to thwart possible speculative attacks in order to retain the inflation rate within the estimated band.

5.5 Chapter Summary

The results of the unit root tests show that the variables are stationary as $I(1)$ process for all the countries in the sample. Likewise, the correlation matrix results show that there exists positive relationship between the exchange rate and currency order flow variable and country risk premium variable for Indonesia, Malaysia, the Philippines and Singapore. Meanwhile, in Thailand, there exists positive relationship between the exchange rate and all the variables in the system.

Furthermore, Johansen cointegration analyses results show that two cointegrating relationships exist at 1% level of statistical significance for all the ASEAN-5 countries based on the full sample. Likewise, among the hypotheses tested, H_1 tests the cointegrating relationships if there exists any trend. Furthermore, using hypotheses H_2 to H_6 to test the long-run cointegrating relationship, the results show that there is a relationship between the exchange rate and country risk premium for all the countries in the sample with the exception of Indonesia. The results of Granger causality tests show that exchange rate Granger causes currency order flow and vice-versa for Malaysia, Singapore and Thailand. This implies that there exists bidirectional causality. Meanwhile, for Indonesia and the Philippines, there exists unidirectional causality from currency order flow to exchange rate movements of USD/IDR and USD/PHP respectively. In addition, the results show that none of the variables in the model is weak.

The short-term correction result shows that the coefficients for all the five countries are negatively significant in between 5% and 10% levels of significance. This shows that in ASEAN-5 countries foreign exchange markets, currency order flow Granger causes exchange rate movements in the short-term. In addition, the R^2 obtained for the countries in the sample while comparing the results, the coefficients of these results and that of Evans and Lyons are significant. Eventhough the R^2 obtained were relatively low, compared with 0.64 and 0.46 obtained by Evans and Lyons (2002a). However, one of the major reasons for the low $R^{2\prime}s$ may be attributable to the relatively low level at which the currencies of emerging economies are being traded in the international market. Likewise, most of the emerging economies do not operate free-floating rather managed floating exchange rate regime, which may lead to frequent occurrence of currency intervention by the monetary authority. These may account for the difference in this finding and that of Evans and Lyons. Nevertheless, the results are consistent with other empirical studies from the developed and emerging markets of similar nature.

The impulse response functions results indicate that the exchange rate fluctuation occurs immediately and stable in response to various shocks to currency order flow and interest rate for all the five countries in the sample. Therefore, the monetary authorities in ASEAN-5 countries may review their interest rate upwards in order to attract both domestic and foreign investments. However, the authority must curtail market speculative attacks in order to check inflation rate. Furthermore, the results of variance decomposition of exchange rate show that currency order flow accounts for 7% of daily exchange rate movements in Indonesian foreign exchange market. Meanwhile, short-term interest, long-term interest and country risk premium account for less than 3.3%. Likewise, in the Malaysian foreign exchange market, 24% of daily exchange rate movements are due to currency order flow. Country risk premium accounts for 5.4%, while the short-term interest and long-term interest account for less than 1% of daily exchange rate fluctuations. Meanwhile, in the Philippines foreign exchange market, currency order flow accounts for 6.4% of daily exchange rate movements, while short-term interest, long-term interest and country risk premium account for less than 5.4% of the daily exchange rate fluctuations. In the Singapore foreign exchange market, approximately 17% of the daily exchange rate movements are because of currency order flow, while less than 1.3% is due to other variables in the system. On the other hand, in the Thailand foreign exchange market, currency order flow accounts for 15% of the daily exchange rate movements. Country risk premium brought about 3.2% of the daily exchange rate fluctuations. However, short-term interest and long-term interest account for less than 1% of the daily exchange rate movements.

Therefore, in ASEAN-5 countries' foreign exchange markets, it appears that currency order flow and country risk variables are the two influential determinant components of exchange rate fluctuations.

CHAPTER 6: EMPIRICAL RESULTS AND DISCUSSION ON FOREIGN EXCHANGE MARKET INTERVENTION

This chapter reports the estimation of the empirical results of the final objective of this thesis. The final objective of this thesis is to investigate ASEAN -5 countries monetary authorities' market intervention and the extent to which this policy tool is effective in curbing the depreciation of their currencies against the US dollar in the international market.

This thesis therefore evaluates with the success criterion for the sale of US dollar in each case, using four major criteria and an aggregate criterion that incorporates the first four such as *Reducing the net currency order flow out of dollar; Reversing the direction of the net currency order flow; Accentuating the net currency order flow; Moderating the net currency order flow* and *General success criterion for net currency order flows.*

6.1 The Empirical Results and Discussion on ASEAN-5 Countries Foreign Exchange Market Intervention

The focus here is on the relationship between currency order flow and market intervention, thereafter, currency order flow and exchange rate fluctuations for all the five countries in the sample.

Table 6.1 reports the summary of the success criteria performance on total intervention days for the ASEAN-5 countries' currencies against US dollar currency order flows. For all the countries in the sample with the exception of Malaysia, the population are set to 1563 days for each criterion (one day is lost for comparing performance with previous day). However, for Malaysia, the population is set to 1496 days for each criterion. The

sample size is 716 days for Indonesia, 673 days for Malaysia, 1173 days for the Philippines, 932 days for Singapore and 783 days for Thailand.

Table 6.1: **Summary of success criteria performance on total intervention days for the ASEAN-5 countries' currencies -USD currency order flows**

Success Criteria (SC)	**SC1**	**SC2**	**SC3**	**SC4**	**SC5**
PANEL A: INDONESIA					
Total Interventions (716) days					
Successful Interventions	226 days	434 days	283 days	304 days	351 days
Conditional (% of Successful Intervention)	**31.52%**	60.61%	39.53%	**42.46%**	49.02%
Expected Number of Success	474 days	964 days	641 days	652 days	784 days
Unconditional (% of Expected No. of Success)	30.31%	61.68%	41.01%	41.71%	50.16%
P-Value	**0.0132****	0.3579	0.6894	0.3882	0.7132
PANEL B: MALAYSIA					
Total Interventions (673) days					
Successful Interventions	305 days	179 days	138 days	235 days	402 days
Conditional (% of Successful Intervention)	45.25%	26.61%	**20.51%**	**34.92%**	59.73%
Expected Number of Success	726 days	400 days	291 days	494 days	955 days
Unconditional (% of Expected No of Success)	48.49%	26.74%	19.45%	33.02%	63.84%
P-Value	0.9320	0.3635	**0.0252***	**0.0485***	0.8991
PANEL C: PHILIPPINES					
Total Interventions (1173) days					
Successful Interventions	390 days	684 days	389 days	714 days	560 days
Conditional (% of Successful Intervention)	**33.25%**	58.31%	**33.16%**	60.92%	47.75%
Expected Number of Success	508 days	921 days	492 days	961 days	758 days
Unconditional (% of Expected No. of Success)	32.50%	58.93%	31.48%	61.48%	48.50%
P-Value	0.1967	0.2257	**0.0173****	0.2036	0.3476
PANEL D: SINGAPORE					
Total Interventions (932) days					
Successful Interventions	540 days	360 days	482 days	351 days	465 days
Conditional (% of Successful Intervention)	**57.94%**	38.63%	**51.72%**	37.66%	49.89%
Expected Number of Success	889 days	609 days	797 days	596 days	787 days
Unconditional (% of Expected No. of Success)	56.88%	38.96%	50.99%	38.13%	50.35%
P-Value	0.1610	0.2165	**0.0015****	0.3372	0.2655
PANEL E: THAILAND					
Total Interventions (783) days					
Successful Interventions	147 days	436 days	152 days	326 days	389 days
Conditional (% of Successful Intervention)	**18.75%**	55.68%	**19.41%**	41.63%	49.68%
Expected Number of Success	282	914	288	673	819
Unconditional (% of Expected No. of Success)	18.03%	58.48%	18.43%	43.06%	52.40%
P-Value	**0.0436***	0.1356	0.2642	0.2397	0.6102

* denotes significance at the 5% level; ** at the 1% level.

From Table 6.1, Row 1 indicates the lists of success criteria. While Row 2 indicates the count of total interventions from the construct of the currency order flows and exchange rate fluctuations for all the countries in the sample between January 4, 2010 and December 31, 2015. Meanwhile, Row 3 presents the total number of interventions that were successful according to each of the specific criterion. Likewise, Row 4 reveals the conditional success rate. That is, it expresses the number of successes as a percentage of the total interventions. For example, in Indonesia (Panel A) SC4 304 days /716 days =

0.4246 or 42.46%. The 304 days represents the total number of successful interventions, while 716 days represents the total number of interventions. The 42.46% represents the percentage of successful intervention. The same interpretative analogy applies to similar parts in the Table. Row 5 presents the expected number of success (unconditional) under each criterion based on the total population for each of the countries in the sample. Meanwhile, Row 6 indicates the unconditional success rate. That is, it expresses the number expected successes as a percentage of the total population (Full sample). For example, for Indonesia (Panel A) SC4 652 days /1563 days = 0.4171 or 41.71%, the 652 days represents the expected number of success based on the 1563 total population. The 41.71% represents the percentage of expected number of success. Likewise, the same interpretative analogy applies to similar parts in the Table. In addition, when the conditional success rate exceeds the unconditional success rate, the conditional success rate is made bold. Row 7 reports the P-value associated with rejecting the null hypothesis that indicates the observed number of successes equal to the expected number of successes. In other words, it presents the p-value associated with one-sided test, and that, under a hypergeometric distribution based on the unconditional frequencies of each sample period, the conditional frequency of success exceeds the unconditional frequency of success. For example, for Indonesia (Panel A), it expresses the probability value of observing number of successes (say X) in a sample of 716 days when the success rate in a population of 1563 days (say Y). Probability values of 5% or less are made bold. For example, using SC4 (moderating the net currency order flow), Bank Indonesia intervention was successful on 304 days or 42.46% based on the sample. The net currency order outflow is moderated relative to the previous day on 652 days of the 1563 days in the population, giving an unconditional proportion of 41.71%. Here, the conditional proportion is greater than the unconditional proportion. This implies that Bank Indonesia market intervention did move in the desired target by moderating the net currency order

flow out of the US dollar at a slow pace, but does not reverse the position. The same interpretative analogy applies to other countries in the sample.

The results show that the conditional probability is greater than the unconditional probability for only two out of the five tests conducted for all the countries in the sample. In three cases, the conditional probability is less than expected. Therefore, it appears that Bank Indonesia reduces and moderates the net currency order flow out of US dollar. However, statistical significance at 1% level is only found on SC1 (p-value 0.0132). Likewise, in the Malaysian foreign exchange market, it appears that Bank Negara Malaysia accentuates and moderates the net currency order flows out of US dollar, however, statistical significance at 5% level is only found twice (SC3 and SC4). Meanwhile, in the Philippines, Singapore and Thailand foreign exchange markets, it seems that the monetary authorities reduce and accentuate the net currency order flow out of US dollar. Although statistical significance is only found on SC3 for the Philippines and Singapore, while in Thailand, statistical significance is only found on SC1.

According to the literature, most of the Central Bank interventions were kept secret/unreported by the monetary authorities. Therefore, this thesis divided the sample according to whether the intervention was detected/reported or not, based on the newswires reports from the Bloomberg.

Table 6.2 reports the summary of success criteria performance on secret intervention days for all the ASEAN-5 countries' currencies against the US dollar currency order flows. Of the 716 days of Bank Indonesian market intervention, 86 days were detected/reported and 630 days were not. Likewise in Malaysia, of the 673 days of Bank

Negara Malaysia market intervention, 68 days were detected/reported and 605 days were not. Also in the Philippines, of the 1173 days of Bangko Sentral ny Pilipinas market intervention, 35 days were detected/reported and 1138 days were not. Meanwhile, in Singapore, of the 932 days of Monetary Authority of Singapore market intervention, 31 days were detected/reported and 901 days were not. While in Thailand, of the 783 days of Bank of Thailand market intervention, 84 days were detected/reported and 699 days were not, based on the newswires reports from the Bloomberg.

Table 6.2: Summary of success criteria performance on secret intervention days for the ASEAN-5 countries' currencies -USD currency order flows

Success Criteria	**SC1**	**SC2**	**SC3**	**SC4**	**SC5**
PANEL A: INDONESIA					
Secret/Undetected Interventions (630) days					
Successful Interventions	214 days	374 days	264 days	254 days	314 days
Conditional (% of Successful Intervention)	**33.91%**	59.37%	**41.91%**	40.32%	49.84%
Expected Number of Success	474 days	964 days	641 days	652 days	784 days
Unconditional (% of Expected No. of Success)	30.31%	61.68%	41.01%	41.71%	50.16%
P-Value	0.1674	0.3083	0.5722	0.3714	0.6833
PANEL B: MALAYSIA					
Secret/Undetected Interventions (605) days					
Successful Interventions	280 days	164 days	126 days	198 days	362 days
Conditional (% of Successful. Intervention)	46.28%	**27.11%**	**20.83%**	32.73%	59.84%
Expected Number of Success	726 days	400 days	291 days	494 days	955 days
Unconditional (% of Expected No of Success)	48.49%	26.74%	19.45%	33.02%	63.84%
P-Value	0.8555	0.2621	**0.0137****	0.2997	0.8018
PANEL C: PHILIPPINES					
Secret/Undetected Interventions (1138) days					
Successful Interventions	328 days	657 days	324 days	701 days	476 days
Conditional (% of Successful Intervention)	28.82%	57.73%	28.47%	**61.60%**	41.83%
Expected Number of Success	508 days	921 days	492 days	961 days	758 days
Unconditional (% f Expected No. of Success)	32.50%	58.93%	31.48%	61.48%	48.50%
P-Value	0.1440	0.3246	0.1931	0.3163	0.4663
PANEL D: SINGAPORE					
Secret/ Undetected Interventions (901) days					
Successful Interventions	492 days	344 days	468 days	339 days	441 days
Conditional (% of Successful. Intervention)	54.61%	38.18%	**51.94%**	37.62%	48.95%
Expected Number of Success	889 days	609 days	797 days	596 days	787 days
Unconditional (% of Expected No. of Success)	56.88%	38.96%	50.99%	38.13%	50.35%
P-Value	0.1237	0.2132	**0.0384***	0.4832	0.2487
PANEL E: THAILAND					
Secret/Undetected Interventions (699) days					
Successful Interventions	134 days	394 days	128 days	304 days	357 days
Conditional (% of Successful Intervention)	**19.17%**	56.37%	18.31%	**43.49%**	51.07%
Expected Number of Success	282 days	914 days	288 days	673 days	819 days
Unconditional (% of Expected No. of Success)	18.03%	58.48%	18.43%	43.06%	52.40%
P-Value	0.1240	0.2532	0.3338	0.1653	0.5239

* denotes significance at the 5% level; ** at the 1% level.

Therefore, this thesis repeats the calculations using the 630 days sample of secret/unreported market intervention for Indonesia, 605 days for Malaysia, 1138 days for the Philippines, 901 days for Singapore and 699 days for Thailand. The results show that Bank Indonesia reduces and accentuates the net currency order flows out of US dollar; although none of the five tests conducted were statistically significant. Likewise, for Malaysia, it appears that Bank Negara Malaysia reverses and accentuates the net currency order flows out of US dollar, but then, only one of the five tests conducted is statistically significant at 1% level of significance (Pv 0.0137). Meanwhile, in the Philippines, it appears that Bangko Sentral ny Pilipinas only moderates the net currency order flow out of US dollar, but, none of the five tests conducted were statistically significant. Furthermore ,in Singapore, it seems the Monetary Authority of Singapore only accentuates the net currency order flows out of US dollar, and statistical significance at the 5% level is only found in SC3 (Pv 0.0384). While in Thailand, it appears that Bank of Thailand reduces and moderates the net currency order flow out of US dollar, but then, none of the five tests conducted were statistically significant. These results therefore confirm that there is no much evidence to show that market intervention improves the situation to alter the US dollar currency order flows in the ASEAN-5 countries foreign exchange markets.

Table 6.3 reports the results of the standard regression of the daily change in the (log) of the spot ASEAN-5 countries' currencies against the US dollar on the net currency order flows. This thesis employs the full sample, non-intervention days (subset of full sample), intervention days (subset of full sample), secret/unreported intervention days (subset of intervention days) and detected/reported intervention days (subset of intervention days).

Table 6.3: Summary of linear regression of the daily change in the log of the spot ASEAN-5 countries' currencies-USD on the net currency order flow

	Coefficient	t-statistic	R-squared	P-value
PANEL A: INDONESIA				
Full- Sample (1563 days)	0.000121	4.6163	0.1179	0.0000**
Non-Intervention days (847)	0.000147	3.0836	0.0675	0.0214*
Intervention days (716)	-0.000114	1.5114	0.0221	0.1311
Secret Intervention days (630)	-0.000895	1.1928	0.0156	0.2334
Detected Intervention days (86)	-0.000564	0.3098	0.0109	0.7575
PANEL B: MALAYSIA				
Full- Sample (1496 days)	0.004260	5.1411	0.1915	0.0000**
Non-Intervention days (823)	0.004350	3.7765	0.1048	0.0013**
Intervention days (673)	0.000346	1.1283	0.0778	0.2311
Secret Intervention days (605)	0.000517	1.1054	0.0535	0.2104
Detected Intervention days (68)	-0.000648	0.2651	0.0323	0.7920
PANEL C: PHILIPPINES				
Full- Sample (1563 days)	0.000128	2.3915	0.0550	0.0271*
Non-Intervention days (390)	0.000621	1.6150	0.0376	0.1235
Intervention days (1173)	0.000107	1.2191	0.0413	0.2179
Secret Intervention days (1138)	0.000114	1.1581	0.0458	0.2310
Detected Intervention days (35)	0.000315	0.8195	0.0020	0.4185
PANEL D: SINGAPORE				
Full- Sample (1563 days)	0.006290	5.7440	0.1879	0.0000**
Non-Intervention days (631)	0.002270	3.1145	0.1013	0.0017**
Intervention days (932)	0.000510	0.5076	0.0003	0.6118
Secret Intervention days (901)	0.000526	0.5090	0.0003	0.6109
Detected Intervention days (31)	0.001980	0.6100	0.0011	0.5470
PANEL E: THAILAND				
Full- Sample (1563 days)	0.000394	4.6984	0.1168	0.0002**
Non-Intervention days (780)	0.000183	2.9517	0.0980	0.0314*
Intervention days (783)	0.000149	1.2695	0.0612	0.2148
Secret Intervention days (699)	0.000112	1.1321	0.0315	0.2452
Detected Intervention days (84)	-0.000845	0.7868	0.0103	0.4784

* denotes significance at the 5% level; ** at the 1% level.

The results show that there are explanatory power (R^2) in the linear regression for the full sample and non-intervention days in the Malaysia and Singapore foreign exchange markets, and statistically significant at 1% level. However, on the intervention days, secret intervention days and detected intervention days, very weak explanatory power and statistically insignificant are deduced. Likewise, in the Indonesia and Thailand foreign exchange markets, the results show thatthere is an explanatory power in the linear regression for the full sample. Meanwhile, non-intervention days, intervention days, secret intervention days and detected intervention days reveal low/weak explanatory power. Nevertheless, the full sample and non-intervention days are statistically significant at 1% and 5% respectively. However, in the Philippines foreign exchange market, the full sample, non-intervention days, intervention days, secret intervention days and detected

intervention days reveal very low/weak explanatory power in the linear regression although, the full sample shows 5% level of statistical significance.

Furthermore, the correlation between currency order flow and exchange rate disappears on intervention days, secret intervention days and detected intervention days for all the countries in the sample. This is difficult to explain. Though, one of the main reasons might be based on the market makers/dealers who observed the news that market intervention was taking place and priced it into the market while the newswires were not informed, thus, making currency order flow unimportant in affecting the exchange rate during intervention days. Therefore, the presence of ASEAN-5 countries monetary authorities in the foreign exchange market appears to affect the relationship between currency order flow and exchange rates of their domestic currencies against the US dollar. Hence, ASEAN-5 countries' foreign exchange markets are sensitive to market intervention.

These results are consistent with other empirical studies, such as Girardin and Lyons (2007) when they investigated on how intervention alters private behavior, using daily data on trades from mutual funds, hedge funds and non-financial corporations. Focusing on the marked period of aggressive Bank of Japan market intervention in the Yen/US dollar market, they find that trades of corporates and hedge funds move significantly in the Bank of Japan market intervention direction. Likewise, Chaboud and Humpage (2005) when they assess the short-term price impact of Japanese foreign exchange intervention operations between 1991 and 2004 using official data from Japan's Ministry of Finance. The findings show that a modest "*learn against the wind"* effect exists, eventhough market intervention lacks forecast capability to move the exchange rate in the desired direction consistent with the Bank of Japan market intervention operations. Marsh (2011) when e examined the behavior of end-user order flows in the foreign exchange

market around the time of profound and extensive market intervention activity by the Bank of Japan. The findings show that, on days when Bank of Japan intervenes in the foreign exchange market, the firm relationship between order flows and exchange rate fluctuations disappears.

6.2 Chapter Summary

The main reason(s) for initiating market intervention in the foreign exchange markets by the monetary authority may not be ascertained. Hence, it is empirically difficult to measure the success (or otherwise) of monetary authority market intervention using one particular criterion. Therefore, this thesis adopts five out of nine criteria as applicable to the emerging market studies some of the tools and methods of success criteria used by Marsh (2011) for the purpose of assessing the success (or otherwise) of ASEAN-5 countries foreign exchange market intervention. The analysis is in one direction, as the monetary authorities in ASEAN-5 countries intervene to curb the depreciation of their currencies against the US dollar. Therefore, this thesis evaluates the success (or otherwise) of the ASEAN-5 countries foreign exchange market intervention operations using four major criteria and an aggregate criterion that incorporates the first four. The focus is on the relationship between currency order flow and market intervention, and thereafter, currency order flow and exchange rate movements.

The results of the five tests indicated that the monetary authorities reduces and accentuates the net currency order flow out of US dollars, though, statistical significance at 1% is found in only 1 out of the 5 success criteria. Therefore, there is no much evidence

to show that market intervention improves the situation to alter the currency order flows in the ASEAN-5 countries' foreign exchange markets, especially against the US dollar.

In addition, there is an explanatory power in the linear regression for the full sample and non-intervention days for all the countries in the sample with the exception of the Philippines. Likewise, the correlation between currency order flow and exchange rate disappears on intervention days, secret and detected intervention days. This implies that, the presence of ASEAN-5 countries monetary authorities in the foreign exchange market seems to affect the relationship between the currency order flow and exchange rates, especially against the US dollar. Therefore, the foreign exchange markets of ASEAN-5 countries are sensitive to market intervention. These results are consistent with other empirical studies of developed market and emerging markets of similar nature.

CHAPTER 7: CONCLUSIONS

7.1 Summary of Thesis: The Main Findings

This thesis examines the relationship between currency order flow and exchange rate of ASEAN-5 countries over a 6-year period (2010 – 2015). This thesis aims to improve the understanding of ASEAN-5 countries exchange rate policy from a market microstructure perspective, thereby attempts to address three research objectives. The first is to examine the role of currency order flow in determining exchange rates movements against USD. Second is to determine the short-run and long-run interaction between micro-macroeconomic variables and exchange rates. Third, to test the effectiveness of central bank intervention in the foreign exchange markets through the behavior of currency order flow.

The hypotheses development for the first and second objective of this thesis are based on the *portfolio shift* model by Evans and Lyons (2002a), and extended by Zhang et al. (2013). These models are applied to analyze datasets of every fifteen-minute currency order flow and exchange rate movements in the ASEAN-5 countries' currency pair against the US dollar, for the period, January 4, 2010 to December 31, 2015. Covering this extensive period, and the quality of the dataset, and its precise high frequency, these datasets are unique. In addition, data for this thesis were sourced from Reuters and Bloomberg databases. The tick-by-tick trading prices data and market intervention newswire reports were sourced from Bloomberg, while Reuters provide daily exchange rate, interest rate and risk premium data for this study. Therefore, this study contributes to the market microstructure of the exchange rate theory in the emerging markets.

For the third objective, this thesis adopts five out of nine criteria as applicable to emerging market studies, namely, *Reducing the net currency order flow out of dollar;*

Reversing the direction of the net currency order flow; Accentuating the net currency order flow; Moderating the net currency order flow and *General success criterion for net currency order flows.* Some of the tools and methods of success criteria used by Marsh (2011) for assessing the success (or otherwise) of the ASEAN-5 countries' monetary authorities market intervention in the foreign exchange markets.

The Augmented Dickey-Fuller (ADF) test is employed to assess the stationary and non-stationary of the time series data. Likewise, the restricted and unrestricted models regression are compared using Granger causality tests and Wald tests in order to identify the direction of the variables (currency order flow and exchange rate). VAR model and OLS with Heteroskedasticity robust standard errors were employed to estimate each vector autoregression equation. In addition, impulse responses of the variables in the system are based on parsimonious VAR. Comparing unrestricted VAR and parsimonious VAR, parsimonious VAR response estimates is expected to have capacity to convey realistic economic information. In addition, among other variables in the specification, Cholesky decomposition is employed to decompose exchange rate movements.

The stationarity of the data is checked, and all the data series in the system are statistically significant at 1% level, and at $I(1)$ process for all the countries in the sample. Furthermore, with the exception of Singapore long-term interest and all the variables fail the JB test. Furthermore, using Johansen cointegration analysis, two cointegrating relationships exist at 1% level of significance for all the countries in the sample. In addition, there exists long-run cointegrating relationship between the exchange rate and country risk premium for all the countries in the sample. Likewise, the results of Granger causality tests indicate that exchange rate Granger causes currency order flow and vice-versa for Malaysia, Singapore and Thailand. That is, there exists bidirectional causality. While in Indonesia and the Philippines, there exists unidirectional causality from currency

order flow to exchange rate movements of USD/IDR and USD/PHP. Furthermore, within the day transactions, for every currency order flow increasing at 1%, there would be a corresponding increase of 17 basis points of IDR price; 55 basis points of MYR price; 26 basis points of PHP price; 35 basis points of SGD price; and 27 basis points of THB price, all against the US dollar. Hence, it shows that currency order flow can explain short-term determination of the exchange rate value of ASEAN-5 countries' currencies against the US dollar.

In addition, the short-term correction result for all the countries in the sample shows that the coefficients are all negatively significant between 5% and 10% levels of significance. This implies that in ASEAN-5 countries' foreign exchange markets, currency order flow Granger causes exchange rate movements in the short-term. Likewise, the model of fifteen-minute currency order flow produces R^2 statistics between 6 percent (Philippines) and 19 percent (Singapore). These relatively low R^2's are due to manage-float exchange rate regime practiced by the sample countries, as this exchange rate regime may lead to frequent occurrence of market intervention by the monetary authority. Moreover, the level at which the currencies of emerging economies being traded in the foreign exchange markets are relatively low, compared with major currencies of the developed markets. These may be some of the main reasons for the difference in the results with that of Evans and Lyons (2002a). Nevertheless, the results are consistent with other empirical findings from the developed markets and some emerging economies of similar nature, such as Brazil and China.

The impulse response functions results illustrate that the exchange rate fluctuation occurs immediately and stable in response to various shocks to currency order flow for all the five countries in the sample. Moreover, the results of variance decomposition of exchange rate indicate that currency order flow accounts for 7% of daily exchange rate

movements in the Indonesia foreign exchange market; 24% in the Malaysia foreign exchange market; 6.4% in the Philippines foreign exchange market; 17% in the Singapore foreign exchange market; and 15% in the Thailand foreign exchange market. Country risk premium averagely accounts for 3.12%, while the short-term interest and long-term interest account for not more than 1% on average for all the five countries in the sample. Therefore, it appears that currency order flow and country risk premium variables are the two influential determinant of exchange rate fluctuations in the ASEAN-5 countries' foreign exchange markets.

Furthermore, this thesis dispense with the success criterion for the sale of US dollars and evaluate the success of the ASEAN-5 countries monetary authorities market intervention operations using four major criteria and an aggregate criterion that incorporates the first four. Based on the results of the five tests conducted, it appears that the group monetary authorities reduces and accentuates the net currency order flow out of US dollars. Statistical significance at 1% level is found in only one out of the five success criteria. Hence, there is a weak evidence to show that market intervention in the ASEAN-5 countries foreign exchange markets improves the situation to alter the US dollar currency order flows. In addition, the standard regression results illustrate that there exists explanatory power for the full sample and non-intervention days for all the countries in the sample with the exception of the Philippines. However, the correlation between currency order flow and exchange rate disappears on intervention days, secret intervention days and detected intervention days for all the five countries in the sample. This implies that, the presence of this group monetary authorities in the market affect the relationship between the currency order flow and exchange rates against the US dollar. Therefore, the ASEAN-5 countries' foreign exchange markets are sensitive to market intervention.

7.2 Research Implications

The thesis used various techniques of the market microstructure approach to explore these issues, and finds that currency order flow can explain short-term determination of the exchange rate value of ASEAN-5 countries' currencies against the US dollar. In addition, it finds that currency order flow and country risk premium is the only two influential determinants of exchange rate for ASEAN-5 countries.

The thesis adopts some market intervention success criteria and ordinary least square approach to explore market intervention and the extent to which this policy tool is effective. The study finds that market intervention is effective in influencing both the exchange rate and currency order flow, as the presence of monetary authorities affect the correlation between exchange rate and currency order flow. The monetary authorities mostly intervene to smooth the foreign exchange market, which is more of "*leaning against the wind"* but unable to reverse the trend. Therefore, the exchange rates of ASEAN-5 countries are sensitive to central bank intervention.

Therefore, this thesis sheds more light to the monetary authorities, market dealers and market players on the importance of employing market microstructure approach to determine exchange rate movements in the emerging markets.

7.3 Research Limitations

This thesis aims to improve the understanding of ASEAN-5 countries' exchange rate policy from a market microstructure perspective. Therefore, it sheds more light on how the value of ASEAN-5 countries' currencies are determined in the long run, and also identify the dynamics of the group currencies movements against the US dollar in the

short- run. Nevertheless, the thesis has limitations and some challenging areas for future research.

First, a comprehensive description on how currency order flow drives exchange rate movements before and after the global financial crisis is not within the scope of this research, as this study only measures the flexibility and volatility of the group exchange rates after the global financial crisis. Second, due to non-availability of data, the number of major trading partners' currency pairs were excluded in the empirical analysis, therefore, cross-section market analysis cannot be performed by this study. Third, this group monetary authority's market intervention information is scarce, except for those that were made available through newswires reports. Therefore, to compare the research evidence with the monetary authority asserted market intervention objective (s) posed a huge challenge.

7.4 Suggestions for Future Research

Future research on the impact of currency order flow on exchange rate before and after the global financial crisis looks promising. This may contribute a comprehensive description on how currency order flow drives the exchange rate movements in the emerging markets, especially, the ASEAN -5 countries' currencies against the US dollar. Next, with availability of data, the number of major trading partners' currency pairs can be increased. Achieving this may indicate detailed empirical evidence on how the ASEAN-5 countries foreign exchange market performs in a cross-section market situation. Furthermore, in investigating the exchange rate movements from the market microstructure perspective, apart from currency order flow, another microeconomic variable (bid-ask) appears promising in this direction. This might shed more light on the

dynamics of exchange rate determination in the ASEAN-5 countries foreign exchange markets.

Importantly, the monetary authorities' market intervention information of the ASEAN-5 countries is scarce, except for those that were sourced from the newswires reports. Therefore, future research should find out more important information on market intervention from the government officials responsible to release such information. Thus, officially asserted objective(s) can be compared with the research evidence. This may provide fundamental insight to the development and subsequent improvements on the foreign exchange policy of the ASEAN-5 countries.

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