

HYBRID MODEL OF EXCHANGE RATE DETERMINANTS IN MALAYSIA

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DEDICATION

This thesis is dedicated to my parents and my beloved husband.

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“To Allah belong all glory and power. To Him mount up (all) words of purity: It is He who exalts each deed of righteousness". All praises for ALLAH SWT who enabled me to complete this thesis. The One, All-Compassionate, All-Merciful, and Magnificent without whose consent nothing can happen in the world.

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ABSTRACT

The nominal exchange rate determination has been one of the most challenging tasks in international finance. Macroeconomic fundamental analysis has dominated the studies of exchange rate movements over the long-run horizon. However, it is a consensus that macroeconomic fundamentals do not perform well in explaining the dynamics of exchange rate over short-run horizon. On the other hand, the microstructure approach and oil price obtained supportive evidence to explain the dynamics of exchange rate at short-run horizon. Thus, the aim of this study is to analyse the nominal exchange rate determination with a multidimensional view, such as macroeconomic fundamentals, oil price, and microstructure approach over long-run and short-run horizons in the context of Malaysia. To achieve this goal, two datasets are used in this study. Firstly, the study examines the impact of macroeconomic fundamentals and oil price on the nominal exchange rate using monthly data for the period of January 1994 to December 2017. The relationship among the determinants is examined in terms of combined cointegration, Dynamic OLS, and threshold cointegration. The results show that a significant long-run relationship exists among nominal exchange rate, macroeconomic fundamentals, and oil price using combined cointegration and Dynamic OLS. The empirical findings also highlight the existence of a significant threshold relationship between the nominal exchange rate and its determinants by Threshold Autoregressive and Momentum Threshold Autoregressive. In addition, the short-run adjustment of the exchange rate deviation from their long-run equilibrium values is determined by Momentum Vector Error Correction Model. The findings show that the short-run dynamics of the exchange rate in the long-run equilibrium path is being corrected through money supply, interest rate, and oil price in Malaysia. Secondly, this study analysed another dataset of high-frequency daily data from 2010 to 2017 using a nonlinear ARDL approach. The results show the nonlinear relationship between the nominal exchange rate and hybrid approach. The empirical findings indicate that instead of the order flow, the bid-ask spread has some informational content to explain the exchange rate movement. The association between the exchange rate and the bid-ask spread supports the view that liquidity effects play an important role in determining the exchange rate. Additionally, the negative changes in the oil price potentially act as the macroeconomic news announcement which plays a significant role in the determination of the Malaysian exchange rate. The empirical results allow for long-run and short-run asymmetric pricing impacts of a hybrid approach on the nominal exchange rate in Malaysia. The results of this study are useful in providing policy direction and practical implications for the monetary authorities and market dealers to employ interest rate for the adjustment of the exchange rate in the long-run and short-run horizons. In addition, the bid-ask spread and oil price should be considered as an influential exchange rate determinants in short-run in Malaysia. Future research potentially sheds light on the asymmetric oil price impact on the Malaysian exchange rate during the outbreak of Covid-19.

ABSTRAK

Penentuan kadar pertukaran nominal telah menjadi salah satu tugas yang paling mencabar dalam kewangan antarabangsa. Analisis fundamental makroekonomi telah menguasai kajian pergerakan kadar pertukaran dalam jangka panjang. Walau bagaimanapun, adalah menjadi konsensus bahawa asas makroekonomi tidak berfungsi dengan baik dalam menjelaskan dinamika kadar pertukaran dalam jangka pendek. Sebaliknya, pendekatan mikro dan harga minyak memperoleh bukti sokongan untuk menjelaskan dinamika kadar pertukaran dalam jangka pendek. Oleh itu, matlamat kajian ini adalah untuk menganalisis penentuan nilai tukar nominal dengan pandangan multidimensi, seperti asas makroekonomi, harga minyak, dan pendekatan mikrostruktur dalam jangka panjang dan jangka pendek dalam konteks Malaysia. Untuk mencapai matlamat ini, dua dataset digunakan dalam kajian ini. Pertama, kajian ini mengkaji kesan asas makroekonomi dan harga minyak ke atas kadar pertukaran nominal dengan menggunakan data bulanan dari Januari 1994 hingga Disember 2017. Hubungan antara penentu-penentu ini dikaji dari segi gabungan kointegrasi, OLS Dinamik, dan kointegrasi ambang. Keputusan menunjukkan bahawa hubungan jangka panjang yang signifikan wujud antara kadar pertukaran nominal, asas makroekonomi, dan harga minyak dengan menggunakan gabungan kointegrasi dan Dinamik OLS. Penemuan empirikal juga menunjukkan kewujudan hubungan ambang yang signifikan antara kadar pertukaran nominal dan penentu-penentunya oleh Ambang Panjang Autoregressive dan Momentum Autoregressive. Di samping itu, sisihan pelarasan jangka pendek pertukaran mata wang dari nilai keseimbangan jangka panjang ditentukan oleh Model Pembetulan Ralat Momentum. Penemuan menunjukkan bahawa dinamika jangka pendek kadar pertukaran dalam keseimbangan jangka panjang dibetulkan melalui bekalan wang, kadar faedah, dan harga minyak di Malaysia. Kedua, kajian ini menganalisis satu lagi dataset harian frekuensi tinggi dari tahun 2010 hingga 2017 dengan menggunakan pendekatan ARDL bukan linear. Dapatan kajian menunjukkan hubungan bukan linear antara kadar pertukaran nominal dengan pendekatan hibrid. Penemuan empirikal menunjukkan bahawa berbanding aliran pesanan matawang, sebaran nilai bida mempunyai beberapa kandungan maklumat untuk menjelaskan pergerakan kadar pertukaran. Hubungan antara kadar tukaran dengan sebaran nilai bida menyokong pandangan bahawa kesan kecairan memainkan peranan penting dalam menentukan kadar pertukaran. Di samping itu, perubahan negatif dalam harga minyak mempunyai potensi untuk bertindak sebagai pengumuman berita makroekonomi yang memainkan peranan penting dalam menentukan kadar pertukaran Malaysia. Keputusan empirikal menunjukkan pendekatan hibrid impak harga asimetrik jangka panjang dan jangka pendek ke atas kadar pertukaran nominal di Malaysia. Hasil kajian ini boleh membantu dalam memberikan hala tuju dasar dan implikasi praktikal bagi pihak berkuasa kewangan dan peniaga pasaran untuk menggunakan kadar faedah bagi pelarasan kadar pertukaran dalam jangka panjang dan jangka pendek. Di samping itu, sebaran nilai bida dan harga minyak harus dianggap sebagai penentu yang berpengaruh terhadap kadar pertukaran jangka pendek di Malaysia. Penyelidikan masa depan berpotensi memberi penerangan mengenai kesan harga minyak asimetri terhadap kadar pertukaran Malaysia semasa pecahnya Covid-19.

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LIST OF ABBREVIATIONS

| | | |
|-------|---|---|
| NER | - | Nominal Exchange Rate |
| PPP | - | Purchasing Power Parity |
| IRP | - | Interest Rate Parity |
| IFE | - | International Fisher Effect |
| FPMM | - | Flexible-Price Monetary Model |
| SPMM | - | Sticky-Price Monetary Model |
| DOLS | - | Dynamic Ordinary Least Squares |
| TAR | - | Threshold Autoregressive |
| M-TAR | - | Momentum Threshold Autoregressive |
| NARDL | - | Nonlinear ARDL |
| FRED | - | Federal Reserve Economic Data |
| DOSM | - | Department of Statistics Malaysia |
| BNM | - | Bank Negara Malaysia |
| OPEC | - | Organization of the Petroleum Exporting Countries |
| BAS | - | Bid-Ask Spread |
| OP | - | Oil Price |

CHAPTER 1

INTRODUCTION

1.1 General Overview

The foreign exchange market is one of the biggest global trading markets by trading volume (BIS, 2016). Due to the dynamic, unprecedented nature, and continuous growth in the foreign exchange market, it has received serious attention across the globe from both the academician as well as industry (Katusiime, Shamsuddin & Agbola, 2015). Corresponding to these facts, the research on exchange rate determination has been growing persistently. Exchange rate determination is significantly influential to the various aspects of the economy and the stakeholders. The role of exchange rate is crucial in the international market as well as its variability is proportional to the economic performance of a country (Duffuor, Marsh & Phylaktis, 2012).

Over the past thirty years, exchange rate has experienced many significant improvements. These developments have substantially contributed to the theoretical foundations of exchange rate determination. However, despite a reasonable contribution and theoretical foundation advancements, a number of researchers highlighted the shortcomings of exchange rate determination. For instance, past studies argued that macroeconomic models are unable to perform better than a random walk model. In the seminal article, Meese and Rogoff (1983a, 1983b) show that macroeconomic fundamentals contain limited information for determination of exchange rate in short-run. Since then, the empirical findings provides the mixed evidences that exchange rate dynamics does not exclusively determined by macroeconomic fundamentals. Such discussion and empirical studies resulted in the development of the hybrid model which combines macroeconomic and microstructure determinants to examine the exchange rate dynamics. The hybrid model of macroeconomic and microstructure determinants achieved reasonable attention due to

its significant contribution in determination of exchange rate, particularly in short-run (Lyons, 2001). Microstructure approach focuses on examining the information transmission towards exchange rate in the foreign exchange market captured through the trading process. The foreign exchange trade is an integrated part of price formation, by which exchange rate is determined and evolved. While, macroeconomic exchange rate models ignore the trading process.

1.2 Background of the Study

The significant development on exchange rate determination has been started from the great depression of 1930s. The great depression resulted in restricting the financial economies by impeding their foreign trade. The failure of financial economies risen the need of a system to oversee the international financial affairs. This led to the development of International Monetary Fund (IMF). The main objectives of IMF are to promote exchange rate stability, maintain exchange arrangements between members, and avoid competitive currency depreciation. In this system, the US Dollar (USD) was selected as a settlement (35\$ per ounce gold) for international balances which is known as Bretton Wood System (Eichengreen & Sachs, 1985). Later, the fixed value of USD against gold was seen overvalued. This overvaluation failed the fixed exchange system and lays the foundation for a floating exchange rate regime. Since the early 1970s, some economies have adopted floating exchange rate, while others have continued to maintain a fixed rate (against USD). The floating exchange rate regime was considered extensively unbalanced period in global economy. Meanwhile, the exchange rate remained unstable in terms of floating as well as long run policy implementation in 1973 worldwide. This instability of the exchange rate was nearly unexplainable and compelled the research community to pay more attention to the exchange rate determination.

The literature has considered different factors for exchange rate determination in long-run and short-run. The earlier and the prominent factors for determination of exchange rate are macroeconomic fundamentals (Fama, 1984; Bilson, 1978;

Dornbusch, 1976; Frenkel, 1976; Mussa, 1976). These fundamentals are commonly known as monetary models which have strong theoretical patterns. The empirical evidences of monetary models are mixed. Moreover, the empirical evidences are not favorable to traditional macroeconomic fundamentals, however it is generally accepted at long horizon (Xie & Chen, 2019; Tawadros, 2017; Alquist & Chinn, 2008). Meese & Rogoff (1983a, 1983b) demonstrate that the random walk model determine the exchange rate better than any monetary models, although there is a disagreement in the literature.

In addition, other than macro fundamentals, the non-economic factors have been considered to determine exchange rate in the short horizon, such as order flow (Anifowose, Ismail & Sukor, 2018; Evans & Rime, 2016; Katusiime et al., 2015). Engel, Lee, Liu, Liu and Wu (2019) examined the Taylor rule fundamentals as an additional factors for explaining exchange rate movement and have greater influential ability in the long and short horizon. Despite the tremendous research, there is a consensus by the researchers in the literature for searching new fundamentals that have more explanatory power than traditional macroeconomic fundamentals in long-run and short-run.

Considerable amount of literature also focused on econometric techniques; a significant player in exchange rate determination. These techniques can be categorized into three categories, such as single equation models, multiple equations models, and panel models. The econometric techniques can be linear or nonlinear which may lie on each of these groups by incorporating a time variation in the parameters or adding an error correction term. Among linear models, the single equation error correction model is most successful model to examine the short-run dynamics (Abhyankar, Sarno & Valente, 2005). The time varying parameter (TVP), such as Kalman filter approach, Bayesian TVP model, random walk model, or Markov switching model, also presents significant success in determining exchange rate (Rossi, 2013). In addition, the multivariate models include, Vector Autoregressive (VAR), factor ECM model, Vector Error Correction Model (VECM), Bayesian Model Averaging (BMA), and

panel ECM model. Among multivariate models, the panel ECM is the most successful specification, although there is little evidence in favor of BMA (Wright, 2008), BVARs (Carriero, Kapetanios & Marcellino, 2009), and factor ECM models (Engel, Mark & West, 2015).

The issue of whether exchange rate behavior is linear or nonlinear remains controversial (Khashei, Bijari & Ardali, 2009; Liew, Baharumshah, Habibullah & Midi, 2008). However, past literature shows a great interest in favor of nonlinear models of exchange rate behavior (Charef & Ayachi, 2018; Alom, 2016; Clements & Lan, 2010). The exchange rate modelling continues to represent a large economic domain and is widely used in many other fields. There are five strands of literature that investigate the exchange rate determination using various methods to examine the nonlinear behavior. First strand adopted the ECM to describe the dynamics of exchange rate from its long-run equilibrium path. Second strand applied the Markov-switching method to examine the regime switch relationship at a particular probability (De Grauwe & Vansteenkiste, 2007; Frömmel, MacDonald & Menkhoff, 2005). Third strand used threshold methods to investigate the nonlinearity in exchange rate behaviors by Kilian and Taylor (2003), Taylor and Peel (2000), and Rapach and Wohar (2006). Fourth strand of researchers used nonparametric channel to examine the association between exchange rate and monetary fundamentals. The nonparametric channel employs different smoothing curves, which is data based modelling rather than economic theory (Chinn, 2008).

Finally, the fifth strand emphasized on time varying parameters to examine the the association between exchange rate and macroeconomic fundamentals. Hendry and Ericsson (2003) explained that such time varying impact might be caused by policy regime changes. The policy regime changes or implicit instabilities underlie the econometric specifications which is used to capture the different responses to macroeconomic developments over time. These instabilities are related to money demand and purchasing power parity concept. However, the past studies mainly focused on linear techniques than the nonlinear specification for determination of

exchange rate (Rossi, 2013). Hence, the linear models are unable to capture the complex nonlinear characteristics of exchange rate dynamics (Lye, Chan & Hooy, 2011; Liew et al., 2008).

1.3 Background of the Problem

The determination of the exchange rate is remained an open question throughout the literature. The in-depth analysis of the literature highlighted that the determination of exchange rate depends on a number of factors. These factors include the choice of significant determinants, sample period, and model either linear or nonlinear (Rossi, 2013). The development of the exchange rate in a specific time horizon is an important aspect of the macroeconomic analysis and market surveillance. It has been challenging for the market practitioners and academicians to determine exchange rate for a different time frame. The exchange rate determination can be categorized into two different time span, i.e., long-run and short-run (Zhang, Lowinger & Tang, 2007). The short-run determination is referred to the time span of tick by tick, daily, and monthly. While, the long-run determination refers to the monthly, quarterly, and annual time span. Thus, the researchers are attempting to determine exchange rate that need to make various choices among different horizons as well as different factors.

The conventional exchange rate determination are based on the macroeconomic fundamentals. Despite its contribution, the monetary models are criticized by research community for not completely account the exchange rate dynamics, especially in short-run (Baharumshah, MacDonald & Mohd, 2017; Meese & Rogoff, 1983). However, the performance of monetary models cannot be ignored in long span which gives useful information to accurately determine exchange rate to all stakeholders (Cheung, Chinn, Pascual & Zhang, 2019; Tawadros, 2017; Cerra & Saxena, 2010). Although the monetary models remain popular in modelling exchange rates, but macroeconomic fundamentals failures have prompted researchers to find alternative techniques for determining the short term exchange rate.

Moreover, different techniques can be used to capture the dynamic behavior of exchange rate in long-run and short-run. The validation of monetary models provides limited evidence on the exchange rate adjustment dynamic using the linear techniques (Lee, Yusop & Yusoff, 2008; Lee & Azali, 2012). These traditional linear methods cannot capture the complex nonlinear patterns of exchange rate dynamics (Alom, 2016; Khashei et al., 2009; Liew et al., 2008). The issue of nonlinear patterns in determining exchange rate has led researchers to use nonlinear techniques. The recent nonlinear techniques gain significant importance as these models are typically designed to accommodate for nonlinear features with high accuracy (Charef & Ayachi, 2018; Gharleghi, Shaari & Sarmidi, 2014; Clements & Lan, 2010). The empirical reasoning of nonlinear pattern of exchange rate provide the evidence of poor performance of macroeconomic variables that may be caused by economic crises (such as, OPEC decision, Asian Financial Crises, Global Financial Crises), forex market risk (such as, liquidity risk, scheduled and non-scheduled news), geopolitical extreme events of supplier or demand nations such as 2006 oil shock, the Arab spring, and corruption (Alom, 2016). All these factors can lead to structural breaks and nonlinear response to exchange rate that distorts linear assumptions.

Considering the fact, it is obvious that nonlinear behavior of exchange rate in the adjustment process can be estimated through nonlinear models. Nonlinear models have become a useful tool in modelling monetary relationship given the experiences gained and conclusion drawn from the financial crises. Previous studies have provided substantial evidence for the existence of nonlinear exchange rate dynamics in Asian economies (Bahmani-Oskooee, Kutan & Zhou, 2008; Hansen, 2011; Liew, 2004; Terasvirta, Tjostheim & Granger, 2010). However, these empirical evidences uses a linear adjustment models. The linear adjustment model cannot capture the asymmetric policy preferences. In this situation, there is a need to account these effects by estimating nonlinear adjustment models that allow for speed of adjustment in exchange rate.

The comprehensive literature review revealed that the determination of exchange rate has been wide area of interest for the researchers, academicians, and practitioners in the developed economies. While, this important subject can hardly

attract much attention in the developing and emerging economies, despite their emergent financial market liberalization and global financial system (Sarmidi, 2010). Exchange rates have been the center of debate in the developing and emerging economies for last few decades. The emerging economies are usually more volatile which contains high liquidity risk than developed economies due to low trading volume (Islam & Izham, 2015). The exchange rate determination in emerging and developing economies shows that they might possess some unique features that can affect the forex rate differently. The unique features demonstrate that it is not guaranteed that if some determinants and models are giving a reasonably good performance will also produce the same performance in another country (Rossi, 2013). Therefore, there is a dire need to investigate the impact of influential determinants on exchange rate at a particular country.

The emerging economies have number of issues that causes research obstacles in exchange rate determination. These issues includes lack resources, issues in governance, and limited access to data. On the other hand, the developed countries has limited such issues that make it easy for researchers to advance research in exchange rate field. Baharumshah, Mohd and Ahn (2009) discussed that the main focus of exchange rate literature is to provide the evidences through macroeconomic fundamentals in the context of emerging economies. Whereas, the exceptions are identified by Chin, Azali, Yusop and Yusoff (2007), and Zhang, Chau and Zhang, (2013), who highlighted that macroeconomic fundamentals have the ability to explain the exchange rate movements in the major Asian currencies. Based on the discussion, it implies that the case of small and open economy (SOE) is of particular interest, where limited evidences are found.

The survival of SOE in risky global competitive environment depends on substantial investment which is quite challenging. In other words, export strategies and exchange rate policies are important for SOE to compete with the major developed countries, such as United States, China, Japan, and Germany (Hooy, Siong-Hook & Tze-Haw, 2015). For instance, the depreciation of currency could lead to imported inflation and financial instability, while the appreciation of the currency could result in loss of competitive advantage in foreign exchange markets, affecting the export

sector negatively. There is also widespread fear that currency appreciation could weaken economic attractiveness to boost foreign direct investment.

Being a small and open economy, the emerging economy of Malaysia appears as an interesting study case. The Malaysian economy is adversely affected by the Asian Financial Crises (AFC) and Global Financial Crises (GFC) which directly affect exchange rate. In addition, the different Malaysian exchange rate regimes make it more complex than others emerging economies (Lye et al., 2011). In Malaysia, the macroeconomic policies are designed to balance key objectives such as growth, stability, and equity. Whereas, both fiscal and monetary policy meet the objectives of development and stabilization. The formulation of fiscal policy in Malaysia has a larger ethnic and political dimension, while monetary policy focuses on two policy objectives; exchange rate stability and price stability. Fiscal reforms in Malaysia have grown considerably more slowly than monetary policy reforms and financial restructuring (McCauley, 2006). Nevertheless, the political factors influential role cannot be ignored, especially during crisis periods, while an informal commitment to exchange rate stability could create policy dilemmas when facing future external shocks. The external shock or global externalities is captured through trade transmission channel which directly influence the exporting commodity currency like Malaysia.

The emerging Malaysian economy has been experiencing unprecedented declines in economic performance, reflecting the recent depreciation of Malaysian Ringgit. The determination of exchange rate through macroeconomic fundamentals is already proven that it contains limited explanatory power of exchange rate (Chan, Pua & Wong, 2019). The discussion on whether or not exchange rate exhibit relationship with macroeconomic fundamentals in long-run and short-run dynamics remains debatable in Malaysia. The past studies examined the macroeconomic fundamentals and exchange rate nexus in long-run in Malaysia (Chia & Lim, 2015; Tze-Haw, Teck & Wooi, 2013; Gharleghi & Shaari, 2012; Sarmidi, 2010; Baharumshah et al., 2009). However, the macroeconomic fundamentals may not sufficiently work through foreign exchange adjustments due to global uncertainty (Azad, 2009). Such uncertainty needs

additional determinants to examine the Malaysian exchange rate, particularly in short-run dynamics.

Furthermore, the recent development in the exchange rate determination identified the limitation of linear model and usefulness of nonlinear adjustment models for adjustment of exchange rate deviation (Baharumshah et al., 2009; Liew et al., 2008). Nevertheless, there is limited evidence to explain the nonlinear adjustments to address the relationship of macroeconomic fundamentals, which may influence the determination of exchange rate. Therefore, this study firstly aims to examine the significant relationship between exchange rate and macroeconomic fundamentals in long-run and short-run dynamics in Malaysia.

Besides the macroeconomic fundamentals, the past literature documented that the exchange rate is endogenously determined by macroeconomic fundamentals. However, the identification of exogenous shock by monetary fundamentals is not possible that would help to examine the exchange rate behavior. The exogenous shock is captured through trade transmission channel which affects the exporting commodity currency through multiple channels. It implies that export-oriented economies are majorly affected by the global commodity prices through its effect on wages and the demand for non-traded goods. Moreover, for a small and open economy that rely on commodities for export earnings, a boom in the world commodity market will generally result in balance-of-payments surplus and an accumulation of foreign reserves that put exert pressure on demand of domestic currency. Hence, it shows that commodity economies, with their global trade arrangement, are a good experience for exchange rate determination (Chen, Rogoff & Rossi, 2011). Thus, the determinants which capture the endogenous and exogenous shock jointly are significant for determination of exchange rate in long-run and short-run dynamics.

Oil price is considered as an important energy commodity that would impact on global commodity market. The extensive literature demonstrated that oil price changes act as an exogenous shock to commodity economies. Among small and open economies, Malaysia is one of the prominent commodity economies in South East Asia which ranked fourth in position in emerging economies list. According to MSCI

Emerging Markets Index, Malaysia has an export-oriented economy that relies heavily on export commodities (MSCI, 2017). The crude oil and petroleum products are among the top export commodities of Malaysia. In addition, the Malaysia Investment Development Authority (MIDA) has identified that the Malaysian oil industry will be prominent in the future, as the oil industry currently contributes 20% to Malaysian's GDP (EIA, 2016). Based on the fact, it highlights that the share of petroleum products in trade is high, hence oil price may be an important determinant of exchange rate. However there should be a caveat that petroleum products are usually traded in USD in Malaysia.

The extensive literature provides the evidence for oil price and exchange rate nexus in developed and emerging economies in the long-run (Chen, Rogoff & Rossi, 2010; Rossi & Sekhposyan, 2011). However, to the best of author knowledge, the oil price along with macroeconomic fundamentals (such as, money supply and interest rate) to examine the exchange rate is under-explored by the research community in developed and emerging economies in long-run and short-run dynamics. Thus, there is a need to give attention to examine the long-run and short-run dynamics of oil price with macroeconomic fundamentals in Malaysia. Therefore, this study secondly highlights the significant relationship among exchange rate, macroeconomic fundamentals, and oil price in Malaysia in long-run and short-run dynamics in Malaysia.

Furthermore, limited contribution of macroeconomic fundamentals for determination of exchange rate compelled the researchers to find the alternative determinants in short-run. Evans and Lyons (2002a) introduced a new concept by incorporating the microstructure information for determination of exchange rate in short-run. The microstructure approach contains private information (information unknown to public) which has a significant impact on exchange rate dynamics. The introduction of microstructure approach has swayed the attention of economists in foreign exchange market, particularly in short-run. The past studies provide the evidence that the microstructure approach has been primarily concerned with key currency pairs of developed economies (Evans & Rime, 2019; Michaelides, Milidonis & Nishiotis, 2019; Ranaldo & Somogyi, 2018; Abolaji, Izlin, Edil, Sukor, and

Mohammed, 2018). However, limited evidences have been found in the context of developing and emerging economies.

A recent development in the exchange rate literature is hybrid approach that combines the macroeconomic fundamentals and microstructure determinants for explaining the short-run dynamics of exchange rate. The hybrid approach has gained the credibility of explaining a significant portion of exchange rate movement. This approach performs better than the traditional models (Evans, 2011b; Rime, Sarno & Sojli, 2010). Unlike other macroeconomic fundamentals, interest rate is a significant factor in influencing the foreign exchange market in short-run. Wu (2012) and Vitale (2006) argues that interest rate contains information on impending change in exchange rate movement that may affect the forex market in short-run horizon. However, the exchange rate movements explained by macroeconomic fundamentals are lower than the microstructure determinants.

Moreover, order flow is a key determinant of the microstructure approach, as it transmits information through excess buying (selling) pressure. Evans and Lyons (2002a) and Bacchetta and Van Wincoop (2006) demonstrates that indirect effects of the transmission of asymmetric information through order flow affect exchange rate movement. The empirical results of the order flow also explain the ability to disseminate asymmetric information of foreign exchange market by excessive buying pressure. Numerous studies support the idea that order flow contains significant explanations for short- and medium-term exchange rate changes (Nguyen & Shin, 2011; Evans & Lyons, 2008).

On the other hand, liquidity concepts is used in microstructure approach to match the buyers and sellers. This indicate that liquidity is another wedge of microstructure approach that investors should look for in foreign exchange markets. The liquidity is maintained in an economy through different exchange systems which mostly use liquidity suppliers to buy or sell currency according to customer demand. The currency suppliers have the monopoly right to buy at low prices and to sell at high prices. This privilege is the main source of compensation for liquidity offers, as bid–ask spread (Chen, Chien & Chang, 2012). Thus, the discussion supports the evidences

that microstructure determinants, such as cumulative order flow and bid-ask spread are considered significant explanatory variables of forex market.

In the microstructure approach, the order flow and bid-ask spread concepts are related, but not same for price discovery (O'Hara, 2003). Past literature has shown that order flow fails to account the low trading currency due to price discovery constraints. This indicates that the cumulative order flow with high trading density currency tends to be greater than the infrequently traded density currency. Hence, the bid-ask spread is suitable for investigating the exchange rate determination in low trading density currency (Chen et al., 2012). Based on discussion, bid-ask spread could not be ignored in low trading density currency, as it could differentially impact on exchange rate dynamics like Malaysia. To the best of author's knowledge, bid-ask spread is under explored to show the impact on nominal exchange rate in short-run. Thus, this study attempts to fill up the literature gap by examining the nonlinear relationship between exchange rate and macro-micro determinants in Malaysia. Therefore, this study thirdly aims to investigate the nonlinear relationship between exchange rate and macroeconomic and microstructure determinants in long-run and short-run in Malaysia.

Besides the microstructure approach, the oil price changes potentially act as observable macroeconomic news to explain the daily movement of exchange rate in commodity currency economies. Killian and Vega (2011) who suggests that oil prices generally do not respond to macro news announcement, indicating that it immediately reflects information of other asset prices. In addition, Ferraro, Rogoff and Rossi (2015) highlighted that oil price is an important factor for exchange rate determination as macroeconomic news announcements. Based on this consideration, it shows that oil as "news" an important determinant of exchange rate at high frequency data. The explanatory power of oil price with other determinants have been found to be an important in determination of exchange rate movement at high frequencies (Fratzcher, Schneider and Van Robays, 2014). Ferraro et al. (2015) demonstrated that at high frequencies, exchange rate is linked to order flow. The order flow is a non-economic determinant, thus to combine with oil price as economic determinant (macro-news), enables to provide greater explanatory power of exchange rate. The

concept is supported by Evans and Lyons (2002a), who reported that hybrid approach of macro-micro determinants conveys high information transmission to determine the exchange rate behavior in short-run.

In line with the arguments, this study emerged a new approach which combines the microstructure determinants, such as order flow and bid-ask spread, and oil price to explain the exchange rate dynamics at high frequency. Thus, the order flow and oil price both contains the asymmetry information transmission channel to interact with bid-ask spread towards exchange rate determination in short-run. Thus, this study focus on assess the nonlinear relationship to show the asymmetry behavior towards investors to make appropriate investment decisions in emerging economies, particularly, Malaysia. Based on detailed discussion, oil price is considered an important determinant to show the nonlinear behavior of exchange rate in short-run horizon. To the best of author's knowledge, there is limited evidences to show the oil price role as macro news on nominal exchange rate in emerging economies at high frequency data. Hence, this study emerged the concept of microstructure determinants and oil price in body of knowledge to examine the nonlinear behavior of exchange rate in long-run and short-run in Malaysia. Therefore, this study fourthly aims to determine the nonlinear relationship between exchange rate and microstructure determinants and oil price in long-run and short-run in Malaysia.

1.4 Problem Statement

The puzzling phenomena of exchange rate determination remain mystified from its inception. The extensive literature highlighted that the exchange rate depends on the choice of determinants, sample period, and model (Rossi, 2013). The past studies further emphasized that the models and predictors which determine the exchange rate considerably significant in one country do not necessarily provide competitive findings for other countries (Shin, Etula & Adrian, 2010; Cheung, Chinn & Pascual, 2005). It has shown that the determination of exchange rate depends on the choice of country for a given model (Chinn & Moore, 2011). Thus, the determination

of exchange rate might provide significantly different results with the different determinants, different techniques, and different country.

In the light of background of the study and background of the problem, this study focuses on a number of issues associated with the nominal exchange rate determination in Malaysia. Past studies highlighted that macroeconomic fundamentals cannot effectively determine the exchange rate in short-run (Molodtsova & Papell, 2009; Alquist & Chinn, 2008; Cheung et al., 2005). Furthermore, the adjustment of nominal exchange rate towards the macroeconomic fundamentals follows nonlinear behavior (Liew et al., 2008). It implies that nonlinear models perform better than linear models in short-run in Malaysia (Alom, 2016; Lye et al., 2011). The consideration of Malaysian exchange rate provides support for the appropriateness of nonlinear model for time series analysis. Therefore, the study employs nonlinear model that can be used under conditions of nonlinearity and structural change. Thus, the first issue investigates the significant relationship between exchange rate and macroeconomic fundamentals in long-run and short-run dynamics in Malaysia.

The second issue emphasis on the additional determinant that identify the exogenous shock to improve the exchange rate determination in short-run dynamics. The economy with a large share of exports in primary commodities capture the exogenous shock in determination of exchange rate (Rossi, 2013; Chen et al., 2010; Chen & Rogoff, 2003). This leads to the strong assumption that oil price with macroeconomic fundamentals has an important role in exchange rate determination in small and open economy. Thus, the role of oil price cannot be ignored in the context of Malaysia. Malaysia is an export-oriented and open economy which is affected by exogenous shocks. However, there is a limited evidence in literature that used the nonlinear model to explain the relationship among exchange rate, macroeconomic fundamentals, and oil price in long-run and short-run dynamics. Therefore, the focus of the second issue is to examine the significant relationship among exchange rate, macroeconomic fundamentals, and oil price in long-run and short-run dynamics in Malaysia.

The third issue emphasizes on the importance of hybrid approach of macroeconomic and microstructure determinants in Malaysian economy. The hybrid approach has been used to investigate exchange rate dynamics for a range of currency pairs (Anifowose, Ismail & Sukor, 2017; Katusiime et al., 2015; Zhang et al., 2013; Chen et al., 2012). However, there are limited evidences that show the significance of this important framework in the context of Malaysia. This lack research given the contribution of order flow as a significant determinant of foreign exchange market in short-run dynamics. Moreover, this study includes the bid-ask spread as an important determinant of low trading currency to explain the short-run dynamics of exchange rate. The past studies have also shown that interest rate role as macroeconomic determinant along with microstructure determinants provide greater explanatory power towards exchange rate dynamics in emerging markets (Abolaji et al., 2018; Zhang et al., 2013). Therefore, this study motivates to investigate the existence of significant nonlinear relationship between nominal exchange rate and macroeconomic and microstructure determinants in long-run and short-run in Malaysia.

The fourth issue highlights that oil price changes act as observable macroeconomic news determinant to explain the contemporaneous effect on exchange rate in short-run. The extensive literature tended to focus on the relationship between oil price and exchange rate in the context of developed economies (Ferraro et al., 2015; Fratzscher et al., 2014). However, very little attention has been given to examine the oil price as macro news determinant along with other determinants to improve the exchange rate determination in emerging economy like Malaysia. Therefore, this study emerged the concept of oil price with microstructure determinants to shed more light on the possible mechanism of asymmetry information transmission to exchange rate dynamics with high frequency data. The nonlinear nature of determinants motivates to employ the nonlinear method to improve the exchange rate determination in long-run and short-run. Therefore, the aim of this study is to explain the nonlinear relationship between exchange rate and microstructure determinants and oil price in long-run and short-run in Malaysia.

1.5 Research Questions

1. Is there a significant relationship between exchange rate and macroeconomic fundamentals in long-run and short-run dynamics in Malaysia?
2. Is there a significant relationship among exchange rate, macroeconomic fundamentals and oil price in long-run and short-run dynamics in Malaysia?
3. Is there a significant nonlinear relationship between exchange rate and macroeconomic and microstructure determinants in long-run and short-run in Malaysia?
4. Is there a significant nonlinear relationship between exchange rate and microstructure determinants and oil price in long-run and short-run in Malaysia?

1.6 Objectives of the Study

1. To analyze the significant relationship between exchange rate and macroeconomic fundamentals in the long run and short run dynamics in Malaysia
2. To investigate the significant relationship among the exchange rate, macroeconomic fundamentals, and oil price in the long-run and short run dynamics in Malaysia
3. To examine the significant nonlinear relationship between exchange rate and macroeconomic and microstructure determinants in Malaysia
4. To explain the significant nonlinear relationship between exchange rate and microstructure determinants and oil price in long-run in Malaysia

1.7 Significance of the Study

This study provides several worthy contributions towards empirical and methodological development, and policy implications in long-run and short-run dynamics. In relation to empirical development, this study fills the gap in literature by adding significant determinants for exchange rate determination in long-run and short-run. Past studies mostly focused on the relationship of macroeconomic fundamentals and exchange rate in long-run. This study contributes in the existing body of knowledge to examine the impact of macroeconomic fundamentals (i.e., money supply and interest rate), and oil price to determine the exchange rate in long-run and short-run dynamics. Furthermore, the potential role of microstructure approach in foreign exchange market remained untapped in high frequency data. Thus, this study serves to fill this gap to investigate the impact of hybrid approach of macroeconomic and microstructure determinants (i.e., cumulative order flow, bid-ask spread, and interest rate differential) in explaining the exchange rate movements in low trading emerging economy. In addition, the oil price role as macro news determinant is under explored in high frequency. However, this study emerged the hybrid approach of oil price with microstructure determinants to determine exchange rate.

In terms of methodological contribution, this study employs the nonlinear models to address the nonlinear behavior of exchange rate in long-run and short-run dynamics in Malaysia. The threshold approach using Enders and Siklos (Threshold autoregressive and Momentum Threshold autoregressive) method is applied to examine the nonlinear adjustments of exchange rate deviation determined by macroeconomic fundamentals and oil price in long-run equilibrium path. Additionally, the nonlinear behavior of foreign exchange market is captured by applying the nonlinear ARDL approach and dynamic multiplier to highlight the significant relationship between exchange rate and hybrid approach (hybrid approach of macro-micro determinants and hybrid approach of microstructure determinants and oil price) in long-run and short-run at high frequency data.

Since most of the studies have focused on the developed economies, this study appears to fill the gap in the empirical indication in the perspective of Malaysia as an

emerging economy. Given the country's diversified economic relationship with the United States, the country's economy is expected to reach a stable level of exchange rate stability. However, it is unfortunate that the country has experienced a steady decline in foreign exchange reserves, which has led to a depreciation in the international market, especially against the US dollar (Anifowose et al., 2018). With the increasing complexity of economic and financial globalization, it is necessary yet challenging to determine the exchange rate behavior. Thus, this study extends the exchange rate literature pertinent to Malaysia by investigating the nonlinear behavior of exchange rate in long-run and short-run dynamics.

From a policy implication point of view, this study is considered of great interest to government regulators, policy makers, and financial institutions. The findings can be beneficial for decision maker to get the future atmosphere of the exchange rate and make informed decision. It will encourage the foreign investor during the favorable environment and warn the policy maker for upcoming crisis. Similarly, practitioners and forecasters at central banks and private businesses will also be interested in knowing, which determinants, models and methodologies successfully determine the exchange rate. Policy makers should also be interested in final assessment of this research whose policy decisions crucially depend on successful forecasts. Moreover, the practitioners and policymakers will have a deeper understanding of explanatory power of currency order flow and bid-ask spread on how it drives the exchange rate movements in the Malaysian exchange market. In addition, it is necessary to adopt appropriate strategies to reduce the oil shocks harmfulness on the foreign exchange market in Malaysia.

1.8 Scope of the Study

The purpose of this study is to highlight the importance of macroeconomic fundamentals, oil price, and microstructure approach for determination of exchange rate. To achieve the purpose, this study developed four different models. First model examines the significant relationship between nominal exchange rate and macroeconomic fundamentals (such as, money supply, income, and interest rate) in

long-run and short-run dynamics in Malaysia. Second model presents the significant relationship among exchange rate, macroeconomic fundamentals (such as, money supply and interest rate), and oil price in long-run and short-run dynamics in Malaysia. Third model highlights the significant nonlinear relationship between exchange rate and hybrid approach of macroeconomic and microstructure determinants (such as, cumulative order flow, bid-ask spread, and interest rate differential) in long run and short run in Malaysia. Fourth model demonstrate the nonlinear relationship between exchange rate and hybrid approach of microstructure determinants (such as, cumulative order flow and bid-ask spread) and oil price, in long run and short run in Malaysia.

Moreover, this study deals with two types of dataset. The first dataset examines the macroeconomic fundamentals and oil price impact on nominal exchange rate using monthly data during the period from January 1994 to December 2017. The sample period from January 1994 to December 2017 is selected due to various reasons. Firstly, the Malaysian economy badly affected by two major crises i.e., Asian financial crisis (1997-1999) and Global financial crises (2008-2010), which is covered in the sample period to see the impact of structural break. In addition, this study use money market rate which is available from 1994 in Data stream, thus it is necessary to take common sample for all the determinants. Therefore, due to the reasons, this study adopted sample period from 1994 to 2017 in order to achieve the exchange rate determination in long-run and short-run dynamics. The second dataset consists of high-frequency daily data over the period from 2010 to 2017 covering 1996 observations. The usage of more recent data is sufficient to capture the deviation in the exchange rate in short-run (Chan, Lye and Hooy, 2010). Further, the currency order flow data is available from 2010 onwards, thus it is reasonable to take common sample for all the determinants. Recent studies of Anifowose et al. (2018), and Anifowose et al. (2017), also used sample period which starts from 2010.

1.9 Organization of the Study

This study consists of seven chapters. Chapter 2 highlights the overview of Malaysia's economy in terms of history of exchange rate, regime arrangements, followed by the discussion of significant decision related to the Malaysia foreign exchange market. Also, an overview of foreign exchange market in Malaysia. Then it further discusses the economic crises to highlight the essential role of Bank Negara Malaysia for adoption of control measure to stabilize the currency.

Chapter 3 explains the background of theories used in this study, which consists of purchasing parity theory, international fisher effect theory, interest rate parity theory, and market microstructure theory. All these theories are related to the determination of exchange rate. Then, by combining all these theories, the monetary models are developed in order to achieve the objectives of this study. The chapter also gives a review of the literature on exchange rate determination. It provides a summary of existing empirical studies of exchange rate models and identifies the gaps to give the necessary theoretical background and empirical support for the study.

Chapter 4 outlines the data sources and methodology used in this study. The data sources explain the type of data, period of data and the valid source from which to collect the data. Prior to implementation of the methodology part, the test for screening of data is required. That is followed by the methodology steps for the data analysis, i.e., unit root (traditional and structural), linear cointegration methods (Bayer and Hanck and Dynamic OLS), nonlinear model (Threshold approach and Momentum Vector Error Correction Model), and diagnostic and stability tests.

Chapter 5 presents the findings of the result of two models for this study. It discusses the association between nominal exchange rates, macroeconomic fundamentals, and oil price for the Malaysian Ringgit/USD. Furthermore, this chapter explains the short-run dynamics of the exchange rates from the long-run equilibrium path, will be corrected on monthly basis. The estimated results will be helpful for policymakers in developing various strategies to explain the exchange rate behavior in long-run and short-run dynamics in Malaysia.

Chapter 6 presents the empirical findings of hybrid model (macro-micro determinants and microstructure determinants and oil price). It also reports the nonlinear relationship between exchange rate and its determinants at high frequency data. Moreover, the result also explicates the foreign exchange market behavior in long-run and short-run in Malaysia. The findings will be useful for suggesting the investment decisions in particular economy.

Chapter 7 summarizes the important findings and links to Malaysian policy implications. Also, the limitations of the study, suggestions, and further recommendations are given in this chapter.

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