CURRENCY ORDER FLOW, EXCHANGE RATE DYNAMICS AND MARKET INTERVENTION: EMPIRICAL EVIDENCE FROM THE MALAYSIAN AND THAILAND FOREIGN EXCHANGE MARKETS.

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Abstract

This paper presents empirical test results of Malaysian and Thailand foreign exchange market microstructure assessment of exchange rate dynamics and market intervention. The study investigates whether currency order flow captures the movement of exchange rate of MYR and THB against US dollar, and how the long-term and short-term components impact the relative estimation of MYR and THB in the international markets. The study construct a measure of currency order flow in the Malaysian and Thailand foreign exchange markets to reflect the pressure of currency excess demand. VAR model is applied to estimate the important role of currency order flow in the determination of the currency exchange rate for the Malaysian ringgit (MYR) and Thailand Bath (THB) against the US dollar (USD). A hybrid model of order flow and exchange rate dynamics proposed by Evans and Lyons (2002a) and extended by Zhang et al (2013) is applied to the countries' foreign exchange market (MYR/USD and THB/USD) to analyze a dataset of every fifteen-minute currency order flow and exchange rate movements from January 2010 to December 2015. Also, the effectiveness of foreign exchange market intervention by the duo central banks (Bank Negara, Malaysia and Central Bank of Thailand) is tested through the behavior of currency order flow. The findings reveal that currency order flow explains an important portion of the movement in the MYR-USD and THB-USD exchange rate. And that, the exchange rates of these countries are sensitive to foreign exchange market intervention.

Keywords: Currency order flow, Exchange rate, Foreign exchange market, Market intervention.

Introduction

In the recent past, the dwindling foreign exchange reserves, subsequent depreciation of currency and consequent market intervention in the foreign exchange market of Malaysia and Thailand monetary authorities have posed a great challenge on their exchange rate policy (ADB, 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, et al. 2011). Also, 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.

Meanwhile, 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). Therefore, 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).

Researchers in this field of international finance concentrated majorly on matured economies and the world currency pairs, but a small number of studies have investigated the essential role currency order flow plays in the foreign exchange markets in the emerging markets. Indeed, among the high-performing economies in Association of Southeast Asian Nations (ASEAN) are Malaysia and Thailand. Given these countries diverse economic relationship with the USA, the economies of these nations ought to achieve a reasonable degree of exchange rate stability. However, it is unfortunate for these countries to experience a continuous reduction in their foreign exchange reserves, which also led to their currency depreciation in the international market, especially against USD. Meanwhile, the successful transition of these emerging economies to full development is important both to the world economy and as a model for other emerging economies. With these countries rising importance in the world economy and the growing complexity of the economic and financial globalization, it is desirable yet challenging to achieve a superior appreciative of how the value of Malaysian ringgit (MYR) and Thailand Bath (THB) against the US dollar (USD) are determined in the international currency market both at the long run and short run. Likewise, the effectiveness of market intervention as a policy tool to influence the future direction of exchange rates through the behavior of currency order flow can be investigated.

A data set for every quarter of an hour currency order flow and exchange rate fluctuations for the period of six years (January 2010 to December 2015) is analyzed using hybrid model of order flow and exchange rate dynamics proposed by Evans and Lyons (2002a) and extended by Zhang et al (2013). Covering this extensive period, and the quality of the data set, and that of its precise high frequency, these data sets are unique. To reflect the pressure of currency excess demand, the study therefore construct a measure of currency order flow in the Malaysian and Thailand foreign exchange markets context. Vector autoregression (VAR) model is applied to estimate the cointegrating relations between cumulative currency order flow and exchange rate fluctuations in the Malaysian and Thailand currency exchange markets. The major concern is to proffer answers to the following questions:

Q1. In the international currency market, does currency order flow capture the movements of MYR and THB exchange rates against the US$?

Q2. In the international currency market, do the long-term and short-term elements impact on the estimation of the MYR and THB?

Q3. In the foreign exchange market, through the behavior of currency order flow, does market intervention as a policy tool influence the future direction of exchange rate of MYR and THB against the USD?

The results show that, there exists bidirectional causality between the currency order flow and exchange rate for both countries. Meaning that, currency order flow Granger causes exchange and vice-versa. While testing the potency of the relationship at longer horizons, the paper consider 6 weeks as 30 trading days, 4 weeks as 20 trading days and 2 weeks as 10 trading days. Therefore, it tests for 30 trading days' time horizon using Cholesky decomposition. The result shows that, there is a strong relationship between cumulative currency order flow and currency exchange rate at 30 trading days. Thus, even at longer horizon, there is a positive and strong relationship between cumulative currency order flow and exchange rates in the Malaysian and Thailand foreign exchange markets. From the results, it appears that currency order flow is the most exogenous variable relative to other variables in the specification, evidencing that, currency order flow can explain up to 15 per cent of the fluctuations in exchange rates for every US$10m/THB purchase, and USD/MYR purchase, currency order flow can explain up to 24 per cent of the currency exchange rate movements. The motivation for this study comes on the premise that currency exchange rate determination using market microstructure approach requires further understanding and light shedding, most especially, in the emerging markets of this nature. Given the span of data, this paper is able to shed more light on the usefulness and appreciativeness of currency order flows in the emerging markets. In addition, based on high frequency data, the paper 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.

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 these countries are sensitive to central bank intervention. However, the paper suggests that without a sound monetary and fiscal policy, using market intervention to stabilize exchange rate may not work in the long-run. While concentrating on the currency order flow and determination of the exchange rate in the international market, this research contributes to the market microstructure of the exchange rate theory in the emerging markets economy. Also, it will help scholars to have profound grasp of currency order flow as one of the major microeconomic factors to be considered in the currency exchange market, most especially, in the emerging markets economy. Importantly, the policy makers and practitioners will have a deeper understanding of the explanatory power of currency order flow on how this influential variable drives the exchange rate movements in the foreign exchange market, not only developed but also emerging markets. This research paper is structured as follows: the next section reviews literature on exchange rate dynamics and market intervention with reference to market microstructure. Then the paper discusses the data and methodology. Finally, the paper presents the empirical results and provides the conclusion.

Literature Review

Market microstructure of exchange rate stresses on the role trading in foreign currencies play in price formation via a concept known as order flow. Evans and Lyons (2007) defined currency order flow to be the difference between the buyer-initiated and the seller-initiated trading interest in a given market, and thus relates largely to what practitioners in the market might refer to as aggressive buying and selling of foreign currencies in the foreign exchange markets. Although, in the models of the following researchers, Lyons (1995), Perraudin and Vitale (1996) and Evans and Lyons (2002a, 2002b), currency order flow gives explanation on concomitant exchange rate fluctuations, as it includes information, either about fundamentals or long-run risk premia, which was hitherto circulated among foreign exchange market dealers and participants. Hence, the uniqueness of the microstructure level analysis when compared to the traditional exchange rate framework is that even though the same information is made available to all market participants but interpreted differently.

Following the research work of Meese and Rogoff (1983) and Frankel and Rose (1995), other researchers (Evans and Lyons, 2002a, 2002b; Osler, 2006; Cheung et al., 2005) follow suit to explain currency exchange rate fluctuations via the process and procedure of technical trading approaches, currency order flows and price formations. Therefore, financial economists and international finance academia are at ease with an information perception in the financial markets, thereby depending on a number of analytical models involving market microstructure and economic fundamentals for an enhanced and appreciativeness of the financial markets. As a measure of the sum of the signed seller-initiated order and that of the buyer-initiated orders in the experiential stipulation, currency order flow is deemed to be an essential information transmission device connecting price fluctuations and diffuse information (Evans, 2011). In fact, market microstructure research works have focused on the explanatory role of currency order flow in the exchange rate models with two basic classifications of data: customer order flow data and interdealer order flow data (Evans and Lyons, 2007).

The work of Evans and Lyons (2002a), using interdealer order flow of four months exchange rate transaction data to analyze the daily fluctuations between DM/US$ and JPY/ US$ shows that, order flow actually accounts for more than 60 percent of daily fluctuations in the DM/US$. Further research study by Evans and Lyons (2002b), focusing on seven different currencies against the US$ shows that, currency order flow can generate an R^2 of 78 percent daily. Furthermore, Berger et al. (2008) examine the relationship between order flow and exchange rate of the EUR/USD, using interdealer transaction data over a period of six-year (1999-2004).

The results show that, a substantial relationship exists between interdealer order flow and exchange rate returns at short horizons. The simple description of inventory effect, information effect and liquidity effect with how currency order flow drives the movements of the exchange rate is summarized by Osler (2006). There exists an unwarranted risk that dealers are exposed to when anticipated currency position is not achieved. To guide against this risk when their inventory positions are not in conformity with their desired levels, they therefore adjust the price by sliding it or increase it to attract more buying or selling orders to maintain and retain their desired currency positions. Consequently, inventory models cannot be used to explain permanent exchange rate movements but momentarily. However, market prices should be permanently affected by order flow using information models. Therefore, there should be cointegrating relationship between currency order flow and exchange rate (Zhang et al., 2013). Meanwhile, Hasbrouck (1991) proposed microstructure VAR model to investigate New York stock exchange. Payne (2003) apply the same model to examine US$/DM for a period of one week (October 6 to 10, 1997), and the result shows that trading with an informed dealers, currency order flow can generate up to 60 percent fluctuations on exchange returns. Froot and Ramadorai (2005) investigate the interaction between permanent shock and transitory shock on exchange rate earnings applying order flow as a main factor of exchange rate fluctuations. They find out that although macroeconomic fundamentals can be used to explain currency return in the long term, but order flow, a microeconomic variable is more appropriate to explain currency return in the short term. Therefore, going by these findings, currency order flow is of great importance to research on in the foreign exchange market, by examining its role in the determination of exchange rate both in the long- and short-term dynamics. However, most of the researchers in this field truly concentrated on the major currency pairs. For example, Rime (2000) employ microstructure approach, investigates the influence of order flow on exchange rate determination on deutschmark, British pound sterling, Canadian dollar, Swiss franc and Japanese yen, all against US dollar, for the period July 1995 to September 1999.

The results show that there is a cointegrating relationship between exchange rate and order flow for deutschmark/US$, British pound sterling/US$ and Swiss franc/US$. It implies that, there is an explanatory power of exchange rate fluctuations when order flow is lagged. Andersen et al. (2003), Evans and Lyons (2005) and Berger et al. (2008) investigate the explanatory power of order flow in their empirical studies. In the studies of currency order flow and exchange rate in the emerging markets, Zhang et al. (2013) examine the influential role of currency order flow on exchange rate fluctuations between Chinese RMB and US$, and they find out that order flow explains significantly exchange rate fluctuations in the Chinese foreign exchange market. More so, research work of Duffuor et al. (2012) reveals that in the Ghanaian foreign exchange market, the end-user order flow does not have much influence on the exchange rate fluctuations. In essence, there is a weak performance. In the Brazilian foreign exchange market, Wu (2010) investigates the interactions between the commercial and financial customer order flow and finds that positive relationship exists between the financial customer order flow and intervention flows, whereas a negative relationship exists between the commercial customer order flow and exchange rate. Menkhoff et al. (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).

On market intervention, it 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). 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 (Dominguez, 2003). 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 et al. (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). Fratzscher et al. (2017) examine foreign exchange market intervention, using confidential daily data on foreign exchange market intervention, the paper makes 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.

However, the effectiveness of market intervention as a policy is highly controversial (BIS, 2013a). Daude et al. (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. Other studies that presents evidence that supports the view that in the short-run central bank market intervention can influence the exchange rate (Dominguez et al 2013; Fatum, 2015).

Meanwhile, active foreign exchange market intervention in the developed market is hardly visible in the last decade with the exception of Japan (Marsh, 2011). But, 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, among others.

But then, 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. 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. 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. Like many other monetary authorities, Malaysian and Thailand monetary authorities have enfolded their foreign exchange market intervention in secrecy.

This study 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 researcher also gathers information from the construct of currency order flow measurement and exchange rate. Hence, it presents a rich context for this paper, which aims at a better understanding of foreign exchange market intervention and the effectiveness of this policy tool in Malaysia and Thailand.

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.

The inconclusiveness of these research studies and their findings inspired the researcher to investigate further, the emerging market currencies of Malaysian ringgit (MYR), Thailand Bath (THB) and that of developed market, US$, to examine the strength at which currency order flow can explain exchange rate movements in the Malaysian and Thailand foreign exchange markets. Also, test the effectiveness of foreign exchange market intervention by the duo central banks (Bank Negara, Malaysia and Central Bank of Thailand) through the behavior of currency order flow.

Malaysian and Thailand Foreign Exchange Market: Market-microstructure Perspective

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, in the sense that it accommodates a daily trading volume of an equivalent of over US$4tn. This is three times over and above the total aggregate amount of transactions on the US equity and Treasury market combined. A spot-on 24-h market opens each trading in Sydney and then shifts as the business day commences in other financial center, i.e. from Sydney to Tokyo, London, New York and Frankfurt. Although, a time comes where two trading sessions are open at the same time. This is described as overlapping trading sessions. In this situation, there is a tendency for more volume to be traded, as all the market participants are "wheel-in" and "deal-in", meaning that more money is transferring hands among the market participants in the foreign exchange market. In Thailand, in relative terms, it is the forces of demand and supply that do determine the exchange rate to an extent. Even though, such forces of demand for currency and supply of currency are derived from international trade value, international capital flows and market expectations among other factors. On July 2, 1997, the country adopted a managed-float exchange rate regime which made the Bank to implement foreign exchange rate management structure that aims to maintain currency stability. In the foreign exchange market, monitoring and supervision of Thai-Baht (THB) exchange rate against other currencies is the responsibility of the Bank of Thailand (BOT). Foreign exchange transactions in Thailand must be carried-out through authorized commercial banks and authorized non-banks, which include authorized money changers, authorized money transfer agents and authorized companies that are granted licenses by the Ministry of Finance to officially carry-out foreign exchange transaction (BOT, 2016). Currently, only few major currencies, for example US$, Euro and Japanese yen are normally used for international trade and service settlement.

For Malaysia, The Bank Negara Malaysia (Central Bank of Malaysia) administered foreign exchange controls on behalf of the Malaysian Government with specific authorities delegated to the authorized banks. The Malaysian Government placed the effective rate for her currency on a controlled and fluctuating basis in June 1973. However, the Bank intervenes as the need arises to maintain and sustain orderly foreign exchange market conditions and to circumvent too many variations in the value of the ringgit in relations with Malaysia trading partners and other international currencies of settlements (Ariff, 1991). Meanwhile, ringgit pegged to the USD in 1997 was replaced with a managed float system in July 2005. The primary motivation for the policy shift according to the Central Bank of Malaysia is to better position Malaysia to respond and benefit from the structural changes happening in the region and in the international environment (Bank Negara Malaysia, 2016).

Noticeably, the introduction of the 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) is the only LVPS for high value and time critical payments acceptable in the country and this operates under real-time gross settlements (RTGS). The main objective is to improve the overall efficiency of the LVPS. 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.

Figure 1 shows the correlation between US$/THB and currency order flow and US$/MYR currency order flow. Spotted from Figure 1, currency order flows are constant between January 2012 and July 2013 and September 2013 and July 2015, respectively for Thailand. Likewise, currency order flows are constant between September 2012 and March 2015 in the Malaysian foreign exchange markets. This strange occurrence made us to investigate further what could have been the major cause. Although, most of the emerging markets economy do not operate free floating rather managed floating which may lead to frequent occurrence of currency intervention by the monetary authority. The findings show that Bank Negara, Malaysia and Bank of Thailand consistently intervene to curtail the depreciation of MYR and THB against the US$ in the foreign exchange market during these periods. This may be one of the major reasons for the currency order flows to remain constant during these periods.

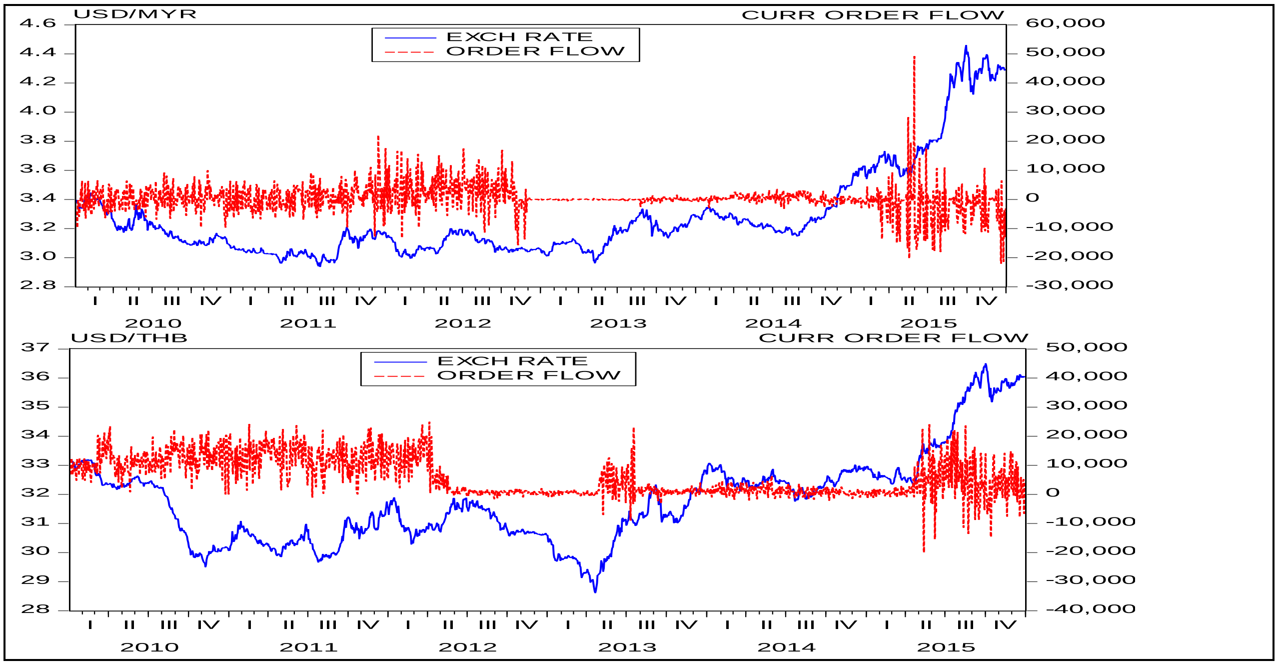

Figure 1: Exchange Rate of USD/ MYR; THB and Currency Order Flow (04/01/2010 – 31/12/2015)

Data and methodology

Data sources

The data were from Reuters and Bloomberg. Spot foreign exchange market and trade transactions on the Malaysian and Thailand foreign exchange market is the focus of this paper.

MYR and THB against the US$ for the period January 4, 2010 to December 31, 2015 is applied to analyze a data set of every quarter of an hour currency order flow and exchange rate movements over a six-year period. For Thailand, a total sample of 1564 trading days excluding weekends and public holidays. Spot currency exchange trading usually opens for business on Monday morning and closes on Friday evening. Even though, trading in the spot foreign exchange market in Thailand is conducted on a 24-hour basis (i.e. from 1700 hour to 1659 hour). Currently, foreign currency transaction settlement period in Thailand is set at T + 2. (i.e. two days after the transaction day). While, for Malaysia, a total of 1,497 trading days excluding weekends and public holidays. The opening time for spot foreign exchange trading in Malaysia starts from 0900 to 1700 (i.e., Malaysian Time GMT+8) with four trading sessions 0900, 1130, 1200 and 1700, respectively. The trading periods are in Malaysian time and usually open for business on Monday morning and closes on Saturday morning, excluding public holidays. The settlement period for foreign exchange transaction is set at T+2 (i.e., 2 days after the transaction day). In addition, this study 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.

Also, the paper 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 Malaysian and Thailand 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 study were sourced from Bloomberg database. The monetary authorities (central banks) under consideration include, Bank Negara, Malaysia (BNM) and Bank of Thailand (BOT).

Measurement of Variables

Measurements of variables are in this order: P_t represents the log of each working day closing exchange rate transaction price; X_t is daily accumulated order flow; $(i_t - i_{tf})$ represents the difference in interest rate for short-term period; $(l_t - l_{tf})$ represents the difference in interest rate for long-term period and $(R_t - R_{tf})$ represents the difference in the country's risk premium. Evans and Lyons (2002a) indicate that the daily currency order flows X_t represent the net position between the buyer- and the seller-initiated currency order flows for the day-trading transactions. The difference in the interest rate for short-term period$(i_t - i_{tf})$ represents local interest rate daily overnight period minus the US interest rate daily overnight period. The difference in the interest rate for long-term period$(l_t - l_{tf})$ represents local inter-bank daily lending rate for 1 year minus the US inter-bank daily lending rate for 1 year.

Country's daily risk premium R_t represents the difference between the prime lending rate and 3 months Treasury bill rate. Therefore, the difference between two countries risk premium is given as$(R_t - R_{tf})$. The interest rate data are expressed on an annual basis. Trade direction and the sum of transaction volume are the two major important things from the definition of order flow. Thus, the major task is to determine the trade direction and sum up the tick trading direction of fifteen-minute intraday data. Measure of spot currency order flow is constructed by assigning values to trade, that is, assigned a value to every single buying and selling trade +1 and –1, respectively. Therefore, the summation of these trade signs is equal to 1-day spot order flow over the entire trading period.

The stationarity of the data is checked, and Table 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 both countries in the sample.

Table 1: Summary of Unit Root Analysis

Variables	At 1st difference	
	Intercept	Trend & Intercept
PANEL A: 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 B: 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 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. Meaning that, all the variables depart from Normality. The skewness for all the variables is less than 1 for Thailand and, less than 2 for Malaysia.

Table 1: Summary of Descriptive Statistics and the Correlation Matrix

PANEL A: 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 B: 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, while, there is a positive relation between exchange rate, currency order flow and country risk difference. 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 among these variables needs further investigation.

Transaction price (P_t) and cumulative currency order flow (X_t). Evans and Lyons (2002a, 2002b) propose a model based on a portfolio shift model. This model can be stated as:

$$\Delta P_t = \Delta \mathcal{M}_{t,} + \lambda \Delta X_t \qquad (1)$$

Where ΔP_t represents changes in spot exchange rate; $\Delta \mathcal{M}_{t,}$ represents macroeconomic information innovations (e.g., changes in interest rate differential); λ represents positive constant; ΔX_t is daily accumulated signed order flows.

Transaction Price (P_t) and Interest Rate ($l_t - l_{tf}$)

As a result of public information innovations $\Delta \mathcal{M}_{t,}$ and the change in the log of the spot exchange rate ΔP_t, Equation (1) needs modification to be comparable to the standard macroeconomic models. The estimation specification can be expressed as:

$$\Delta P_t = \alpha . \Delta \left(l_t - l_{tf} \right) + \beta . \Delta X_t + e_t \qquad (2)$$

Where ΔP_t represents change in log of the spot exchange rate; $\Delta\mathcal{M}_{t,}$ in Equation (1) is the change in interest rate differential; that is, $\Delta\mathcal{M}_{t,} = \Delta\left(l_t - l_{tf}\right)$, we substitute $\Delta\mathcal{M}_{t,}$ for change in long-term interest rate differential $\Delta\left(l_t - l_{tf}\right)$. Interest rate is considered to be an important variable that causes exchange rate movements in macroeconomic models, also available on a daily basis. Hence, it is considered suitable for experiential research. ΔX_t represents the daily cumulative order flow, while α and β represent regression parameters, and e_t is the error term.

Term Spread and Country's Risk Premium $(\boldsymbol{R_t - R_{tf}})$

Country's risk premium is a variable considered in the literature to have a positive and strong significance in the studies of emerging markets (De-Medeiros, 2004; Duffuor et al., 2012; Wu, 2010; Zhang et al., 2013). Country's daily risk premium R_t represents the difference between the prime lending rate and 3 months Treasury bill rate. Therefore, the difference between two countries risk premiums is given as $(R_t - R_{tf})$, the local country's risk premium minus that of the US's risk premium. The research work of Evans (2011) states that currency transaction spot rate P_t of a pair currency with their interest rate short-term period is practically determined according to the standard of the monetary policy of the central banks concerned. Therefore, the paper considers Bank Negara Malaysia, Bank of Thailand and the Federal Reserve as the central banks concerned in this study. Quote for all dealers is at a USD/MYR; USD/THB and is given as:

$$P_t = \mathrm{E}P_t + (i_t - i_{tf}) - R_t \qquad (3)$$

Where P_t is the transaction price; $(i_t - i_{tf})$ represents difference 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 3 months Treasury bill rate.

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

$$(l_t - l_{tf}) - (i_t - i_{tf}) = (R_t - R_{tf}) \qquad (4)$$

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

Methodology

The portfolio shift model (Evans and Lyons, 2002a, 2002b) and extended by Zhang et al. (2013) is used in this study, and apply a VAR model proposed by Hasbrouck's (1991) to examine the market microstructure elements of MYR and THB currency exchange rate fluctuations against USD. Johansen's (1995) cointegration is applied to run the analysis with particular reference to the setting of VAR. Cointegration is said to exist between two time series if they are individually nonstationary, even though there exists a linear combination of them with stationarity (Evans and Lyons, 2007). By interpretation, it can be said that a stable long-run equilibrium relation exists. Therefore, VAR framework is extended in the analysis to calculate approximately the explanatory power of currency order flow on exchange rate movements MYR and THB against USD.

The Vector Autoregression (VAR) Model.

The VAR model assumes that quotes from the market are immediately reflected based on public information available to the traders; hence, the informed traders take advantage of this to earn returns via their currency market orders.

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

The model:

$$H_t = \mathrm{B}D_t + E_t \tag{5}$$

and

$$H_t = \begin{pmatrix} P_t \\ X_t \\ (i_t - i_{tf}) \\ (l_t - l_{tf}) \\ (R_t - R_{tf}) \end{pmatrix}_{5\times1} ; \mathrm{B} = \begin{bmatrix} \beta_{1,1} & R & \beta_{1,5l} \\ \vdots & \vdots & \vdots \\ N & O & N \\ \vdots & \vdots & \vdots \\ \beta_{5,1} & U & \beta_{5,5l} \end{bmatrix}_{5\times5l} ; D_t = \begin{pmatrix} P_{t-1} \\ \vdots \\ L \\ \vdots \\ R_{t-1} \end{pmatrix}_{5l\times1} ; E_t = \begin{pmatrix} \varepsilon_{t1} \\ \varepsilon_{t2} \\ \varepsilon_{t3} \\ \varepsilon_{t4} \\ \varepsilon_{t5} \end{pmatrix}_{5\times1} \tag{6}$$

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:

$$H_t = \Gamma D_{t-1} + \varepsilon_t \tag{7}$$

hence,

$$H_t' = f\ [P_t,\ X_t,\ (i_t - i_{tf}),\ (l_t - l_{tf}),\ (R_t - R_{tf})] \tag{8}$$

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.

Presentation of Empirical Results

Table 3 reports the results of Johansen cointegration tests for the two 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 both 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 2: Cointegration Analyses with Levels (Ranks)

PANEL A: 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 Crit. Value (0.05) Probability	285.2089 69.8189 (0.0001)***	63.8831 47.8561 (0.0008)***	32.0589 29.7971 (0.0270)**	7.8313 15.4947 (0.4836)	0.4453 3.8415 (0.5046)
Max-Eigen Crit. Value (0.05) Probability	221.3258 33.8769 (0.0001)***	31.8243 27.5843 (0.0134)***	24.2276 21.1316 (0.0177)**	7.3860 14.2646 (0.4445)	0.4453 3.8415 (0.5046)
PANEL B: 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 Crit. Value (0.05) Probability	153.6605 69.8189 (0.0000)***	57.2116 47.8561 (0.0052)***	28.7464 29.7970 (0.0657)	13.3888 15.4947 (0.1013)	0.0812 3.8414 (0.7756)
Max-Eigen Crit. Value (0.05) Probability	96.4488 33.8769 (0.0000)***	28.4651 27.5843 (0.0385)**	15.3575 21.1316 (0.2646)	13.3076 14.2646 (0.0704)	0.0812 3.8414 (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 4 shows the results of the uniqueness of the cointegrating relationships of the variable space tested in the VAR specification. i.e. $H_t' = f\ [P_t\ ,\ \ X_t\ ,\ (i_t - i_{tf})\ ,\ (l_t - l_{tf})\ \ ,R_t\ ,\ R_{tf},\ Trend\ ]$. 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 the two countries in the sample. For example, p-value of 0.0606 is rejected for Malaysia, 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 both countries in the sample.

Table 3: Cointegrating Equations Restriction Tests

	P_t	X_t	$(i_t - i_{tf})$	$(l_t - l_{tf})$	R_t	R_{tf}	Trend
PANEL A: 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
$H_2: P_t = -X_t,\ \chi^2$ (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
$H_3: (i_t - i_{tf}) = - (l_t - l_{tf}),\ \chi^2$ (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
$H_5: R_t = -R_{tf}, \chi^2$ (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
PANEL B: 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
$H_2: P_t = -X_t,\ \chi^2$ (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
$H_5: R_t = -R_{tf}, \chi^2$ (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
$H_6: R_t = -R_{tf}$, 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, the paper 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 Malaysia, the p-value of 0.2887 is accepted from the test results. 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) for the two countries. 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 presents the results of Granger causality tests and long-run weak exogeneity test of the key variables for the two countries. The results show that exchange rate Granger causes order flow and vice-versa both countries. This implies that there exists bidirectional causality.

Table Error! No text of specified style in document.. **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: 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 B: 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% and 1% level is denoted by * and *** represent the level of statistical significance.

Table 6 presents the results of hypotheses tests on the cointegrating relationship among 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 4: Long-Run Formation

	P_t	X_t	$(i_t - i_{tf})$	$(l_t - l_{tf})$	$(R_t - R_{tf})$
PANEL A: 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 B: 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:

Malaysia:

$$\mathcal{U}_i = -P_t + 0.0055 * X_t + 3.6487 * (i_t - i_{tf}) - (l_t - l_{tf}) + (R_t - R_{tf})\text{;} \quad (9)$$

$$\mathcal{U}_{ii} = -2.4023 * P_t - 0.0508 * X_t + (i_t - i_{tf}) - 4.5074 * (l_t - l_{tf}) - 0.8878 * (R_t - R_{tf}) \quad (10)$$

Thailand:

$$\mathcal{U}_i = -P_t + 0.0027 * X_t + 2.3142 * (i_t - i_{tf}) - (l_t - l_{tf}) + (R_t - R_{tf})\text{;} \quad (11)$$

$$\mathcal{U}_{ii} = -10.1159 * P_t - 0.0169 * X_t + (i_t - i_{tf}) - 5.1350 * (l_t - l_{tf}) - 2.1321 * (R_t - R_{tf}) \quad (12)$$

The currency order flow is positively significant for the two countries, implying that there would be higher domestic currency price of MYR and THB against the US dollar once there is a higher imbalance currency position in the net buying activity in both countries foreign exchange markets. Likewise, with a beta coefficient of 0.0055 in the USD/MYR 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, 55 basis points of the MYR price against the US dollar and 27 basis points of the THB price against the US dollar, respectively.

$$\Delta P_t = \mathcal{U} + \alpha_1 * \Delta P_{t-1} + \beta_1 * \Delta X_{t-1} + \beta_2 * \Delta X_{t-2} + \theta * \mathcal{U}_{ii\ t-1} + \varepsilon_{p,t} \quad (13)$$

$$\Delta X_t = \mathcal{U} + \alpha_1 * \Delta P_{t-1} + \alpha_2 * \Delta P_{t-2} + \theta * \mathcal{U}_{i\ t-1} + \varepsilon_{X,t} \quad (14)$$

$$\begin{aligned}\Delta(R_t - R_{tf}) = {} & \alpha_1 * \Delta P_{t-1} + \alpha_3 * \Delta P_{t-3} + \varphi_3 * \Delta(i_{t-3} - i_{tf-3}) + \lambda_1 * \Delta(l_{t-1} - l_{tf-1}) \\ & + \lambda_2 * \Delta(l_{t-2} - l_{tf-2}) + \lambda_3 * \Delta(l_{t-3} - l_{tf-3}) + \delta_1 * \Delta(R_{t-1} - R_{tf-1}) \\ & + \delta_2 * \Delta(R_{t-2} - R_{tf-2}) + \delta_3 * \Delta(R_{t-3} - R_{tf-3}) + \varepsilon_{R,t} \quad (15)\end{aligned}$$

Table 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 both countries. The short-term correction results are negatively significant at 5% level with a coefficient error correction term θ of -0.0413 for Malaysia, and Thailand -0.0330.

Table 5. Error Correction Modeling Estimates

	ΔP_t	ΔX_t	$\Delta(R_t - R_{tf})$
PANEL A: 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 B: 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. 5% and 1% level is denoted by ** and *** represent the level of statistical significance. Standard errors are shown in ( ).

The results indicate that, for both 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 both countries. (Malaysia -0.0912***, and Thailand -0.0564***). This implies that, an important factor influencing exchange rate fluctuations is currency order flow in the Malaysian and Thailand foreign exchange markets.

The R^2 obtained for both countries are relatively low compared with Evans and Lyons (2002a) 0.64 and 0.46. For example, In Malaysia, the R^2 obtained is approximately 0.17. In Thailand, the R^2 obtained is 0.13. One of the major reasons for these relatively low $R^2's$ 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. More so, most of the emerging economies (including Malaysia and Thailand) 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. De-Medeiros, (2004); Cerrato et al. (2011); Zhang et al. (2013); Evans and Lyons, (2005); Marsh and Rourke (2005); Sager and Taylor (2008); Evans, (2010); Rime et al., (2010).

In testing the strength of the relationship at longer horizons, the study considers 10 trading days as two weeks, 20 trading days as 4 weeks and 30 trading days as 6 weeks. Therefore, the paper tests with Cholesky decomposition for a time horizon of 30 trading days. Table 8 reports the results of decomposition of each item forecast error variance in the specification for the two countries. 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.6. 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: 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 B: 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 result indicates that 24% of variations in the exchange rate movements are caused by currency order flow in the Malaysian foreign exchange market, and 15% in the Thailand foreign exchange market. Therefore, currency order flow may account for 24% and 15% of exchange rate movements per trading day in the Malaysian and Thailand foreign exchange markets, respectively. Furthermore, 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%. 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 appeared to be an important determinant factors of exchange rate fluctuations for both countries foreign exchange markets.
To address the third question, the paper adopts five criteria as proposed by Marsh (2011). The OLS regression is adopted to analyze the data .The model specification and estimation method run to test intervention effectiveness:

$$\Delta X_t = \alpha + INT_{tt} + e_t \quad (16)$$

$$\Delta X_t = \alpha + INT_{ts} + e_t \quad (17)$$

$$\Delta P_t = \alpha + \beta \cdot \Delta X_t + e_t \quad (18)$$

Where $\Delta \mathrm{X_t}$ is change in currency order flow, $\Delta \mathrm{P_t}$ 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.

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 Malaysian and Thailand currencies (emerging market currencies) against the US dollar. Therefore, the analysis is in one direction, since these countries' monetary authorities mainly take action to limit the depreciation of their currencies against US dollar. Hence, this study 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. Furthermore, this paper 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 study 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:

$$SC1_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < 0 \\ 0 \text{ otherwise} \end{cases} \quad (19)$$

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:

$$SC2_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < 0, \text{and } COF_{t-1} > 0 \\ 0 \text{ otherwise} \end{cases} \quad (20)$$

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:

$$SC3_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < COF_{t-1}, \text{and } COF_{t-1} < 0 \\ 0 \text{ otherwise} \end{cases} \quad (21)$$

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:

$$SC4_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < COF_{t-1}, \text{and } COF_t \geq 0, \text{and } COF_{t-1} > 0 \\ 0 \text{ otherwise} \end{cases} \quad (22)$$

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:

$$SC5_t = \begin{cases} 1 \text{ if } INT_t = 1, \text{and } COF_t < 0 \text{ or } COF_t < COF_{t-1} \\ 0 \text{ otherwise} \end{cases} \quad (23)$$

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

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

Table 9 reports the summary of the success criteria performance on total intervention days for the two countries' currencies against US dollar currency order flows. For Thailand, the population is 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 673 days for Malaysia and 783 days for Thailand.

Table 9: **Summary of success criteria performance on total intervention days for the two countries' currencies -USD currency order flows**

Success Criteria (SC)	**SC1**	**SC2**	**SC3**	**SC4**	**SC5**
PANEL A: 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 B: 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.

From Table 9, 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 the two countries 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 Malaysia (Panel A) SC3 138 days /673 days = 0.2051 or 20.51%. The 138 days represents the total number of successful interventions, while 673 days represents the total number of interventions. The 20.51% represents the percentage of successful intervention. The same interpretative analogy applies to Thailand 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.

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 Malaysia (Panel A) SC4 235 days /1496 days = 0.3492 or 34.92%, the 235 days represents the expected number of success based on the 1496 total population. The 34.92%

represents the percentage of expected number of success. Likewise, the same interpretative analogy applies to Thailand 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 Malaysia (Panel A), it expresses the probability value of observing number of successes (say X) in a sample of 673 days when the success rate in a population of 1496 days (say Y). Probability values of 5% or less are made bold. For example, using SC4 (moderating the net currency order flow), Bank Negara intervention was successful on 235 days or 34.92% based on the sample. This implies that Bank Negara 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 Thailand.

The results show that the conditional probability is greater than the unconditional probability for only two out of the five tests conducted for both countries. In three cases, the conditional probability is less than expected. Therefore, 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 Thailand foreign exchange markets, it seems that the monetary authority reduces and accentuate the net currency order flow out of US dollar, while the 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 study divided the sample according to whether the intervention was detected/reported or not, based on the newswires reports from the Bloomberg.

Table 10 reports the summary of success criteria performance on secret intervention days for both countries' currencies against the US dollar currency order flows. In Malaysia, of the 673 days of Bank Negara Malaysia market intervention, 68 days were detected/reported and 605 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 10: Summary of success criteria performance on secret intervention days for the two countries' currencies -USD currency order flows

Success Criteria	**SC1**	**SC2**	**SC3**	**SC4**	**SC5**
PANEL A: 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
PANELB: 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 paper repeats the calculations using the 605 days sample of secret/unreported market intervention for Malaysia, and 699 days for Thailand. The results show that 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). 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 both countries foreign exchange markets.

Table 11 reports the results of the standard regression of the daily change in the (log) of the spot Malaysia and Thailand countries' currencies against the US dollar on the net currency order flows. This paper 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 11: Summary of linear regression of the daily change in the log of the spot two countries' currencies-USD on the net currency order flow

	Coefficient	t-statistic	R-squared	P-value
PANEL A: 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 B: 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 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 Thailand foreign exchange market, the results show that there 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. Furthermore, the correlation between currency order flow and exchange rate disappears on intervention days, secret intervention days and detected intervention days for both countries. 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 both 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, both countries' foreign exchange markets are sensitive to market intervention. These results are consistent with other empirical studies, such as Chaboud and Humpage (2005) and Marsh (2011).

Conclusion

The determination of MYR and THB exchange rate against the US$ in the long term as well as short term are hereby investigated, taken into consideration the influential role of cumulative currency order flow. To reflect the pressure of currency excess demand, the study constructs a measure of currency order flow in the Malaysian and Thailand foreign exchange market context. VAR is applied to estimate the long-run components and short-run dynamics, and the results show that between the cumulative currency order flow and exchange rate of US$ and MYR; and US$ and THB, there exists cointegrating relationship. Therefore, the major fluctuations in the exchange rate of the THB/US$ and MYR/ US$ is actually due to currency order flow. The explanatory power of the currency order flow is positively strong. With a positive beta coefficient of 0.00547 in the USD/MYR exchange rate and a positive beta coefficient of currency order flow (0.0027) in the US$/THB exchange rate. It means that within the day transaction, for every currency order flow increasing at 1 per cent, there will be a corresponding increase of 55 basis points of the MYR price against the US$ and 27 basis points of the THB price against the US$.

Insomuch that, the results show that currency order flow, a microeconomic variable, has significant explanatory power to capture the MYR and THB exchange rate movements in the foreign exchange market, it then brings to the attention of the Monetary Authority of Malaysia and Thailand the importance that should be attached to the market microstructure. In addition, while comparing the results, the coefficients of this study and that of Evans and Lyons (2002a, 2002b) are significant. Even though, the R2s for both countries are relatively low at 0.17 and 0.13 compared to 0.64 and 0.46 from the research work of Evans and Lyons (2002a, 2002b). Although, this is not amazing, in the sense that the level at which the currencies of emerging markets economy being traded in the international market are relatively low compared with that of world major currencies of the developed markets. In addition, most of the emerging markets economy does not operate free floating rather managed floating which may lead to frequent occurrence of currency interventions by the monetary authority. More so, empirical evidence shows that the correlation between currency order flow and exchange rate disappears on intervention days, secret intervention days and detected intervention days for both countries. This implies that, the presence of the monetary authorities in the market affect the relationship between the currency order flow and exchange rates against the US dollar. Therefore, these countries foreign exchange markets are sensitive to market intervention. However, the study suggests that without a sound monetary and fiscal policy, using market intervention to stabilize exchange rate may not work in the long-run.

The results of the findings are in consistent with other empirical studies, such as that of De Medeiros (2004), Marsh and O'Rourke (2005), Evans and Lyons (2005), Chaboud and Humpage (2005), Girardin and Lyons (2007), Sager and Taylor (2008), Evans (2010), Rime et al. (2010), Cerrato et al. (2011), Marsh (2011) and Zhang et al. (2013).

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