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Article

Asymmetric effect of real exchange rate risk on foreign direct investment: Empirical evidence in ASEAN-4

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Abstract: This study investigates the asymmetric effect of exchange rate risk (volatility) on the real foreign direct investment (FDI) inflows in Malaysia, the Philippines, Singapore, and Thailand (ASEAN-4) using the Nonlinear Autoregressive Distributed Lag (NARDL) model. The results revealed the occurrence of a long-run asymmetric cointegration between real FDI inflows and real exchange rate risk in the Philippines, Singapore, and Thailand, but not in Malaysia. For the Philippines and Singapore, there is evidence of long-run asymmetry whereas short-run asymmetry exists for the case of Thailand. These findings imply that the asymmetric effects prove to be useful in providing essential information to the related parties on how FDI inflows react to exchange rate risks differently. Therefore, policymakers in ASEAN countries should be concerned about the asymmetric effect of the exchange rate volatility to mitigate the stylized effects of exchange rate movements on FDI inflows.

Keywords: Asymmetric Effect; Real Exchange Rate Risk; Foreign Direct Investment; ASEAN-4

JEL codes: F21; F31; O53

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1. Introduction

In ASEAN countries, foreign direct investment (FDI) has been regarded as an important driver that improves a country's economic performance and international competitiveness due to its positive contribution towards technological spillover, job creation, improved managerial skills and productivity since the mid-1980s. Researchers have been trying to identify the main factors that attract FDI inflows, but a sufficient set of factors with the ability to drive FDI on a global scope are yet to be discovered (Groh & Wich, 2012). While there are certainly some factors that explain FDI from or towards certain countries, the same factors are sometimes not relevant when tested in other countries (Blonigen & Piger, 2014). Based on the currency area hypothesis, one of the factors that affect FDI is the exchange rate movement (Takagi & Shi, 2011). For example, based on data about Japan's FDI in China and ASEAN-4 (Indonesia, Malaysia, Philippines, and Thailand) in nine manufacturing sectors from 1981 to 2002, Xing and Wan (2006) found that the recipient country's relative real exchange rate had a significant effect on the competition between China and ASEAN-4 (Indonesia, Malaysia, the Philippines, and Thailand) for Japanese FDI movement.

Despite the well-established literature on the relationship between exchange rate and FDI, especially in developed countries, it is rare to find studies done in ASEAN countries that examine the impact of exchange rate movements on FDI inflows asymmetrically. Hence, the issue of the relationship between FDI and the exchange rate direction, and its significance are still very much relevant. The empirical literature on the impact of exchange rate movements on FDI has largely focused on two main hypotheses. Firstly, a devaluation of the host country currency would encourage FDI inflows into the host country. Secondly, greater exchange rate volatility would discourage FDI inflows into the host country. This current study applies the second moment of the exchange rate movements by examining the asymmetric effect of the exchange rate volatility on FDI. While there exists empirical literature on the impact of exchange rate volatility on FDI inflows (Bahmani-Oskooee & Hajilee, 2013; Al-Abri & Baghestani, 2015; Maria et al., 2017), most of these studies have not examined the asymmetric effect of exchange rate volatility on FDI inflows. Therefore, the objective of this paper is to investigate the asymmetric effect of real exchange rate volatility on real inward FDI among the selected ASEAN countries (Malaysia, Philippines, Singapore, and Thailand) using asymmetric cointegration as well as causality analysis by incorporating asymmetric effect using the Nonlinear Autoregressive Distributed Lag (NARDL) model. Therefore, this study extends prior research and contributes to the literature by analyzing whether real FDI reacts differently to real exchange rate risk.

2. Literature Review

A financial view of FDI is conditional on some form of information asymmetry in international financial markets where the exchange rate is one of the most important financial variables that influence the relative advantage held by an MNE vis-à-vis a local firm (Choi et al., 2007; Takagi & Shi, 2011). A firm is assumed to maximize its profits given an exchange rate for a potential host country concerning the FDI source country. The direction of the exchange rate movement effect on the FDI depends on the MNE's objective in foreign direct investment, either local market-oriented or export-oriented (Moosa, 2002; Chen et al., 2006; Takagi & Shi, 2011; Lin, 2011). Under this framework, depreciation of the host country currency is likely to attract FDI inflows because of the MNE's comparative advantage over domestic firms with regards to production cost (Stevens, 1998; Osinubi & Amaghionyeodiwe, 2009; Takagi & Shi, 2011; Jongwanich & Kohpaiboon, 2013). On the other hand, if the FDI is for re-export purposes, the FDI and trade are then complemented. In this case, appreciation of the local currency reduces the FDI inflows through decreased competitiveness. In other words, FDI can be a tool used in foreign exchange risk hedging with the assumption that MNE may be more efficient in hedging the risk.

With several insignificant relationships between the FDI inflows as well as nominal exchange rate movement at both country and firm levels, researchers started to adopt exchange rate volatility; when making investment decisions, it is the risk that the investors take into consideration rather than the exchange rate movement (Campa, 1993). Goldberg and Kolstad (1995) pointed out two theoretical arguments associated with the effect of exchange rate volatility on FDI, namely the arguments of production flexibility and risk-aversion. Under the production flexibility argument, higher exchange rate volatility increases FDI with the assumption that the firms can adjust their variable factors following the realization of nominal or real shocks. After testing two different measurements of exchange rate volatility (standard deviation versus volatility) in the U.S between non-manufacturing and manufacturing industries, Schmidt and Broll (2009) found a clear distinction in the impact of the exchange rate risk on FDI. While the standard measure showed a negative effect on FDI outflows in all industries, the non-manufacturing industries displayed a positive correlation with increased exchange risk. Meanwhile, according to the risk-aversion theory, higher exchange rate volatility will decrease FDI inflows as it lowers the certainty of future expected cash flows, thus encouraging investors to rearrange their investments. However, Kiyota and Urata (2004) argued that as FDI is not a portfolio-type investment and it incurs large sunk costs, investors are likely to be risk-averse. Accordingly, higher exchange rate volatility would discourage FDI because potential investors would regard it as a greater risk rather than increased flexibility in the exchange rate. Meanwhile, if foreign investors are not risk-averse and intend to maximize their profits from the exchange rate uncertainty, higher exchange rate volatility may have a positive impact on FDI by serving the host country via local production facilities (Darby et al., 1999). The risk-aversion arguments are more compelling under short-term volatility whereas the production flexibility argument appears more convincing over the long-term period. This is because the factors of production are usually fixed for the short-run. Therefore, the firms are only risk-averse to volatility in their future profits but over the long-run, firms can adjust their use of variable factors.

Meanwhile, Markusen's (1995) argument on the relationship between the exchange rate volatility and FDI is in line with export substituting FDI. He argued that some firms also engage in FDI to avoid international trade costs including the currency risk. For that reason, as the exchange rate becomes more uncertain, more firms will choose to serve foreign markets through a local production facility in the host country rather than exports, which increase FDI inflows in host countries. In other words, the effect of exchange rate uncertainty also depends on the objective of FDI decision either for local market-oriented or export-oriented firms when serving the host country (Hakro & Ghumro, 2011). Conversely, if the FDI objective is to re-export, higher exchange rate volatility could hurt FDI inflows as investors experience a riskier stream of profits.

However, the existing literature lacks a clear consensus on the effects of exchange rate volatility on FDI (Osinubi & Amaghionyeodiwe, 2009). Studies have shown that MNEs tend to be risk-averse towards the exchange rate volatility along with the production cost. The increase in the exchange rate volatility hurts FDI inflows in recipient developed or developing countries (Goldberg & Kolstad, 1995; Bénassy-Quéré et al., 2001; Barrell et al., 2007; Chowdhury & Wheeler, 2008; Takagi & Shi, 2011). The negative effect is most evident in industries where sunk costs are relatively high. Besides, Kiyota and Urata (2004) found that volatilities in both the host currency and cross-rate real exchange rate had strong negative impacts on FDI flows from Japan to the host countries. Furthermore, Hara and Razafimahefa's (2005) study findings on FDI inflows in Japan indicate that high volatility of the host country's exchange rates discourages FDI if the foreign companies use a large share of imported inputs in their production. Due to the uncertainty in the FDI production planning introduced by instability in the local currency, entry is discouraged. Moreover, Barrell et al.'s (2007) results on the US FDI in the UK and Continental Europe showed that US firms tend to be risk-averse and often decrease their investments as exchange rate volatility rises.

Other studies have discovered that exchange rate uncertainty discourages FDI inflows in developing countries, thus supporting the risk-averse argument (Gottschalk & Hall, 2008; Osinubi & Amaghionyeodiwe, 2009; Kandilov & Leblebicioğlu, 2011; Sharifi-Renani & Mirfatah, 2012). For instance, Kandilov and Leblebicioğlu (2011) found that the exchange rate volatility (either using a Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model or a simple standard deviation measure) harms FDI inflows in Colombia. Osinubi and Amaghionyeodiwe (2009) also identified less FDI inflows in countries with a high degree of currency risk as compared to countries with more stable currencies. Meanwhile, Bahmani-Oskooee and Hajilee (2013) established mixed results where the effect of exchange rate volatility is negative in Chile, France, Malawi, South Africa, and the UK, but with a positive impact in Colombia, Italy, Singapore, Sweden, and the US.

Apart from that, some studies mentioned undetermined evidence on the relationship between exchange rate risk and FDI. For instance, Gorg and Wakelin (2002) found that exchange rate volatility had no statistically significant effect on the US inward FDI in 12 developed countries using either the standard deviation of the changes or by the trend of the exchange rate. Moreover, Sekmen (2007) showed that despite the evidence of a long-run relationship between exchange rate volatility and FDI in Turkey, the effect is considered weak. The results seem to be consistent with Chong and Tan's (2008) study in Southeast Asian countries including Malaysia, Indonesia, and Thailand.

With the weak and varying results about the relationship between exchange risk and FDI in previous literature, there is a possibility for the existence of an exchange rate asymmetry effect on micro and macroeconomic variables, including the FDI inflows (Muller & Verschoor, 2006; Koutmos & Martin, 2007; El bejaoui, 2013). Under the assumption of symmetry, the similar effects of the exchange rate during appreciation and depreciation may not be valid in real situations. Therefore, proponents of the exchange rate asymmetry effect have argued that the study of the financial market should consider not only the time-varying nature of volatility but also the asymmetric effect of volatility towards both good and bad news (Muller & Verschoor, 2006; Koutmos & Martin, 2007; Delatte & López-Villavicencio, 2012). Compared to the good news of the same magnitude, volatility tends to increase more in response to bad news. If this effect is present, foreign exchange market volatility tends to increase when there is a fear of financial or economic crisis.

The asymmetric effect of exchange rate risk on the micro and macroeconomics in ASEAN countries could be attributed to central bank interventions and the asymmetric hedging behaviors of MNEs. The central bank's intervention generates uncertainty in the market about the true value of the exchange rate (McKenzie, 2002; Suardi, 2008). In ASEAN countries that mostly practice a fixed and managed floating exchange rate regime, the central bank plays a significant role in managing the exchange rate (Parsley & Popper, 2006; Xing & Wan, 2006; Tan & Chong, 2008; Lily et al., 2014). The central bank tends to intervene against the foreign exchange rate if the exchange rates go beyond the desirable rate by buying and selling their foreign reserves or changing the interest rate (Patnaik et al., 2011). Based on the objective of the MNEs (market-oriented or export-oriented), most usually adopt only one-sided hedges in which the firm managers perceive greater risk in terms of outcomes involving a loss rather than in terms of dispersion of outcomes, suggesting an asymmetry with positive and negative changes (Iorio et al., 2000; Koutmos & Martin, 2003). Therefore, the asymmetric hedging behavior could be one of the sources for the asymmetric effect of exchange rate on FDI.

In summary, FDI decisions are complex and diverse. Even though well-established theoretical work can be found in the literature, the effects of exchange rate volatility on FDI continue to be ambiguous. This controversy, therefore, motivates the conduct of this research on the comparison relationship between the asymmetric effects of exchange rate volatility on the FDI inflows in Malaysia, the Philippines, Singapore, and Thailand, countries where the empirical evidence has yet to be intensively developed.

3. Methodology

3.1.Data

The current paper is part of the ongoing research on FDI under the research grant scheme funded by Universiti Malaysia Sabah. The research is based on two periods of studies: (1) based on data from 1971 to 2013 (completed) and (2) data from 2014 to 2020 using temporal disaggregation approach (in progress). Therefore, the current study used yearly time series data on the exchange rate and inward FDI from four ASEAN countries (Malaysia, the Philippines, Singapore, and Thailand) from 1971 to 2013. The inward FDI was obtained from the United Nations Conference on Trade and Development (UNCTAD) database[1]. Meanwhile, the exchange rate and other related variables for respective countries were collected from World Development Indicators and Global Development Finance database[2]. Foreign direct investment inflows consist of capital provided (either directly or through other related enterprises) by a foreign direct investor to the FDI enterprise, or capital received by foreign direct investment from the FDI enterprise (UNCTAD, 2010). The foreign direct investment inflows are then adjusted by dividing the nominal FDI value at the current price (U.S. dollars) by the GDP at a constant price (base year = 2010) for controlling the effect of host country size in the cross

[1]UNCTAD website,http://unctadstat.unctad.org, provides access to their database.

[2] World Bank website, http://databank.worldbank.org/data/home.aspx, provides access to their database.

country analysis (Albuquerque et al., 2005; Schmidt & Broll, 2009). The simple calculation of the adjusted FDI (AFDI) is shown as follows:

$$AFDI = \frac{FDI_{Current\ \text{Price}}}{GDP_{2010}} \quad (1)$$

The nominal exchange rate (NER) is the domestic currency vis-à-vis the foreign currency, the US dollar. In this study, the real exchange rate indices of the respective currency are calculated by using the purchasing power parity (PPP) approach. Thereafter, the real exchange rate (RER) is defined as the NER of the domestic currency vis-à-vis the U.S dollar multiplied by the ratio of the price level in the USA to the price levels in the domestic currency. Thus, a rise (fall) in the real exchange rate index indicates a real depreciation (real appreciation) of the local currency. To calculate the RER, the formula from Osinubi and Amaghionyeodiwie's (2009) study is used in a simple form as follows:

$$RER = NER \times \frac{P_{US}}{P_H} = NER \times \frac{WPI_{US}}{CPI_H} \quad (2)$$

Where RER are the real exchange rates, NER is nominal exchange rates, P_{US} is the US prices, P_H is the domestic price. The US price level is proxied by the Wholesale Price Index (WPI) of the USA, while the Consumer Price Index (CPI) is used as a proxy for the domestic price level.

3.2 *Econometric Models*

In this study, firstly, descriptive statistics analysis, and unit root tests were used to analyze the characteristics of the variables. Then, the asymmetric cointegration model of NARDL was utilized to test the asymmetric effects of the exchange rate (RER) risks on FDI inflows over the long-run in each country studied. In addition to that, to model the asymmetric effects of exchange rate risk towards FDI, the use of asymmetric bivariate GARCH models such as the Exponential GARCH (Nelson, 1991) or the Threshold GARCH (Glosten et al., 1993; Zakoian, 1994) were considered. However, since this study used low-frequency data and the ARCH test of Engle (1982) failed to reject the null hypothesis of no ARCH effect for each residual of the series variables (see Table 1), GARCH model was not suitable to be used in this study. Conversely, the conditional variance (VRER) for the respective sample countries' exchange rates were estimated and derived using the standard univariate GARCH (1,1) model (Bollerslev, 1986) on the RER series as follows to represent the exchange rate risk or volatility to be incorporated in the asymmetric cointegration equation or NARDL in Section 3.4.

$$rer_t = \alpha + \beta rer_{t-1} + e_t, \quad (3)$$

$$e_t \mid \Omega_t \sim N(0, h_t),$$

$$h_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1}, \quad (4)$$

where h_t is the current conditional variance depending on both past values of the shock which is captured by the lagged squared residual, e_{t-1}^2 and on the past value of itself which is captured by the lagged conditional variance, h_{t-1} (Bollerslev, 1986).

3.3 *Unit Root Tests*

Before further analysis, the unit root tests were conducted to check for the stationarity and order of integration of the series variables. In this study, the Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) and Phillips-Perron (PP) (Phillips & Perron, 1988) unit root tests were adopted. The lag length for the ADF test was chosen by minimizing the Schwarz information criterion.

Another alternative approach is the Phillips-Perron (PP) test suggested by Phillips (1987), extended by Perron (1988) as well as Phillips and Perron (1988). Rather than taking account of the extra terms in the data-generating process (DGP) by adding them to the regression model (as in the ADF test), a non-parametric correction to the *t*-test statistic is undertaken to account for the autocorrelation that is present when the underlying DGP is not autoregressive at the first level, AR(1). Phillips and Perron (1988) proposed an alternative (non-parametric) method of controlling for serial correlation when testing for a unit root. The PP method estimates the non-augmented Dickey-Fuller (DF) test and modified the *t*-ratio of the coefficient to ensure that the serial correlation does not affect the asymptotic distribution of the test statistic. The details of the tests will not be further explained since both tests have been extensively discussed in numerous studies.

3.4 NARDL Model

The recently developed NARDL approach by Shin, Yu, and Greenwood-Nimmo (2014) which accounts for nonlinear and asymmetric adjustment was employed. The general form of the NARDL model can be shown as:

$$\Delta y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 x_{t-1}^{+} + \beta_3 x_{t-1}^{-} + \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + \sum_{i=0}^{q} \left(\theta_i^{+} \Delta x_{t-i}^{+} + \theta_i^{-} \Delta x_{t-i}^{-} \right) + e_t \quad . \qquad (5)$$

At first, the following equation was specified to illustrate the asymmetric long-run equation of FDI (Shin et al., 2014; Ibrahim, 2015):

$$fdi_t = \alpha_0 + \alpha_1 vrer_t^{+} + \alpha_2 vrer_t^{-} + e_t \, , \qquad (6)$$

where *vrer* is a conditional variance of the real exchange rate, and $\alpha = \left(\alpha_0, \alpha_1, \alpha_2 \right)$ is a vector of unknown long-run parameters to be estimated. Meanwhile the $vrer_t^{+}$ and $vrer_t^{-}$ represents the partial sums of positive and negative changes in VRER:

$$vrer_t^{+} = \sum_{i=1}^{t} \Delta vrer_i^{+} = \sum_{i=1}^{t} \max \left(\Delta vrer_i, 0 \right) \, , \qquad (5)$$

and

$$vrer_t^{-} = \sum_{i=1}^{t} \Delta vrer_i^{-} = \sum_{i=1}^{t} \min \left(\Delta vrer_i, 0 \right) \, . \qquad (6)$$

To be specific, equation (6) can be framed or reformulated into an ARDL setting (Pesaran et al., 2001; Shin et al., 2014; Ibrahim, 2015) as in equation (9) as follows:

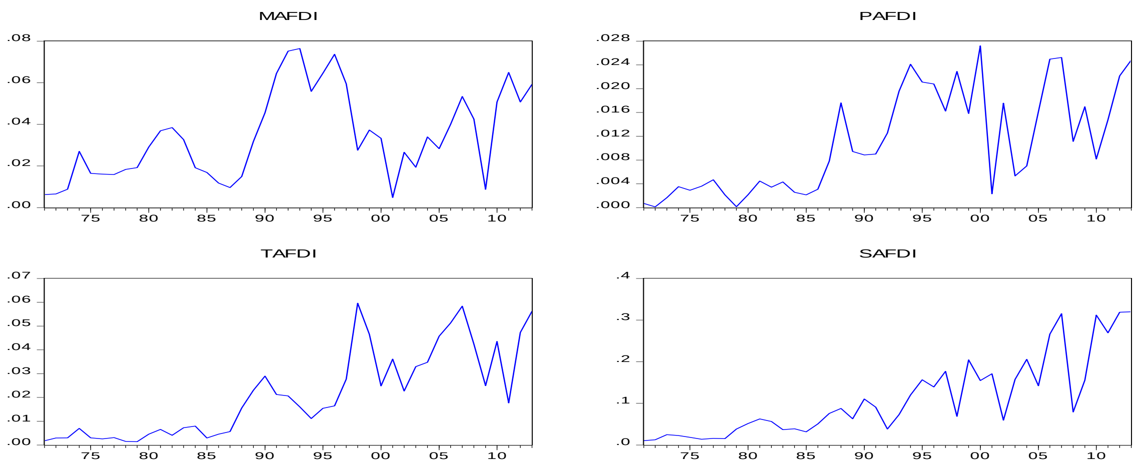
$$\Delta fdi_t = \beta_0 + \beta_1 fdi_{t-1} + \beta_2 vrer_{t-1}^{+} + \beta_3 vrer_{t-1}^{-} + \sum_{i=1}^{p} \varphi_i \Delta fdi_{t-i} + \sum_{i=0}^{q} \left(\theta_i^{+} \Delta vrer_{t-i}^{+} + \theta_i^{-} \Delta vrer_{t-i}^{-} \right) + e_t \, , \qquad (7)$$

where all variables are previously defined, and p and q are lag orders. The term $\sum_{i=0}^{q} \theta_i^{+}$ measures the short-run influences of positive changes in the conditional variance of the real exchange rate (increase in exchange rate risk) while $\sum_{i=0}^{q} \theta_i^{-}$ measures the short-run influences of negative changes in the conditional variance of the real exchange rate (decrease in exchange rate risk). From equations (6) and (9), both $\alpha_1 = -\beta_2 / \beta_1$ and $\alpha_2 = -\beta_3 / \beta_1$ represent the long-run impacts of an increase and decrease in the conditional variance of real exchange rates on the FDI. To test for the presence of cointegration among the variables involves the Wald F test of the null hypothesis of $H_0 : \beta_1 = \beta_2 = \beta_3 = 0$ as in standard ARDL model (refer to Pesaran et al. (2001) and Shin et al. (2014) for more details on the test procedure). If the cointegration exists, then an examination of long-run and short-run asymmetries using the Wald F test can be done on the null hypotheses of $H_0 : \beta_2 = \beta_3$ $H_0 : \theta^+ = \theta^-$ and respectively.

4. Empirical Results

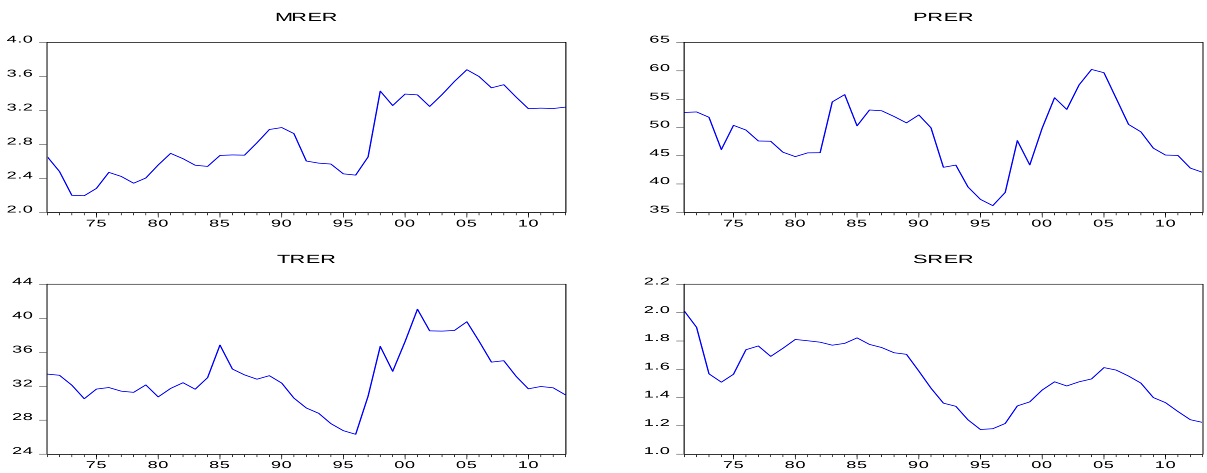
Despite the fluctuations during the sample period, FDI inflows (in an adjusted form) across all sample countries show an upward trend especially from the start of the mid-period, as early as the 1990s (see Figure 1). Additionally, the FDI inflows in all sample countries experienced a significant drop during the periods of the Asian financial crisis (1997-1999) and the global financial crisis (2007-2009) especially in the case of Malaysia and the Philippines.

Figure 1: Adjusted Foreign Direct Investment



Notes: AFDI stands for 'Adjusted Foreign Direct Investment' based on equation (1) for respective countries: Malaysia (M), Philippines (P), Thailand (T), and Singapore (S).

Figure 2: Real Exchange Rate



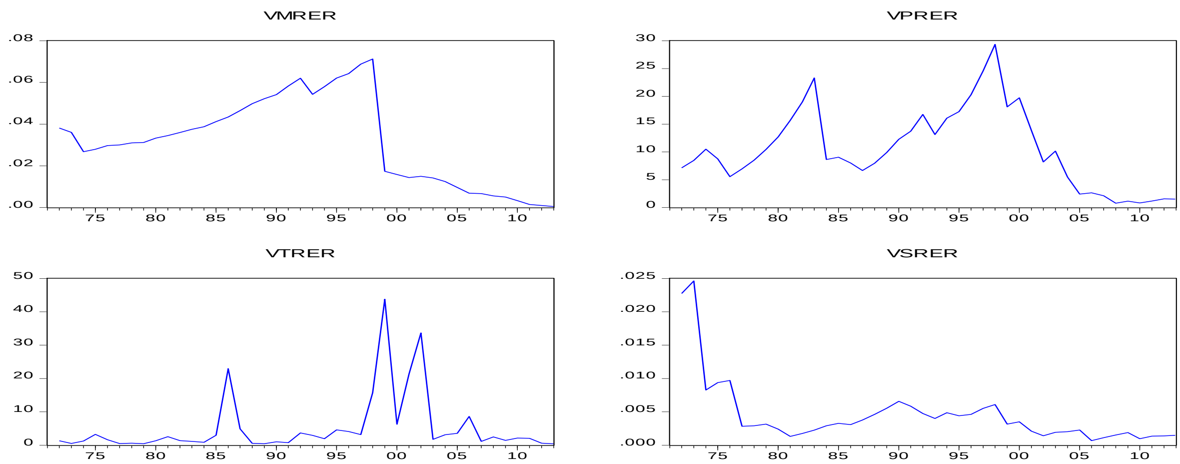
Notes: RER stands for 'Real Exchange Rates" based on equation (2) for respective countries: Malaysia (M), Philippines (P), Thailand (T), and Singapore (S).

The RER is the sample countries also showed fluctuations over this period (see Figure 2). Interestingly, Malaysia's RER suggested an increasing trend compared to the RER of other sample countries. In this study, the exchange rate was quoted as units of home currency per USD; an increase in RER indicates that Malaysia's RER is getting weaker against the USD. On the other hand, the RER for Singapore experienced a downward trend, indicating that Singapore's RER has been further strengthened. Moreover, as with the FDI, the RER in all sample countries is affected by the financial crisis; there was significant home currency depreciation in all sample countries during the Asian financial crisis.

Meanwhile, Figure 3 shows the exchange rate risks or volatility in sample countries. Unlike Malaysia and Singapore, the exchange rate risks for Thailand and the Philippines are relatively large, especially during the Asian financial crisis. Meanwhile, the exchange rate risk for Singapore is relatively small and stable, particularly after 1976.

Through diagrammatic observation, as shown in Figure 1 to Figure 3, it can be concluded that there is a potential relationship between FDI and exchange rate movements (real exchange rates and real exchange rate risk). The relationship became more strikingly obvious during the financial crisis period. During the crisis period, the FDI inflows tended to have an inverse relationship with the RER. While in the same period, real exchange rate risk reflected a positive relationship with RER, but a negative relationship with FDI. More specifically, during the financial crisis period, the RER in sample countries experienced a rise or depreciation in home currency. At the same time, the impact of the shock triggered by the financial crisis on the RER subsequently led to an increase in the real exchange rate risk as shown by an increase in volatility. The increase in exchange rate risk due to the financial crisis resulted in a negative impact on FDI. However, formal tests are needed to verify the observation results through these diagrams.

Figure 3: Real Exchange Rate Risk



Notes: RER stands for 'Real Exchange Rates" based on equation (2) for respective countries: Malaysia (M), Philippines (P), Thailand (T), and Singapore (S). Meanwhile, V stands for "Volatility" based on equation (3) and (4).

Table 1 shows a statistical summary for each series of studied variables (adjusted FDI and real exchange rate risk or volatility) in all the sample countries. The real exchange rate risk (volatility) for the Philippines (VPRER) and Thailand (VTRER) have positive mean values of 2.011 and 0.801, respectively, while other variables have recorded negative mean values. The standard deviation (SD) for the studied variables ranged from 0.7 to 1.2, with the highest values of 1.248 and 1.202 found in the Philippine's FDI (PAFDI) and Thailand's real exchange rate risk (VTRER), respectively.

Except for VTRER and Singapore's real exchange rate risk (VSRER), almost all variables have skewness statistics with negative values. Kurtosis statistics show that for some variables, such as the PAFDI, the real exchange rate risk of Malaysia (VMRER) and VSRER have excess kurtosis ranging from 3.3 to 5.5, reflecting the effects of significant structural changes in the series of variables, the presence of thick (fat) tails and leptokurtosis. Some series of variables such as PAFDI, VMRER, and VPRER have non-normal distributions as shown by large and significant Jarque-Bera statistics (JB). However, all residual series for each variable is free from the heteroscedasticity problem, and almost all residual series do not have any significant autocorrelation problems except for PAFDI and Singapore FDI (SAFDI).

Table 1: Summary Statistics

	MAFDI$_t$	VMRER$_t$	PAFDI$_t$	VPRER$_t$	TAFDI$_t$	VTRER$_t$	SAFDI$_t$	VSRER$_t$
Mean	-3.566	-3.861	-4.971	2.011	-4.319	0.801	-2.549	-5.745
SD	0.709	1.196	1.248	0.976	1.121	1.202	0.952	0.775
Skewness	-0.582	-1.498	-1.447	-0.958	-0.411	0.736	-0.276	0.543
Kurtosis	2.585	4.754	5.483	2.904	1.897	3.041	2.084	3.393
JB	2.670	21.089***	25.436***	6.440**	3.311	3.796	2.000	2.336
$\chi^2_{SCLM,2}$	1.926	0.031	6.371**	0.421	1.189	2.365	4.982*	2.210
$\chi^2_{ARCH,2}$	2.285	0.130	2.663	0.486	0.647	0.860	0.521	1.202

Source: Authors' calculation. *Notes*: ***, ** and * denote significance at 1%, 5% and 10% levels respectively. SD = Standard Deviation, JB = Jarque-Bera test statistic for normal distribution, $\chi^2_{SCLM,2}$ = Lagrange Multiplier statistic for serial correlation test with 2 lags and $\chi^2_{ARCH,2}$ = Engle's test statistic for heteroscedasticity with 2 lags. All variables are in logarithm form.

Stationarity tests based on ADF and PP tests suggest that only a series of variables such as Malaysian FDI (MAFDI), PAFDI, VTRER, and VSRER are stationary at the level $I(0)$. Conversely, VMRER, VPRER, FDI Thailand (TAFDI), and SAFDI are stationary at the first difference, $I(1)$. The complete results for the unit root tests are shown in Table 2.

Table 2: Stationarity Test

Variable	Level		First Difference	
	ADF	PP	ADF	PP
MAFDI$_t$	-3.471**	-3.365**	-8.623***	-8.871***
VMRER$_t$	3.101	3.154	-4.290***	-4.335***
PAFDI$_t$	-3.063**	-2.883*	-9.514***	-11.883***
VPRER$_t$	-0.587	-0.863	-6.293***	-6.338***
TAFDI$_t$	-1.761	-1.761	-7.681***	-8.170***
VTRER$_t$	-3.105**	-3.150**	-6.618***	-9.204***
SAFDI$_t$	-1.734	-1.868	-6.449***	-23.279***
VSRER$_t$	-2.715*	-2.687*	-7.394**	-7.394***

Source: Authors' calculation. *Notes*: ***, ** and * denote significance at 1%, 5% and 10% levels respectively. The constant term is included in the test equations, and the optimal lag order for the ADF test is selected using SIC. All variables are in logarithm form.

Table 3 shows the NARDL bounds tests as well as the long-run and short-run asymmetric tests. Following the NARDL bounds tests, evidence of cointegration between FDI and exchange rate risk was found to be significant at 5 percent and 10 percent significance level in the Philippines, Thailand, and Singapore, thus suggesting that both variables, i.e. FDI and exchange rate risk, co-move over the long-run. Further examinations of the long-run and short-run asymmetries revealed that the long-run relationship between FDI and exchange rate risk is asymmetric in all those countries with significant cointegration. However, short-run asymmetry is found to be significant only in the case of Thailand. These results suggest that the FDI movement is affected by positive and negative exchange rate risks differently.

Associated with the cointegration results, the estimation of the cointegration and long-run equations (regressions) were then analyzed without the inclusion of Malaysia. The results are presented in Table 4. The results show that the FDI movement is affected by the positive exchange rate risk in the long run for both the Philippines and Singapore as both coefficients are significant at the 5 percent and 10 percent levels, respectively. The effect of the exchange rate risk is relatively larger and more significant in the Philippines (0.712) as compared to Singapore (0.493). No significant evidence of the long-run effect was found in the case of Thailand. However, in the short-run setting, the results indicate that only Thailand experienced a significant short-run relationship between the FDI and exchange rate risks, with both positive and negative exchange rate risks having different signs of coefficients. Further causality tests revealed that both positive and negative exchange rate risks do cause the FDI movement in the short run. The details of the short-run estimation results are presented in Table 5.

Table 3: NARDL Bounds Test for Cointegration

Model	Bounds F-Statistic	Conclusion	LR Symmetry Test, $F_{H_0:\beta_2=\beta_3}$	SR Symmetry Test, $F_{H_0:\theta^+=\theta^-}$
$NARDL(1,0,2): F(MAFDI \mid MPOS, MNEG)$	3.509	No Cointegration	NA	NA
$NARDL(1,0,0): F(PAFDI \mid PPOS, PNEG)$	4.778**	Cointegration	6.685**	0.080
$NARDL(1,0,0): F(TAFDI \mid TPOS, TNEG)$	3.767*	Cointegration	7.571***	4.920**
$NARDL(1,1,0): F(SAFDI \mid SPOS, SNEG)$	4.418**	Cointegration	9.518***	0.826

Source: Authors' calculation. *Notes*: LR and SR denote long-run and short-run respectively. For the bounds test, the asymptotic critical value bounds for a small sample size were obtained from Narayan (2005). Lower bound, $I(0)$ = 4.770, 3.435 and 2.835; upper bound, $I(1)$ = 5.855, 4.260 and 3.585 at 1%, 5% and 10% levels respectively. The ***, ** and * denote significance at 1%, 5% and 10% levels respectively. NA = not applicable.

Table 4: Nonlinear Long-Run Relations

Dependent Variable	Independent Variable	Coefficient	P-Value
$PAFDI_t$	Constant	-6.267	0.000
	$PPOS_t$	0.712	0.026
	$PNEG_t$	0.119	0.571
$TAFDI_t$	Constant	-6.257	0.000
	$TPOS_t$	-0.027	0.890
	$TNEG_t$	-0.209	0.313
$SAFDI_t$	Constant	-3.792	0.000
	$SPOS_t$	0.493	0.099
	$SNEG_t$	-0.093	0.687

Source: Authors' calculation. *Note*: P-Value denotes probability value.

5. Discussion

Except for Malaysia, the current study presents evidence of the cointegration between FDI and exchange rate risk in the Philippines, Thailand, and Singapore; the results suggest that both variables, i.e. FDI and exchange rate risks, co-move in the long-run. Further investigation of the long-run and short-run asymmetries revealed that the long-run relationship between FDI and exchange rate risk was asymmetric in the Philippines, Thailand, and Singapore. However, the short-run asymmetry was only found to be significant in the case of Thailand. The existence of the asymmetric effect of exchange rate risk suggests that the FDI movement is affected by positive and negative series of exchange rate risks differently. The non-existence of cointegration in Malaysia between FDI and exchange rate risk implies that an asymmetric approach is more suitable to explain the relationship between the studied variables.

Moreover, the evidence in long-run asymmetries shows that positive exchange rate risk shocks have a stronger effect on FDI inflows than negative exchange rate risk shocks in the Philippines and Singapore. These findings indicate that an increase in exchange rate volatility could increase the aggregate FDI in the Philippines and Singapore. The findings in the current study are consistent with other previous studies (e.g., Pain & Van Welsum, 2003; Ellahi, 2011; Bahmani-Oskooee & Hajilee, 2013) that have indicated higher exchange rate volatility increases FDI inflows. This implies that negative information on exchange rate risk has a greater impact than positive information of exchange rate movements on FDI inflows. Additionally, the effect of the exchange rate risk is relatively larger and more significant in the Philippines as compared to Singapore. However, no evidence has been found in the case of Thailand. Over the short-run, the results indicate that only Thailand experienced a significant relationship between the FDI and exchange rate risks, with both positive and negative exchange rate risks having different signs of coefficients. Further causality tests revealed that both positive and negative exchange rate risks do cause the FDI movement over the short-run.

Table 5: Short-run Model Based NARDL Estimation Results

Dependent Variable	Independent Variable	Coefficient	F-Statistic	Diagnostic Test
$\Delta PAFDI_t$	Constant	0.135		$JB = 86.787^{***}$
	$\Delta PPOS_t$	0.094	$F_{All} = 0.701$	$\chi^2_{SC,2} = 1.169$
			$F_{Pos} = 0.004$	$\chi^2_{Het,2} = 0.083$
	$\Delta PNEG_t$	0.511	$F_{Neg} = 0.749$	CUSUM = S
				$CUSUM^2$ = S
$\Delta TAFDI_t$	Constant	-0.064		$JB = 2.141$
	$\Delta TPOS_t$	0.294*	$F_{All} = 2.562^c$	$\chi^2_{SC,2} = 0.839$
	$\Delta TPOS_{t-1}$	-0.251*	$F_{Pos} = 3.723^b$	$\chi^2_{Het,2} = 0.455$
			$F_{Neg} = 2.877^c$	CUSUM = S
	$\Delta TNEG_t$	-0.200*		$CUSUM^2$ = S
$\Delta SAFDI_t$	Constant	0.074		$JB = 3.475$
	$\Delta SPOS_t$	0.351	$F_{All} = 1.106$	$\chi^2_{SC,2} = 0.109$
	$\Delta SPOS_{t-1}$	-0.820	$F_{Pos} = 1.106$	$\chi^2_{Het,2} = 1.382$
			$F_{Neg} = 0.992$	CUSUM = S
	$\Delta SNEG_t$	-0.266		$CUSUM^2$ = S

Source: Authors' calculation. Notes: ***, ** and * denote significance at 1%, 5% and 10% levels respectively. F-statistic is the F-Granger statistic for causality test from exchange rate risk to FDI. For autocorrelation and heteroskedasticity tests, SC = serial correlation, and Het = Heteroskedasticity. For CUSUM tests, S = stable. All variables are in logarithm form.

The results (higher volatility attract FDI inflows) imply that the aggregate FDI in these countries most likely serves the local market of the host country (Hakro & Ghumro, 2011) and the investors are not risk-averse (Bahmani-Oskooee & Hajilee, 2013). Some firms aim to avoid the costs of international business transactions including currency risk. Therefore, if the exchange rates become more uncertain, more firms might choose to serve the host market, which would increase inward FDI in host countries. Additionally, if foreign investors are not risk-averse, they can adjust their variable factors towards the temporary shocks in the economy by increasing the production flexibility of local productions in the host country. Moreover, the risk-aversion arguments are based on short-term decision making whereas the production flexibility argument appears to be long term decision making. Therefore, the firms will only be risk-averse to volatility in their future profits but in the long-run firms are now able to adjust their use of variable factors. Besides, if a host country has a friendly investment environment that would compensate for the cost of exchange rate volatility, the investors would be encouraged to invest in the host country. For instance, even though the Singapore economy relies on import and export business, Singapore is a hub for financial services that attract many investors in financial services that serve the local market.

6. Conclusions and Recommendations

The results of the current study have multiple theoretical and practical implications in determining FDI inflows on the currency area hypothesis. For the body of knowledge, the study extended the theoretical understanding of the effects of exchange rate movements on FDI inflows by providing evidence that the FDI inflows react differently to increases and decreases in real exchange rate volatility or risk. Specifically, the evidence in long-run asymmetries indicated that positive exchange rate risk or higher volatility shocks have a stronger effect on FDI inflows than negative exchange rate risk or lower volatility shocks. While empirical literature emphasizes the importance of symmetric effects, the asymmetric effects prove to be useful in providing essential information to the related parties on how FDI inflows react differently to the asymmetric risks in the exchange rate movement. Therefore, policymakers should intervene in foreign exchange markets to maintain a country's competitiveness by monitoring the exchange rate movement stability because not all industries have a positive impact from the increase of exchange rate volatility or uncertainty. As indicated by Kiyota and Urata (2004), FDI incurs large sunk costs; thus, not all firms have the production flexibility to adjust to the local market if there is a sudden macroeconomic shock within the economy. Beyond that, policymakers should maintain an investment-friendly climate to preserve the existing FDI as well as attract new FDI inflows. In this study, the main focus is on the asymmetric effect of exchange rate risk. Future research is recommended to investigate other factors that have asymmetric effects on FDI such as inflation.

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