Exchange Rate Pass-Through: A Comparative Analysis of Inflation Targeting & Non-Targeting ASEAN-5 Countries

Abstract: In the context of the debate on Exchange Rate Pass-Through (ERPT) under inflation targeting regimes, this study analysis the ERPT in inflation targeting and non-targeting economies of ASEAN-5. Employing a *Non-linear Autoregressive Distributed Lag (N-ARDL)* framework on data from 2000: Q1 to 2019 Q:4, our key empirical findings suggest that the exchange rate shocks do lead to significant changes in inflation. There is also prima facie evidence of asymmetric effects of exchange rate shocks in Singapore, Philippines, and Indonesia and the results varied between and among inflation targeting and non-targeting countries. The results also varied in the short and long-terms, whereas in the long-run, asymmetric effects of real exchange rate persist only for Indonesia and Singapore. Regardless of the inflation targeting or non-targeting regime, oil price shocks are found to be the most crucial factor with the largest impact on inflation in ASEAN-5 economies. Money supply and output growth also found to have some effect on inflation, though the results varied among countries. Our findings have profound implication for monetary policy formulation and price stability.

Keywords: Exchange Rate Pass-through, Monetary Policy, Inflation Targeting, Money Supply, GDP, Oil Price, ASEAN-5.

JEL Code: E51, E52, F31, E31.

1. Introduction

Maintaining price stability by containing the inflation to a moderate rate has been very often considered as of the most important responsibility of central banks and monetary authorities. The role of monetary authorities in maintaining financial stability, monitoring the capital flows and sustaining economic growth becomes more challenging, especially after the great inflation period of 1970-80s and the Global Financial Crisis 2007- 08 (Nasir et al., 2015). Besides the additional challenges and triple mandate to maintaining the price as well as the financial and economic stability, containing inflation remains the most vital task. In pursuit of price stability, a number of countries have adopted the strategy of explicit inflation targeting (see Bernanke et al 2001 and Nasir and Vo, 2020). However, the inflation dynamics of any open economy in the 21st century are very much down to the internal as well as external balances. Developing economies, in particular, are affected by the outlook of the international economy and financial system. Globalization and liberalisation of the global economy have brought us higher volumes of cross-border investments, trade and rapid international capital flows. The tremendous advantages of these international investments and trade are prominent, however, the increasing trade and capital inflows have been a longstanding concern due to their impact on inflation and economic growth (Filardo and Genberg, 2010; Huynh and Burggraf, 2020). While there are always the fears of capital flight and reversal of capital inflows which can and had adversely affected the Asian economies and financial markets in the Asian Financial Crisis 1997, there are crucial effects on the exchange rate which can affect the monetary policymakers endeavours to achieve the price stability. Several countries, which were affected by the 1997 financial crisis, have switched to other exchange rate regimes after the crisis to allow them more flexibility and to cope with more volatile capital inflows environments (see Calvo and Reinhart, 2002). While the floating exchange rate regime has been widely adopted, inflation targeting (IT) has also become a general topic among monetary policymakers (see Prasertnukul et al., 2010). The exchange rate fluctuations may affect the competitiveness of an economy, its ability to repay and service the cost of debts which are denominated in foreign currencies, there are also implications for the inflation and hence for the monetary policy.

Exchange rate pass-through (ERPT) or the degree of exchange rate variations that transmits to domestic prices has drawn enormous attention of academics, practitioners and policymakers (Forbes, et al 2015, Forbes, 2016; Nasir and Vo, 2020). There has been a debate that the ERPT has diminished due to the adoption of inflation targeting (Edwards, 2007, Junior 2007). However, the recent studies have acknowledged the presence of ERPT and its effect on price levels even in the inflation targeting (see Nasir and Vo, 2020 for evidence from UK, Canada and New Zealand). Overarching empirical evidence on the ERPT is mixed and debatable, depending on the data or econometric technique used in these studies, especially the results vary significantly due to the exchange rate regime or the manner of inflation control of the authority in each country (Vo et al., 2018; Balcilar et al. 2020). The importance of ERPT in monetary policymaking is paramount and is acknowledged in existing literature (see Prasertnukul et al., 2010; Forbes, 2015; Vo et al., 2018; Nasir and Simpson, 2018; Nasir 2020, among others). If the transmission of foreign exchange shocks to domestic prices or inflation levels is high, it may also affect the adoption of exchange rate regime in a country (Ghosh,

2013). In contrast, a lower pass-through effect will allow that country to follow more independent and flexible monetary policy in which inflation targeting can be implemented rather more easily (Choudhri and Hakura, 2006). Moreover, low ERPT indicates a smaller exposure to external shocks. Though in such a case, depreciation of domestic currency may not be helpful in improving the trade deficit or to boost exports during the economic downturn (Ito and Sato, 2008). Concomitantly, ERPT is equally important for external and internal balances and hence for the macroeconomic policymaking (Nasir and Leung, 2020). The particular focus of the subject treatise is on the impact of ERPT on inflation, specifically in the context of inflation targeting. Although a number of developed countries have adopted inflation targeting (IT) strategy which was pioneered by New Zealand in the early of 1990s, it took a while before the emerging economies including the ones in South East Asia followed the course, intending to improve their policy performance. Among the five founding countries of the Association of South-East Asian Nations (a.k.a ASEAN-5) which are the focus of this study, Thailand (May 2000), Philippines (January 2002) and Indonesia (July 2005) have adopted the explicit inflation targeting strategy (see Genberg and He, 2009; Hammond, 2012).

Contextualizing on the contrasting argument and unsettled debate on the ERPT under inflation targeting (e.g. contrast Edwards, 2007, Junior 2007; Forbes 2016 and Nasir and Vo, 2020), this study contributes by examining the relationship between real effective exchange rates, inflation, and other determinants of inflation in ASEAN-5 countries (including Indonesia, Malaysia, the Philippines, Singapore and Thailand). As the literature suggests, in addition to the exchange rate dynamics, oil price shocks, money supply, GDP growth and unemployment are among the key determinants of inflation levels (Nasir et al., 2020a). This study contributes to the existing evidence on ERPT and inflation in the following ways. First, the debate of the ERPT is unsettled and the evidence is contrasting. Second, the existing studies on ERPT including some rare evidence on ASEAN (e.g., Vo et al., 2018) have focused on using linear approaches whereas this study employs an N-ARDL framework which accounts for the nonlinear and asymmetric aspects of ERPT in ASEAN-5 economies. Third, we particularly emphasized and distinguish between the inflation targeting and non-targeting economies by examining whether the ERPT differs between and within inflation targeting and non-targeting economies. Fourth, this study verifies the debates on ERPT in small and open economies of Southeast Asia as a comparison to previous studies mostly focusing on other regions and often on developed countries. Lastly, we also included the oil shocks, output growth and monetary supply and their impact in inflation targeting and non-targeting ASEAN-5 economies.

Specifically, we focus on addressing two main questions: First, whether the exchange rate pass-through (ERPT) exists in these countries? Second, are there any differences in the magnitude of ERPT between inflation targeting and non-targeting countries? These questions are important for policymakers in these emerging small and open economies which are greatly dependent on external trade and foreign investments (see Prasertnukul et al., 2010). To find the answers of the research questions, we employed the data on ASEAN-5 economies from 2000: Q1 to 2019: Q4 and in a Non-linear Autoregressive Distributed Lag (N-ARDL) framework which accounts for the nonlinear and asymmetric effects as well differences in the long and short-run relationships. The key empirical findings suggest that the exchange rate shocks do lead to significant changes in inflation. There is also prima facie evidence of asymmetric effects

of exchange rate shocks in Singapore, Philippines, and Indonesia and the results varied between and among inflation targeting and non-targeting countries. The results also varied in the short and long-terms whereas in the long-run, asymmetric effects of real exchange rate persisted only for Indonesia and Singapore. Regardless of the inflation targeting or non-targeting regime, oil price shocks are found to be the most crucial factor with the largest impact on inflation in ASEAN-5 economies. Money supply and economic growth are also found to affect inflation though the results varied among countries. Our findings have profound implication for monetary policy formulation and price stability.

The rest of the paper proceeds as follows: Section 2 briefly discusses existing evidence on the subject. Section 3 presents the data and sets out the methodology. Section 4 analyses the results and discussions. Finally, Section 5 draws conclusion and policy implications.

2. Literature review

2.1 ERPT and inflation

The dynamics of exchange rate are not only important for the trade balance but also have profound implications for a country's price stability (Hume, 1742) and hence for its monetary policy. Though the variations in the exchange rate have a significant impact on the trade balance and the depreciation of one country's currency can help to improve it (e.g., Yildirim and Ivrendi, 2016, Nasir and Leung, 2020), on the flipside, depreciation can also increase the inflation. Therefore, the effect of exchange rate movement on domestic price levels or exchange rate pass-through is crucial for monetary policy formulation. Recent empirical studies have investigated the transmission mechanism of exchange rate pass-through to inflation and provided mixed evidence in different economies (Prasertnukul et al., 2010, Nasir and Vo, 2020). According to Forbes et al (2015), several factors might influence the magnitude of ERPT including import/export composition, currencies of pricing, levels of inflation, or time-variation. For instance, Campa and Goldberg (2005) have argued that ERPT tends to be lower for countries with low inflation rate and low exchange rate volatility. Another study by Choudri and Hakura (2006) has suggested that the relationship between ERPT and the average inflation rate is positive. Their results supported Taylor's (2000) argument that a country with low inflation level will experience a decline in ERPT. Furthermore, the magnitude of ERPT also changes over time, however, there is limited and contrasting evidence. For example, Jasová et al (2016) documented changes in ERPT in advanced and emerging economies since the GFC. Similarly, Stulz (2007) maintained that ERPT has fallen in Switzerland while Fleer et al. (2016) have reported a sharp increase in the pass-through magnitude. More recently, Nasir and Simpson (2018) focusing on Brexit suggested an increase in the magnitude of ERPT in the UK. Similarly, Nasir (2020) argued that ERPT is very vital for inflation dynamics in the UK. Furthermore, that neglecting the sharp depreciation post-Brexit has led to poor inflation forecasting by the Bank of England. In evidence from BRICS economies, Balcilar et al. (2020) have reported asymmetric evidence of ERPT. Furthermore, ERPT also depends on the state of the economy. Concomitantly, these contrasting arguments and findings imply that the ERPT is not a non-existent phenomenon and can have crucial implications for inflation and price stability. But it also requires further investigation, particularly in the context of inflation

targeting. As in a remarkable study, Forbes (2016, p.3) argued that "*we have surprisingly poor understating of exactly how exchange rate movements affect inflation*".

2.2 Inflation targeting and ERPT

Global economic uncertainties, especially in the post-GFC era, have posed unprecedented challenges to monetary authorities in maintaining price and financial stability. Since the first country, New Zealand adopted inflation targeting in the 1990s, more than 28 countries have followed this framework (IMF, 2017). Supposedly, the inflation-targeting framework with well-anchored inflation expectations can provide more stable economic environments (Bernanke and Mishkin, 1997). The claimed advantages of the inflation targeting as a strategy are widely known including the increase of accountability of monetary authorities as well as the more transparency and flexibility of their policies (Bernanke et al 2001, Nasir et al 2020). While all central banks are required to be more accountable and transparent, these characteristics are often emphasized in the context of inflation targeting strategies (Filardo and Genberg, 2010). Furthermore, central banks in inflation targeting economies are supposed to have greater ability to pursue their monetary policy objective (i.e. price stability) independently, compared to their non-targeting counterparts.

In addition to the issues associated with the ERPT, exchange rate fluctuations are also the concern of policymakers in achieving inflation target (see Prasertnukul et al., 2010). Generally, it is argued that an inflation-targeting framework can work well under a floating exchange rate regime. However, Gali and Monacelli (2005) claimed that the combination of these two regimes might increase exchange rate volatility and hence it could affect inflation target achievement. In this regard, empirical evidence is inconclusive. For instance, Schmidt-Hebbel and Tapia (2002) maintained that the exchange rate volatility is, in fact, not higher than that of other countries under inflation targeting and floating exchange rate regimes since it reduces unexpected shocks. Moreover, Edwards (2007) suggests that monetary policies under the inflation targeting framework are considered to be more transparent and predictable. More importantly, the adaption of inflation targeting by some countries has triggered a debate on the ERPT under this monetary policy framework. On this aspect, some studies, for instance, Minella et al. (2003) on Brazil, argued that the ERPT might have declined due to the inflation targeting. Similarly, Mishkin and Savastano (2001) also suggested that the adoption of inflation targeting not only anchors inflation expectations when facing depreciation but also reduce ERPT due to the increased credibility of the monetary authority. More recently, Junior (2017) supported the notion of a decline in ERPT since the beginning of inflation targeting but also argued that it should not be inferred as the complete absence of ERPT. On contrary, the recent empirical evidence on the ERPT and inflation targeting has strongly refuted this line of reasoning (Nasir and Simpson, 2018) and has shown that in fact, ERPT has increased in inflation-targeting countries (Forbes, 2016; Nasir and Vo, 2020). Now the question is where the ASEAN-5 stands in this regard and whether the ERPT in the ASEAN-5 economies has been influenced by the adoption of inflation targeting by some of the member countries.

2.3 Inflation targeting in ASEAN-5

Inspired by the successful adoption of inflation targeting in some of the developed countries in terms of stabilizing domestic price levels, some of the emerging economies have also shifted

to this framework. Among the ASEAN-5 countries, Thailand which was one of the most adversely affected countries in the 1997 Asian Financial Crisis, adopted the inflation targeting in 2000. The Philippine's central bank Bangko Sentral ng Pilipinas (BSP) switched to inflation targeting regime in 2002 after a long period of implementing monetary targeting (see Lim, 2008). Indonesia although did announce the adoption of inflation targeting in 2000, but it was not until July 2005 when the Bank Indonesia replaced its long-followed strategy of monetary base targeting with the inflation targeting (Rachman, 2016).

The primary objective of central banks in the adoption of inflation targeting is to narrow the difference between inflation expectations and announcement rates by explicitly setting the inflation target (Inoue et al., 2013). However, the effectiveness and commitment to inflation targeting policy vary among these countries (see Siregar and Goo, 2010). With respect to the exchange rate, the aims of inflation targeting to stabilize price levels and lower inflation rates can be achieved by either reducing ERPT or exchange rate variability (Prasertnukul et al., 2010). Although some evidence suggests that the exchange rate volatility has been reduced in those countries in which inflation targeting was adopted (i.e., Indonesia, Philippines, and Thailand), the debate on the ERPT is inconclusive. For instance, Cortinhas (2009) reports some evidence of ERPT in the Philippines and Thailand while there is no such evidence found in Singapore and Malaysia during 1968–2001 period. Furthermore, the ERPT to inflation in different measurements also reveals different results. For example, it is suggested that the consumer price index (CPI) was less affected by the pass-through effect compared to the producer price index (PPI) in Indonesia, Malaysia, Thailand, and Singapore during the period of 1994–2006 (see Ito and Sato, 2008). Moreover, the adoption of inflation targeting leads to a decline in exchange rate volatility in Korea, Indonesia, Thailand, and the Philippines over the period 1990-2007 (Prasertnukul et al., 2010). These results suggest that there might be a relationship between the exchange rate dynamics and inflation in the ASEAN countries which then raises further questions on the ERPT under the inflation targeting and non-targeting economies. The idea of adopting inflation targeting in the ASEAN-5 countries is based on its expected success in controlling inflation and that the central banks mostly pay more attention to inflation control under the inflation targeting regime when conducting monetary policy. However, the evidence, for instance, a study by Rachman (2016) on Indonesia, casts doubt on the success of inflation targeting. Nonetheless, among the very limited studies which focused on the ASEAN region, a study by Vo et al (2018) which investigated ERPT in ASEAN-5 economies did not account for the inflation targeting. Furthermore, despite the overwhelming evidence on the asymmetric effects of exchange rate dynamics (Balcilar et al. 2020; Nasir et al 2020), their empirical framework did not consider the nonlinearities and asymmetries and demarcation between the short and long-run relationships. Contextualizing on these factors the subject study addresses the caveats in the existing body of knowledge and the empirical framework employed for that purpose in this study is set out in the next section.

3. Methodology & Data

3.1. Methodology

We employed the non-linear Auto-Regressive Distributed Lag (N-ARDL) model for estimating and analyzing the impacts of potential determinants, real exchange rate, oil prices,

money supply, and economic growth on inflation shocks. The N-ARDL framework accounts for the nonlinear and asymmetric effects as well as differences in the long and short-run relationships. Our main reason to choose the nonlinear approach is due to the impact of exchange rate movements on inflation. There are several studies which have reported asymmetric effects of the exchange rate (see Reitz et al., 2008; Taylor, 2001; Bahmani-Oskooee et al., 2020; Balcilar et al., 2020; Nasir et al 2020 and Nasir et al 2020c). The relationship among these variables can be specified in that form:

$$\pi_t = \beta_\pi \pi_{t-i} + \beta_{REX}(REX)_{t-i} + \beta_{Oil} Oil_{t-i} + \beta_{MS} MS_{t-i} + \beta_{GDP} GDP_{t-i} + e_t \quad (Eq.1)$$

Where inflation (π_t) is determined by its historical values (persistence element,π_{t-i}), national output or economic performance (GDP), supply/cost (energy, representing as oil) shocks, Money Supply (MS), and finally, exchange rate pass-through (REX). The novelty of the employed N-ARDL approach is that it takes into account the two features of estimates such as asymmetries and non-linearities regarding our studied relationship among our variables. As we are interested in investigating these asymmetries and nonlinearities in the context of inflation in ASEAN-5 countries. N-ARDL is the logically appropriate framework of analysis. The N-ARDL co-integration approach is based on the seminal work by Shin et al (2011) which found its roots in the contributions by Pesaran and Shin (1999) and Pesaran et al. (2001). To start with, we can specify the Eq. (1 & 2) in the following long-run model of inflation:

$$\pi_t = a_0 + a_1 REX_t^+ + a_2 REX_t^- + a_4 Oil_t + a_5 MS_t + a_6 GDP_t + e_t \quad (Eq.2)$$

In which π_t is inflation and their determinants are as specified in equation (1 & 2), $a = (a_0 - a_6)$ is a co-integrating vector having the long-run parameters. In Equation (2) the REX_t^+ and REX_t^- are sums of positive and negative changes with partial forms in the real effective exchange rate, it can be specified as:

$$REX_t^+ = \sum_{i=1}^{t} \Delta REX_i^+ = \sum_{i=1}^{t} \max(\Delta REX_i, 0) \quad (Eq.3)$$

and

$$REX_t^- = \sum_{i=1}^{t} \Delta REX_i^- = \sum_{i=1}^{t} \min(\Delta REX_i, 0) \quad (Eq.4)$$

In the light of formulation presented above (Eq. 2), the relationship between the REX and π_t is expected to be negative (a_1). However, a_2 would exhibit the connection between exchange rate and inflation shocks when reducing them. Since these two variables are theoretically expected to show the opposite direction of movement, our expectation is the negative sign of estimates of a_2. Furthermore, we also posit that the decrease in the exchange rate would increase the inflation in the higher level than the increase in the exchange rate that might lead to a decline in inflation. Saying differently, the negative shocks (depreciation) will experience a greater influence than the positive shocks, for example, $a_2 > a_1$. This implies downward price or exchange rate pass-through rigidity which could be reflected in the inflation. At the same time, the long-run impacts presented in the Eq. (2) have the expectations to reflect an asymmetric pass-through effects. At this juncture, we can frame the Eq. 2 into a Nonlinear

Autoregressive Distributed Lag Model (N-ARDL) setting (Please see more at the following studies such as Shin et al. (2011) Pesaran and Shin (1999) and Pesaran et al. (2001)) as follows:

$$\Delta\pi_t = a + \beta_1\pi_{t-1} + \beta_2 REX^+_{t-1} + \beta_3 REX^-_{t-1} + \beta_4 Oil_{t-1} + \beta_5 MS_{t-1} + \beta_6 GDP_{t-1} + \sum_{i=1}^{p} \emptyset_i \Delta\pi_{t-i} + \sum_{i=0}^{q} (\theta_i^+ \Delta REX^+_{t-i} + \theta_i^- \Delta REX^-_{t-i}) + \sum_{i=0}^{s} \gamma_i \Delta Oil_{t-i} + \sum_{i=0}^{v} \delta_i \Delta MS_{t-i} + \sum_{i=0}^{w} \Omega_i \Delta GDP_{t-i} + e_t \qquad (Eq.5)$$

Where we have defined all the variables earlier and $p, \mathrm{q}, \mathrm{s}, \mathrm{v}, \mathrm{w}$ are lag orders and $a_1 = -\beta_2/\beta_1$ $a_2 = -\beta_3/\beta_1$ are the aforementioned long-run impacts of going up/down in the *REX* on inflation (Eq. 2). In Eq. 2, the $\sum_{i=0}^{q} \theta_i^+$ captures the short-run effects of an increase in the exchange rate on inflation whereas $\sum_{i=0}^{q} \theta_i^-$ measures the short-run impacts of a decrease in the exchange rate on our dependent variable. Concomitantly, in this research setting, we can examine the asymmetric long-run as well as the asymmetric short-run relationship between REX (pass-through) and inflation shocks (π_t).

The implementation of our N-ARDL methodology will be entailed on the following procedures. Initially, the stationary test (by adapting the unit root test) will be performed to investigate if the order integration of underlying data series has. It is worth acknowledging that the conventional model to cointegration is valid whether the time-series are stationary at the original level or first-differencing form, saying differently, I (0) or I (1), however, it is still crucial to perform to unit root test to avoid that we are using the second-differencing variable (I(2)). Because Ibrahim (2015) mentioned that the computation of F-statistics to test the cointegration would be failed if having these variables, the traditional Dickey-Fuller test was used. Hence, we would estimate Equation 2 by using the Ordinary Least Square approach. After estimating our Nonlinear ARDL model, we will use the bounds testing estimates devised to examine the presence of co-integration. In so doing, we would test the null hypothesis $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ with the Wald F-test. In the last and final step of the analysis, we would investigate the both (long- and short-term) asymmetries in the relationship among our variables, we would also have a discussion about the effect of other independent variables. Regarding the inflation shocks, we would derive the asymmetric cumulative dynamic multiplier effects of a 1% change in the exchange rate; for example, REX^+_{t-1} and REX^-_{t-1} as:

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{REX^+_{t-1}}, m_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{REX^-_{t-1}}, h = 0,1,2 \ldots\ldots\ldots \quad (Eq.6)$$

A point to note here is that as $h \to \infty, m_h^+ \to a_1 \; and \; m_h^- \to a_2$. The use of Nonlinear ADRL is widely practised in economic and financial studies (see Sharma and Kautish, 2019; Nasir et al., 2020). Thereupon, our paper will follow the existing and established approach to examine the effects of real exchange rate on inflation in targeting and non-targeting countries.

3.2 Data

Our dataset spans over the period from 2000Q1 to 2019Q4 for 5 ASEAN countries to make our results comparable. The data were retrieved from different reliable sources. Table 1 represent our main variables, the abbreviation as well as the explanation for our estimates.

[Please insert Table 1 here]

4. Findings and discussions

4.1. Descriptive statistics and stationary test

Table 2 presents a summary of descriptive statistics for each variable among ASEAN-5 countries. There are two main and worth noting points here. The ARDL approach does not strictly require the classification of I (0) or I(1) (Pesaran, Shin, Smith, 2001). We employed the Augmented Dickey-Fuller (ADF) to examine the existence of unit root in our dataset. As our expectation, all variables are I (0) or I (1). Therefore, we proceed further with F-test is only validated for 'bounds test' in I (0) and I (1).

[Please insert Table 2 here]

Secondly, the other descriptive statistics are consistent to the economic information, such as the average quarterly inflation in Malaysia, Thailand, Singapore, Philippines, and Indonesia are 2.16, 2.03, 1.58, 3.98, and 6.55, respectively. When it comes to macroeconomic performance, we can observe that Indonesia witnessed the highest inflation during the period of analysis while the other ASEAN countries experienced inflation, ranging from 1.58% to 3.98%. In the distribution perspective, we can see that the majority of variables exhibit skewness and heavy-tail phenomenon. Therefore, using the linear approach for these determinants might be unbiased. Except Thailand with 4% in average economic growth, the remaining countries have slightly higher average economic growth rate of around 5%. While the Philippines chose to expand their money supply with the highest average M2 (10.88%), the Singapore money supply is the lowest value (8.28%). It also validates our data for reliability to use. Therefore, in the following part, we will perform the estimates to examine the previous research questions and our hypotheses.

4.2. Bound testing for Nonlinear Co-integration in ASEAN-5 countries

Table 3 summarizes the results of Bounds testing for the nonlinear cointegration for the ASEAN-5 countries.

[Please insert Table 3 here]

In addition, Panel B in Table 3 gives the results of BDS test, which explicitly show that the series are not identically and independently distributed (iid). Thus, we proceed to the estimation of NARDL model. When comparing the F-statistics with the lower and upper bounds, represented in Table 3, we can conclude that there exists the long-run relationship between inflation and its determinants as specified in the Eq. 2. Thus, we can further investigate their association in details and proceed with the estimation.

4.3. Nonlinear Auto-Regressive Distributed Lag (N-ARDL) estimates

Table 4 demonstrates the results of N-ARDL between inflation and other determinants with the asymmetric effects in real exchange rate among the ASEAN-5 countries. Our findings report the asymmetric evidence in both short and long runs, in which Panel A, B, and C present the short-term estimates, long-term estimates, and diagnosed effects, respectively.

Panel A indicates the short-term effects of inflation determinants such as real exchange rate, oil prices, economic growth and money supply. At first glance, we observe that past inflation negatively influences the current inflation. In terms of the exchange rate – the main story in our model, we can see that the positive exchange rate shocks (appreciation) positively correlate with the inflation while this effect is opposite for negative shocks of the exchange rate. We found the asymmetric effects in clear form in three countries such as Singapore, Philippines, and Indonesia. The coefficients in the changes in the exchange rate over the previous quarters are significant at 1% level. However, in Malaysia and Thailand, we found no clear evidence on the exchange rate and inflation. When looking at the oil prices impact, the short-term effects of oil prices positively contribute to inflation. Our findings are consistent with the previous literature for instance by Nasir et al. (2018b, 2019 and 2020c) on the role of oil prices shocks in determining inflation dynamics. Although the ASEAN-5 countries do not strictly set the exchange rate targets, our work also finds the significant impact of the real effective exchange rate on inflation and evidence of exchange rate pass-through to inflation. Finally, the short-term money supply shocks have no clear pattern to contribute to inflation. However, in recent years the ASEAN-5 countries seem to be good at managing the monetary policy to financial stability and economic growth.

The long-run results presented in Panel B suggest that there is no significant evidence that there are asymmetric effects of real exchange rate on inflation, except Indonesia and Singapore. To be more specific, the increase in positive and negative shocks in the exchange rate in Indonesia would mitigate the rise in inflation. However, it is quite counterintuitive that the increase in the exchange rate will positively contribute to inflation in this country. In contrast, the coefficient of REX in both cases (positive and negative) are mainly insignificant across the remaining countries such as Thailand, Malaysia, and the Philippines. Our main story should draw attention to oil prices. It means that inflation in ASEAN-5 countries shows a positive response to the oil price shocks. Hence, the oil prices positively contribute to the inflation in this region and the results prevail for long-run suggesting a permanent impact of oil shocks. Interestingly, ASEAN-5 countries are likely to be good at managing inflation using monetary aggregates. The results suggest that the monetary expansion is not the prime cause of inflation in the ASEAN-5 economies (except Singapore) which implies that they might be good at managing the monetary aggregate and hence inflation.

Lastly, Panel C summarizes the results of dialogistic testing to examine the robustness of our model and estimates. First, the explanatory feature, captured by R-squared, is the best in Indonesia. These ASEAN-5 countries' determinants could explain the movement in inflation from 49% to 78%. Our Error Correction Term (ECT) showed the negative value (varying from -0.38 to -0.73) and significant value (1% level) which is interpreted as the stability of the model and pace of adjustment. Furthermore, the F-statistics suggestion the rejection of the null hypothesis that all coefficients are zero and hence there is clear evidence of the statistically significant joint impact of explanatory variables. Moreover, the Breusch-Godfrey (BG) LM test and Durbin Watson test suggest that the null of no-auto correlation was not rejected at 1% level of significance. Furthermore, we do reject the null hypothesis of no heteroscedasticity. Therefore, our model specification does not represent heteroscedasticity. Finally, it is inferred

that our model is correctly specified. Once again, the diagnostic tests manifest the robustness of our results.

4.4. Further robustness and the cumulative multiplier analysis estimates

In order to ensure the stability of our model, we performed the parameter stability test, which is present in Figure 1. The results for the CUSUM test showed the parameters are stable, for the entire period. The results of CUSUM of Squared test suggested some periods where the parameters crossed the 5% level, however, they remained in closer to the bound within 10% level and reverted to the 5% level suggesting and overall confidence of 90%. Overall, our model is stability for us to interpret these results.

[Please insert Figure 1 here]

Finally, the cumulative multiplier analysis to analyze the multiplier impact of real effective exchange rate on inflation. The results showed that a positive shock i.e. 1% appreciation in REX leads to a reduction in inflation in Malaysia and Thailand. On the contrary, a negative shock i.e. 1% decrease or depreciation in REX lead to an increase in the inflation in Malaysia and Thailand. Interestingly in the case of Singapore, an appreciation (depreciation) of Singaporean dollars or a positive (negative) shock to the REX (1%) leads to a positive (negative) response from the inflation which persisted for several periods (quarters). The results on the Philippines show an asymmetric impact as both the negative and positive shock showed positive response from inflation, though the positive shocks were more pronounced. Lastly, Indonesia showed interesting contrast as initially the positive shock i.e. 1% increase in REX showed a positive while the negative shock i.e. 1% decrease in REX showed a negative response from inflation. However, after some quarters the positive shocks are shown to have the negative impact, suggesting that the appreciation leads to a reduction in inflation while the negative shocks showed a positive impact suggesting that the depreciation can be inflation. This change in direction of impact can be associated with the J-curve behaviour often prevalent in the impact of exchange rate shocks on the trade balance. In a nutshell, there is prima facie evidence of ERPT.

5. Conclusions

The impact of exchange rate pass-through on macro-economic factors in general and price stability, in particular, is a longstanding and debatable issue. The start of inflation targeting has given this debate a new context and there have been arguments from both sides. Some argued that the ERPT has diminished due to the inflation targeting while others argued that, in fact, it had been the other way around. Contextualizing on this debate, in this paper, we investigated the relationship between real effective exchange rates, inflation, and other main determinants of inflation including oil prices, money supply and economic growth in inflation targeting and non-targeting economies of ASEAN-5. To account for the non-linearities and asymmetries among the variables of interest which have been often condoned, we employed a Non-linear Autoregressive Distributed Lag (N-ARDL) framework. We also performed various robustness tests which provide support to the empirical results and inferences based on the N-ARDL framework.

Our empirical findings lead us to conclude that exchange rate shocks do lead to significant changes in inflation and hence the ERPT exists, even under the inflation targeting members of ASEAN-5. In the policy context, it implies that the ERPT has crucial implications for the monetary policy and depreciation can post challenges to price stability. Furthermore, the strategy of inflation targeting does not diminish the ERPT. There is also prima facie evidence of asymmetric effects of exchange rate shocks in Singapore, Philippines, and Indonesia and the results varied between and within inflation targeting and non-targeting countries. This implies that the monetary policy setting shall account for the asymmetries in the exchange rate shocks. The results also varied in the short and long-terms whereas in the long-run, asymmetric effects of real exchange rate persist only for Indonesia and Singapore. This suggests that a policy response to the exchange rate shocks shall account for the differences between the short and long-run impact. In addition to the ERPT, we also conclude that the oil price shocks are one of the major determinants of inflation in the ASEAN-5 economies and they pose serious challenges to price stability. The impact of oil shock is prominent in both inflation targeting and non-targeting economies which implies that the strategy of inflation targeting does not diminish the impact of oil shocks. Therefore, the monetary policymakers in the ASEAN-5 countries should account for the oil shocks. However, it must be acknowledged that the oil shocks are cost shocks and a contractionary monetary policy stance to suppress the demand may not be the appropriate policy tool in the face of oil shocks. Economic growth and monetary expansion do not seem to pose significant risks to price stability in the ASEAN-5 economies, though the effects are non-negligible either. In the policy setting, this implies that the easing monetary policy to support growth may not pose substantial challenges to price stability in the underlying economies. Therefore, monetary policy can be accommodative. Our study contributes to the debate on ERPT and inflation and particularly emphasized whether the pass-through effects on inflation are different between inflation targeting and non-targeting economies. It also verifies the debates on ERPT in small and open economies in Southeast Asia as a comparison to previous studies on other regional and developed countries.

This study has focused on the ASEAN-5 economies; however, there are some limitations in terms of its scope and future research can focus on the other members of ASEAN. Further research can also focus on incorporating the expectations channels as it has been often argued that the inflation targeting does influence the inflation expectations.

References

Bahmani-Oskooee, M., Huynh, T. L. D., & Nasir, M. A. On the Asymmetric Effects of Exchange-Rate Volatility on Trade Flows: Evidence from US-UK Commodity Trade. *Scottish Journal of Political Economy*. https://doi.org/10.1111/sjpe.12257

Baak, S.J., Al-Mahmood, M., & Vixathep, S., 2007. Exchange rate volatility and exports from East Asian countries to Japan and the USA. *Applied Economics* 39, 947-959.

Balcilar, M., Roubaud, D., Usman, O. Wohar, M. (2020), Testing the Asymmetric Effects of Exchange Rate Pass-Through in BRICS Countries: Does the state of the economy matter? World Econ. Accepted Author Manuscript. doi:10.1111/twec.12990

Bernanke, B.S. & Mishkin, F.S., 1997. Inflation targeting: a new framework for monetary policy? *Journal of Economic perspectives* 11, 97-116.

Calvo, G.A. & Reinhart, C.M., (2002). Fear of floating. *The Quarterly journal of economics* 117, 379-408.

Campa, J.M. Goldberg, L.S., 2005. Exchange rate pass-through into import prices. Review of Economics and Statistics 87, 679-690.

Choudhri, E.U. & Hakura, D.S., 2006. Exchange rate pass-through to domestic prices: does the inflationary environment matter? *Journal of international Money and Finance* 25, 614-639

Cortinhas, C., 2009. Exchange rate pass-through in ASEAN: implications for the prospects of monetary integration in the region. *The Singapore Economic Review* 54, 657-687.

Edwards, S., 2007. The relationship between exchange rates and inflation targeting revisited. *Series on Central Banking, Analysis, and Economic Policies.*

Filardo, A. & Genberg, H., (2010). Targeting inflation in Asia and the Pacific: lessons from the recent past. *BIS papers*, 251-73.

Forbes, K., Hjortsoe, I., Nenova, T., (2015). The Shocks Matter: Improving Our Estimates of Exchange Rate Pass-Through, Bank of England External MPC Unit Discussion Paper, No. 43.

Forbes, K., (2016). Much Ado About Something Important: How do Exchange Rate Movements Affect Inflation?The Manchester School, 84 No. S1 15–41.

Gali, J., Monacelli, T., 2005. Monetary policy and exchange rate volatility in a small open economy. *The Review of Economic Studies* 72, 707-734.

Genberg, H. & He, D., (2009). Exchange rate, monetary financial issues policies in Asia. *World Scientific Publishing Co. Pte. Ltd*., Singapore.

Ghosh, A., 2013. Exchange rate pass through, macro fundamentals and regime choice in Latin America. *Journal of Macroeconomics* 35, 163-171.

Hammond, G. 2012, State of the art of inflation targeting – 2012, Centre for Central Banking Studies, Bank of England. Handbook – No. 29

Hume, D. (1742) Essays, Moral, Political, and Literary A. Kincaid, Edinburgh.

Huynh, T. L. D., and Burggraf, T. 2020. If worst comes to worst: Co-movement of global stock markets in the US-China trade war. *Economics and Business Letters*, 9(1), 21-30.

Ito, T. & Sato, K., 2008. Exchange rate changes and inflation in post-crisis Asian Economies: Vector Autoregression Analysis of the exchange rate pass-through. *Journal of Money, Credit and Banking* 40, 1407-1438.

Junior, R.P.N., 2007. Inflation targeting and exchange rate pass-through. Econ. Apl. 11 (2), 189–208

Minella, A., De Freitas, P.S., Goldfajn, I., & Muinhos, M.K., 2003. Inflation targeting in Brazil: constructing credibility under exchange rate volatility. *Journal of international Money and Finance* 22, 1015-1040.

Mishkin, F., & Savastano, M. (2001), Monetary policy strategies for Latin America. *Journal of Development Economics* 66, 415-444.

Nasir, M.A., Ahmad, M., Ahmad, F. and Wu, J. (2015), "Financial and economic stability as 'two sides of a coin': Non-crisis regime evidence from the UK based on VECM", Journal of Financial Economic Policy, Vol. 7 No. 4, pp. 327-353

Nasir, M.A. & Simpson, J., (2018). Brexit associated sharp depreciation and implications for UK's inflation and balance of payments. *Journal of Economic Studies* 45, 231-246.

Nasir, M. A. Naidoo, L. Shahbaz, M. Amoo, N. (2018b), Implications of oil prices shocks for the major emerging economies: A comparative analysis of BRICS, Energy Economics, 76, 76-88.

Nasir, M. A. Al-Emadi, A.A. Shahbaz, M. Hammoudeh, S. (2019), Importance of oil shocks and the GCC macroeconomy: A structural VAR analysis, Resources Policy, 61, 166-179.

Nasir, M.A., Huynh, T.L.D. Vo, X.V., (2020a). Exchange Rate Pass-Through & management of Inflation expectation in a Small Open Inflation Targeting Economy, International Review of Economics & Finance, forthcoming.

Nasir, M. A. (2020), Forecasting inflation under uncertainty: The forgotten dog and the frisbee, Technological Forecasting & Social Change, Forthcoming.

Nasir, M. A. Vo, V.X., (2020). A Quarter Century of Inflation Targeting & Exchange Rate Pass-Through: Evidence from the First Three Movers, structural change and economic dynamics, Forthcoming.

Nasir, M. A., Lorente, D. B., & Huynh, T. L. D. (2020c). Anchoring inflation expectations in the face of oil shocks & in the proximity of ZLB: A tale of two targeters. Energy Economics, 104662.

Prasertnukul, W., Kim, D. & Kakinaka, M., (2010). Exchange rates, price levels, and inflation targeting: Evidence from Asian countries. Japan and the World Economy 22, 173-182.

Rachman, F. (2016), Is Inflation Target Announced by Bank Indonesia the Most Accurate Inflation Forecast? Economics and Finance in Indonesia, 62(2), 98-120.

Reitz, S., & Taylor, M. P. (2008). The coordination channel of foreign exchange intervention: A nonlinear microstructural analysis. *European Economic Review*, 52(1), 55-76.

Siregar, R.Y. & Goo, S., (2010). Effectiveness and commitment to inflation targeting policy: Evidence from Indonesia and Thailand. *Journal of Asian Economics* 21, 113-128.

Sharma, R. and Kautish, P. (2019). Dynamism between selected macroeconomic determinants and electricity consumption in India: An NARDL approach. *International Journal of Social Economics*. Vol. 46 No. 6, pp. 805-821.

Schmidt-Hebbel, & K., Tapia, M., 2002. Inflation targeting in Chile. North American. *Journal of Economics and Finance* 13, 125–146.

Taylor, J.B., 2000. Low inflation, pass-through, and the pricing power of firms. *European economic review* 44, 1389-1408.

Taylor, J. B. (2001). The role of the exchange rate in monetary-policy rules. *American Economic Review*, 91(2), 263-267.

Vo, T. A., Le T. T. Q., Nguyen V. P., Ho M. C., & Vo H. D., (2018). Exchange rate pass-through in ASEAN countries: an application of the SVAR model. *Emerging Markets Finance and Trade*. DOI:10.1080/1540496X.2018.1474737.

Table 1. The summary of our main variables

Variables	Abbreviation	Explanation
Inflation	π	We used the monthly Consumer Price Index, year on year percentage change for the ASEAN-5 countries such as Malaysia, Thailand, Singapore, Philippines and Indonesia as a proxy for inflation. The data was seasonally adjusted and standardized (unit measurement: %).
Real Exchange Rate	REER	To represent the exchange rate, we used the monthly data on the Real Effective Exchange Rate, the data was collected from the Bank for International Settlements (BIS) (unit measurement: point).
Oil prices	Oil	For oil prices, we collected the monthly data on crude oil prices (West Texas Intermediate, WTI). The data was retrieved from FRED, Federal Reserve Bank of St. Louis (unit measurement: USD).
Money supply	MS	For money supply, we collected the monthly data on the M2 which is the broadest measure of money supply available. The data was collected from each national bank in ASEAN-5 countries (unit measurement: %).
GDP growth	GDP	We used the data on real GDP growth to represent the output growth outlook of the ASEAN-5 countries. The data was year on year growth rate which was standardized and seasonally adjusted. The data was collected from the national banks (unit measurement: %).

Table 2. Summary of descriptive statistics

Variables	Mean	Standard deviation	Skewness	Kurtosis	Stationary
Panel A: Malaysia					
Inflation	2.16	1.44	0.95	7.29	I(1)
GDP	5.04	2.59	-1.45	7.74	I(0)
Money supply	9.39	9.80	-0.32	2.95	I(1)
Oil	61.76	25.94	0.34	2.15	I(1)
Exchange rate	95.86	5.23	-0.41	2.31	I(1)
Panel B: Thailand					
Inflation	2.03	1.93	0.40	4.30	I(0)
GDP	4.00	2.93	0.15	6.30	I(1)
Money supply	8.84	7.93	0.29	2.07	I(0)
Oil	61.76	25.94	0.34	2.15	I(1)
Exchange rate	96.75	8.83	-0.14	1.97	I(1)
Panel C: Singapore					
Inflation	1.58	2.03	1.12	3.35	I(1)
GDP	5.15	4.44	-0.02	3.98	I(0)
Money supply	8.29	8.58	0.63	2.81	I(1)
Oil	61.76	25.94	0.34	2.15	I(1)
Exchange rate	101.24	8.00	0.01	1.47	I(1)
Panel D: Philippines					
Inflation	3.98	2.05	0.6	3.17	I(1)
GDP	5.38	1.71	-0.73	3.07	I(0)
Money supply	10.88	9.96	0.36	3.04	I(1)
Oil	61.76	25.94	0.34	2.15	I(1)
Exchange rate	96.84	11.65	-0.37	2.02	I(1)
Panel E: Indonesia					
Inflation	6.55	3.66	1.2	4.21	I(0)
GDP	5.27	0.94	-0.57	5.1	I(1)
Money supply	9.17	11.21	0.17	2.86	I(1)
Oil	61.76	25.94	0.34	2.15	I(1)
Exchange rate	87.82	9.16	-1.02	3.79	I(0)

Notes: Stationary test represents the Dickey-Fuller test with the stationary at original level I(0) or first-difference level I(1).

Table 3. Cointegration test and Brock, Dechert and Scheinkman (1987) test

Panel A: Cointegration test					
Bounds test for the Nonlinear	**Malaysia**	**Thailand**	**Singapore**	**Philippines**	**Indonesia**
F-statistics	4.38	4.05	8.20	9.52	11.42
Lower-Bound (95%)	2.39	2.39	2.39	2.39	2.39
Upper-Bound (95%)	3.38	3.38	3.38	3.38	3.38
Conclusion	Cointegration	Cointegration	Cointegration	Cointegration	Cointegration
Panel B: Brock, Dechert and Scheinkman (1987)					
Exchange rate	**Malaysia**	**Thailand**	**Singapore**	**Philippines**	**Indonesia**
Dimension 2	0.02***	0.04***	0.007	0.01***	0.07***
Dimension 3	0.04***	0.08***	0.01*	0.02***	0.12***
Dimension 4	0.06***	0.105***	0.02***	0.03***	0.16***
Dimension 5	0.06***	0.122***	0.03***	0.04***	0.18***
Dimension 6	0.07***	0.126***	0.03***	0.04***	0.19***

Notes: *** 1% level of significance ** 5% level of significance *10% level of significance: Null hypothesis is that there is not cointegration.

Table 4. Nonlinear-ARDL estimation for ASEAN-5 inflation.

Variables	**Malaysia**	**Thailand**	**Singapore**	**Philippines**	**Indonesia**
Panel A: Short run estimates					
$Inflation_{(t-1)}^{a}$	-0.52 [-4.25]	-0.42*** [-4.45]	-0.73*** [-6.82]	-0.38*** [-5.38]	-0.51*** [-7.30]
$Exchange\ rate^{+}_{(t-1)}$			3.93* [-6.82]	1.41 [1.18]	-16.38*** [-3.06]
$Exchange\ rate^{-}_{(t-1)}$				2.71 [1.48]	-14.46** [-2.27]
$Oil_{(t-1)}$		1.38*** [3.48]		0.88*** [3.03]	1.98** [2.26]
$Money_{(t-1)}$		-0.02 [-0.93]	0.07*** [3.01]	-0.05*** [-4.14]	-0.18*** [-3.74]
$GDP_{(t-1)}$			-0.03	-0.02	1.94***

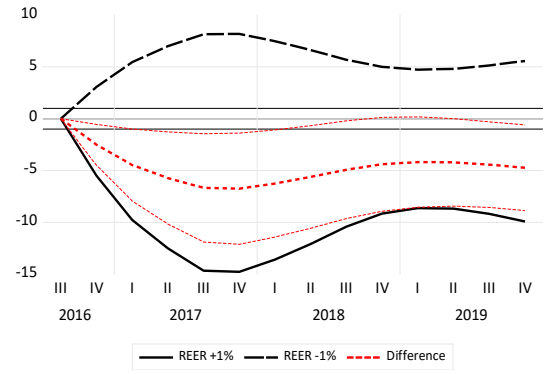
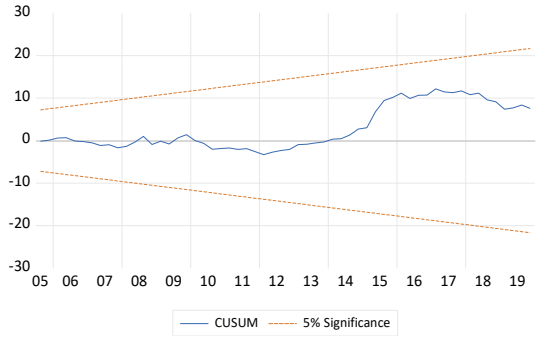
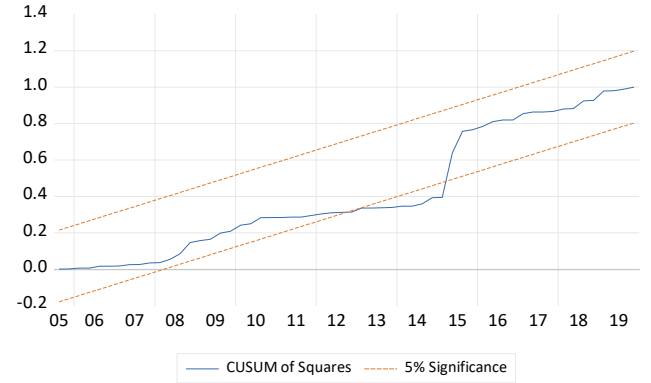
			[0.84]	[-0.25]	[3.15]
ΔExchange rate^{+}			34.91*** [2.93]	23.00*** [3.58]	43.31*** [5.51]
ΔExchange rate$^{+}_{(t-1)}$			28.90** [2.14]	10.00 [1.62]	25.81*** [2.92]
ΔExchange rate$^{+}_{(t-2)}$			21.53 [1.48]	7.86 [1.20]	49.11*** [6.66]
ΔExchange rate$^{+}_{(t-3)}$			21.52 [1.53]	19.10*** [2.85]	22.19** [2.54]
ΔExchange rate^{-}				-3.60 [-0.51]	13.51 [1.31]
ΔExchange rate$^{-}_{(t-1)}$				-7.27 [-1.00]	43.59*** [4.71]
ΔExchange rate$^{-}_{(t-2)}$				-12.59* [-1.94]	39.63*** [4.29]
ΔExchange rate$^{-}_{(t-3)}$				-12.46** [-2.07]	39.58*** [4.19]
ΔOil	1.99** [2.41]	4.05*** [5.96]		2.85*** [5.41]	3.17*** [2.78]
ΔOil$_{(t-1)}$	1.21 [1.42]	0.64 [0.83]		1.16** [2.07]	3.04*** [3.05]
ΔOil$_{(t-2)}$	0.90 [1.11]	3.67*** [5.39]		1.39** [2.65]	1.69* [1.79]
ΔOil$_{(t-3)}$	2.63*** [3.20]	1.31 [1.64]		1.84*** [3.41]	1.69* [1.83]
ΔMoney supply		0.02 [0.67]	-0.03 [-1.32]	-0.03 [-1.66]	-0.24*** [-6.16]
ΔMoney supply$_{(t-1)}$		0.04* [1.94]	-0.06** [-2.33]	0.03* [2.00]	-0.04 [-1.30]
ΔMoney supply$_{(t-2)}$			-0.03 [-1.96]	0.03* [1.78]	
ΔMoney supply$_{(t-3)}$			-0.05* [-1.96]		
ΔGDP	0.10 [1.04]		0.06** [2.14]	-0.23** [-2.66]	0.30 [0.77]
ΔGDP$_{(t-1)}$	-0.05		0.07**	-0.20***	-1.53***

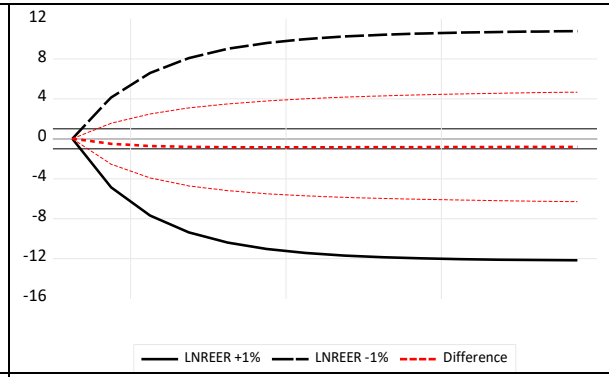
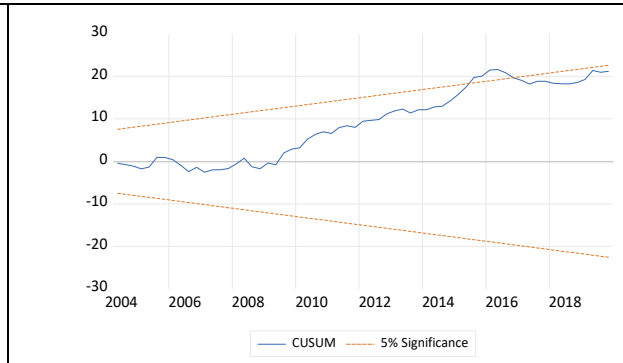
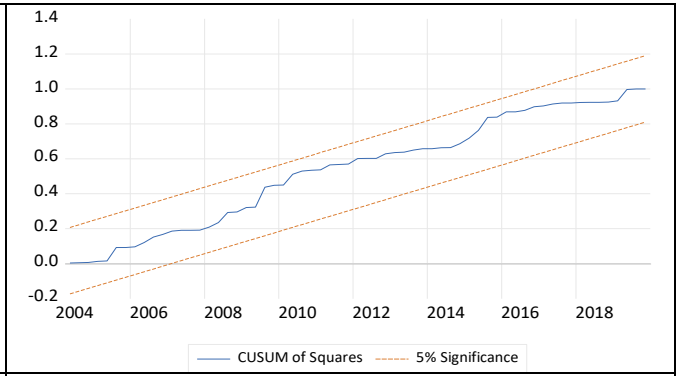
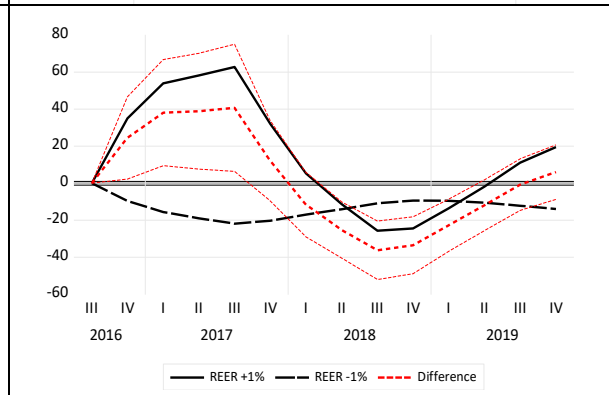
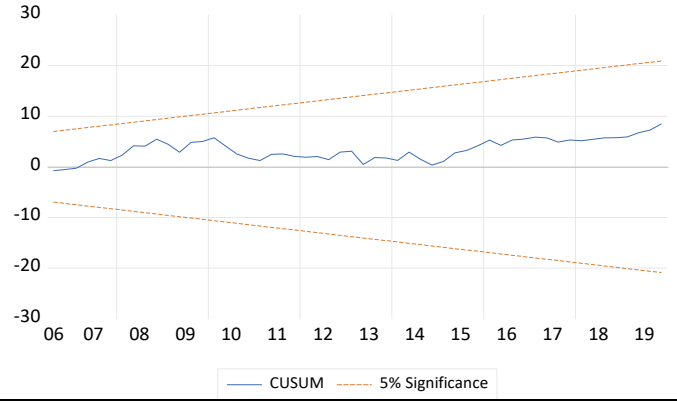
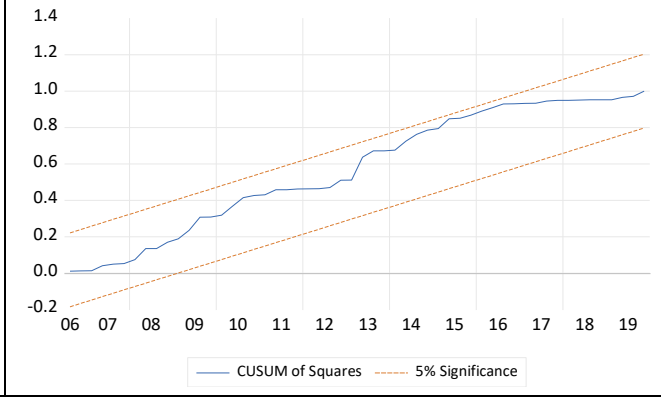
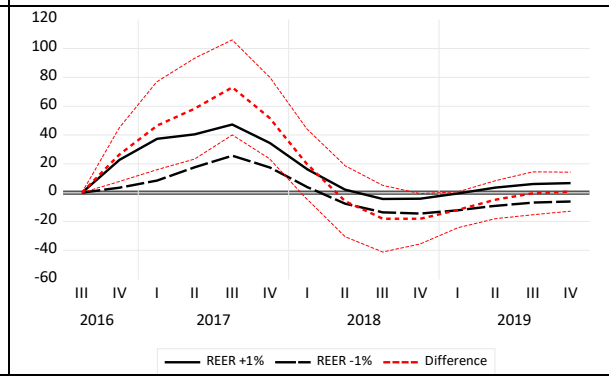
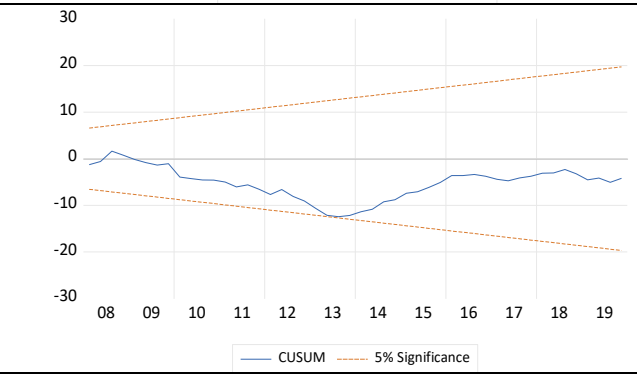
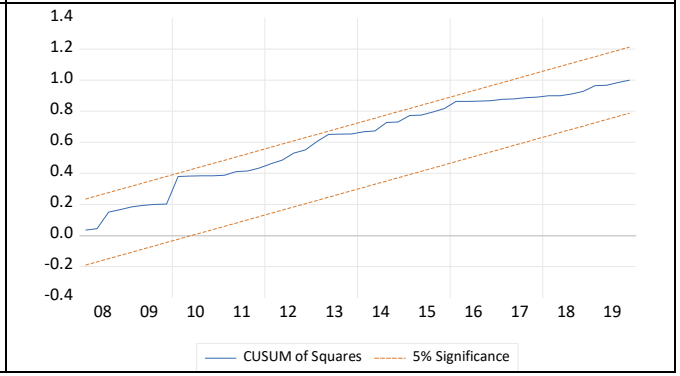
	[-0.51]		[2.29]	[-2.79]	[-4.11]
$\Delta GDP_{(t-2)}$	0.07 [0.91]		0.05 [1.47]	-0.02 [-0.27]	-1.09*** [-3.06]
$\Delta GDP_{(t-3)}$	-0.16** [-2.18]			-0.16** [-2.60]	-1.00*** [-3.65]
Exchange rate^{+} [b]	-5.62 [-1.57]	-4.84** [-2.29]			
Exchange rate^{-} [b]	-3.09 [-1.16]	-4.35 [-1.41]	9.52** [2.46]		
Money[b]	-0.05*** [-2.75]				
$\Delta Inflation_{(t-1)}$	0.32** [2.49]		0.35*** [3.21]	0.52*** [4.72]	
$\Delta Inflation_{(t-2)}$	0.20 [1.50]		0.30*** [2.75]		
$\Delta Inflation_{(t-3)}$	0.28** [2.10]		0.43*** [3.56]		
Oil[b]			0.71* [1.83]		
GDP[b]		0.02 [0.63]			
Constant	-2.81** [-2.41]	-4.34*** [-2.95]	-1.80 [-1.45]	-1.80* [-1.72]	-10.09*** [-4.37]
Panel B: Long run estimates					
Exchange rate $^{+}$	-10.63* [-1.81]	-11.42** [-2.31]	5.40* [1.84]	3.71 [0.89]	-32.12*** [-2.90]
Exchange rate $^{-}$	-5.84 [-1.81]	-10.26 [-1.53]	13.07** [2.53]	7.14 [1.01]	-28.35** [-2.16]
Oil	2.25** [2.61]	3.25*** [4.46]	0.97* [1.90]	2.31*** [2.91]	3.89** [2.15]
GDP	0.12 [0.65]	0.06 [0.66]	-0.04 [-0.91]	-0.06 [-0.22]	3.80*** [3.44]
Money supply	-0.09** [-2.05]	-0.04 [-0.97]	0.10*** [3.20]	-0.13*** [-3.18]	-0.35*** [-4.12]
Constant	-5.32** [-2.00]	-10.23*** [-3.49]	-2.48 [-1.53]	-4.75 [-1.51]	-19.78*** [-4.37]

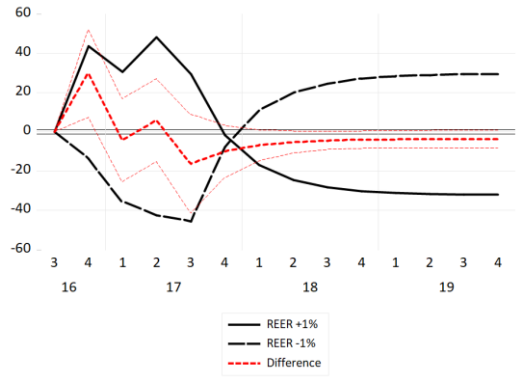
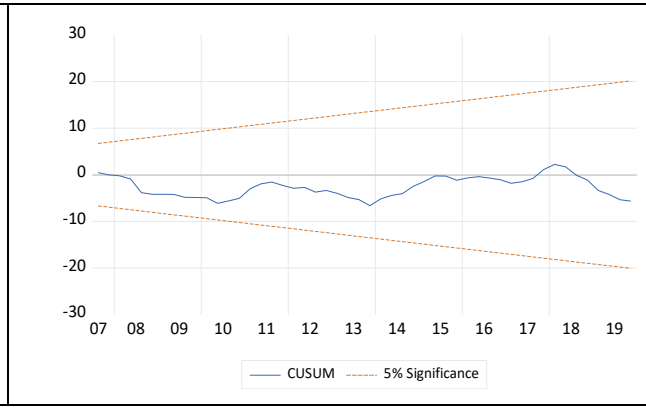
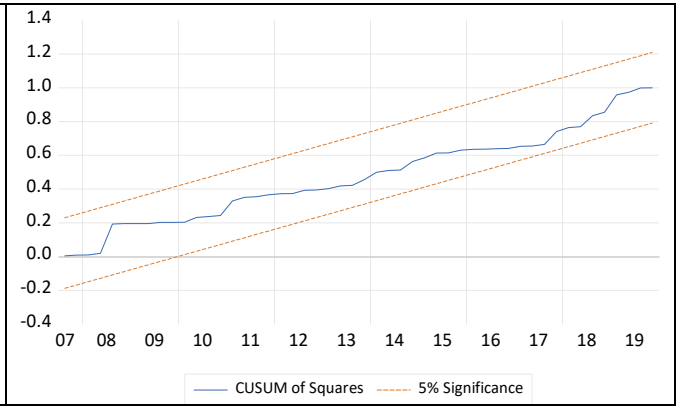
Panel C: Diagnostic Test					
R^2	0.56	0.69	0.76	0.84	0.82
Durbin Watson	1.79	1.80	1.82	1.91	1.80
ECT	-0.53***	-0.42***	-0.73***	-0.38***	-0.51***
JB test	0.00	0.42	0.22	0.74	0.99
Breusch-Godfrey test	0.35	0.43	0.17	0.94	0.41
Heteroskedasticity test	0.94	0.28	0.25	0.21	0.44
Wald-test	205.74***	350.30***	241.09***	1150.343***	1521.292***
RAMSEY	1.03	0.99	2.96***	0.164	0.818
Lag selection model	6, 1, 0, 0, 0, 0	2, 1, 4, 0, 4, 0	6, 0, 0, 1, 0, 0	4, 3, 4, 1, 1, 1	5, 4, 1, 0, 3, 4

Notes: ***1% level of significance ** 5% level of significance *10% level of significance. [a] p-value incompatible with t-Bounds distribution; [b] Variable interpreted as Z = Z(-1) + D(Z). The JB is Jarque-Bera test for the error normality. White-test were used for heteroskedastic. Note: White heteroskedasticity-consistent standard errors & covariance. Optimal lag selection based on AIC.

Figure 1. N-ARDL multiplier of exchange rate shocks and responses of inflation of ASEAN-5

Countries	N-ARDL multiplier of exchange rate	CUSUM Test	CUSUMQ Test
Malaysia			

Thailand			
Singapore			
Phillipines			

Indonesia	 60 40 20 0 -20 -40 -60 3 4 1 2 3 4 1 2 3 4 1 2 3 4 16 17 18 19 REER +1% REER -1% Difference	 30 20 10 0 -10 -20 -30 07 08 09 10 11 12 13 14 15 16 17 18 19 CUSUM 5% Significance	 1.4 1.2 1.0 0.8 0.6 0.4 0.2 0.0 -0.2 -0.4 07 08 09 10 11 12 13 14 15 16 17 18 19 CUSUM of Squares 5% Significance