

The Impact Of Thin Trading Adjustments On Exchange Rate Exposure

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Abstract: This study investigates the multiple exchange rate exposure of large non-financial firms in Asia and emerging countries using the unadjusted and adjusted two-factor exchange rate exposure model. The autoregressive-distributed lag (ARDL) method was applied to investigate the existence of exchange rate exposure. The Dimson-Fowler-Rorke (DFR) adjustment method was applied to adjust the ordinary least squares (OLS) market risk estimator for the thin trading phenomenon. The study's findings indicate that exchange rate exposure does affect firm value. Incorporating the DFR market beta in the exchange rate exposure model indicates two important findings. Firstly, there is a significant increase in the number of firms exposed to exchange rate movements, especially in Indonesia, Thailand, Sri Lanka, and Vietnam. Secondly, there are more firms that will be exposed to multi bilateral exchange rate exposure across the sample countries. The findings imply that market characteristics such as thin trading could be an alternative explanation of the exchange rate exposure puzzle. Furthermore, future research should include asymmetric analysis as an alternative explanation for exchange rate exposure.

Keywords: exchange rate exposure; thinness market; beta adjustment; ARDL; Asian countries

JEL: C58, F31, G10, G14, G15

Introduction

Studying the exchange rate exposure remains a significant subject for empirical investigation due to its potential negative effects on an economy (Ye, Hutson and Muckley, 2014). The traditional exchange rate exposure theory, based on the flow-oriented model by Dornbusch and Fischer (1980) suggests that exchange rate changes can affect a firm's competitive advantage and hereafter its share price. Therefore, if the value of a currency has a significant effect on a country's economy, a similar relationship should be present at the firm level, because those countries that adopt a floating exchange rate regime are expected to face higher volatility in exchange rates, leading to future cash flow variability among firms (Ho, 2012; Gomes Neto and Veiga, 2013; Sikarwar, 2014).

Based on the market value method, at firm level analysis, exchange rate exposure refers to a firm's value sensitivity toward exchange rate movements (Adler and Dumas, 1984; Jorion, 1990; Bartram, 2007). Share returns can be used as the proxy for firm value because share prices respond to exchange rate movements, since the current value of firms' future cash flows are incorporated into their share prices, and it is what investors consider the worth of the firm (e.g., Aggarwal and Harper, 2010; Du and Hu, 2014; Kang, Kim and Lee, 2016). Thus, theoretically, every firm is expected to be exposed to exchange rate movements irrespective of their involvement in international transactions, because exchange rate movements may also indirectly affect a firm with little or no foreign involvement through its suppliers, consumers and competitors (Parsley and Popper, 2006; Aggarwal and Harper, 2010; Hutson and Laing, 2014; Kang, Kim and Lee, 2016). However, empirical studies have shown little support

for the exchange rate exposure theory where the percentage of significant firms that have been exposed to exchange rate movements has tended to be lower than the theory expected. For example, in Parsley and Popper's (2006) study in selected Asian countries, they indicated that less than 30 percent of the sample firms were exposed to exchange rate movements. The phenomenon is known as the exchange rate exposure puzzle. The inconsistency between the theory and empirical evidence may cause difficulties for the affected parties, such as policymakers, firms, and investors when formulating the appropriate mitigating hedging strategies to the exchange rate exposure.

Re-examination of the previous literature about the standard Capital Asset Pricing Model (CAPM) exchange rate exposure model reveals that some previous studies (Jn, 1990; Parsley and Popper, 2006; Muller and Verschoor, 2007; Verschoor and Muller, 2007; Lin, 2011; Bacha et al., 2013; Du, Hu and Wu, 2014; Ye, Hutson and Muckley, 2014; Sikarwar, 2020) have paid less attention to some of the crucial issues that could lead to inefficiency in the exchange rate exposure. One of the problems is the presence of thin trading in share prices. The use of market returns as a control variable in the CAPM-based two-factor exchange rate exposure model (Jorion, 1990; Parsley and Popper, 2006; Muller and Verschoor, 2007; Verschoor and Muller, 2007; Lin, 2011; Bacha et al., 2013; Du, Hu and Wu, 2014; Ye, Hutson and Muckley, 2014) can lead to inefficiency in the exposure model with the existence of thin trading, especially in frontier and emerging markets.

The market beta estimates will only be an appropriate measure if all the shares in the stock market are actively traded and the price

adjustment speeds reacting to new information are equal (Dimson, 1979; Sercu, Vandebroek and Vinaimont, 2008). However, in most cases, not all securities are traded in the same interval, and some of them are not traded for a period of time, which leads to bias in the market index's calculation (Mohamad and Nassir, 1994; Pasaribu, 2009). Consequently, a biased market beta risk estimator in an exchange rate exposure model may affect the efficiency of an exchange rate exposure model's performance, so corrections must be carried out (Mirza and Shabbir, 2005; Al-Ajmi, 2015). Only if all the share price shares that represent the market portfolio index are actively trading and price adjustment speeds to new information are equal would the market beta estimate be an acceptable indicator (Dimson, 1979; Sercu, Vandebroek and Vinaimont, 2008). However, not all stocks are exchanged at the same interval in most activities, and some of them are not traded for a period of time, which results in a bias in the calculation of the stock index (Mohamad and Nassir, 1994; Pasaribu, 2009). Therefore, in an exchange rate exposure model, a biased market beta risk estimator will affect the efficiency of the exchange rate exposure model, so corrections must be made (Al-Ajmi, 2015; Mirza & Shabbir, 2005).

Therefore, the goal of this analysis is to re-investigate the exposure of large non-financial firms to the exchange rates in selected Asian frontier and emerging countries before and after adjusting the exposure model for the thin trading phenomenon. This article makes three major contributions. Firstly, a comparative analysis of the relationship between share returns and multiple bilateral exchange rates has not been extensively studied in some Asian economies, especially in frontier countries (Chue and Cook, 2008; Ye, Hutson and Muckley, 2014). After the stud-

ies of Adler and Dumas (1983, 1984), empiric exchange rate exposure studies have concentrated primarily on developed countries such as the US and European markets (Verschoor and Muller, 2007; Chue and Cook, 2008; Lin, 2011; Luiz, Júnior and Rossi Júnior, 2012) and developing Asian countries (Chue and Cook, 2008; Lin, 2011). Comparison studies that paid attention to Asian frontier countries such as Vietnam are lacking. Therefore, to have a better explanation of the multiple exchange rate exposures in those nations, this analysis takes account of countries from both frontier (Bangladesh, Pakistan, Sri Lanka and Vietnam) and in the emerging markets (Indonesia, Malaysia, the Philippines and Thailand).

Secondly, this paper applies the adjusted two-factor exchange rate exposure model to capture firms' exchange rate exposure by considering the thin trading issue. This study applied the Dimson-Fowler-Rorke (DFR) adjustment method (Fowler and Rorke, 1983) to calculate the adjusted market portfolio return beta before incorporating it in the exchange rate exposure model. The method was applied due to its improvement in correcting bias betas as compared to Dimson's (1979) and Scholes and Williams's (1977) methods (Soetjiono, Murhadi and Srnawati, 2013). Meanwhile, as indicated in Bartov and Bodnar's (1994) study, there is a lack of support for exchange rate exposure in firms abnormal returns due to mispricing. Thus, with this thin trading correction, the adjusted exchange rate exposure model should be more robust in terms of providing the true risk estimator in countries with evidence of thin trading (Lim, Brooks and Kim, 2008). To our knowledge, none of the previous studies have applied an adjusted exchange rate exposure model for the thin trading issue in the context of Asian countries. Thirdly, this

study also extends the method of estimation when investigating firms' exchange rate exposure. This study adopts the autoregressive distributed lag (ARDL) model, as proposed by Pesaran, Shin and Smith (2001), which has a few major advantages. Firstly, this approach is applicable even if the variables are stationary, integrated or mutually cointegrated. Secondly, this method is more robust and performs better with a small sample size of data. Thirdly, the model has less problems with endogeneity, as long as it is free of autocorrelation problems (Zubaidi, Hamizah and Masih, 2009; Nkoro and Uko, 2016).

The structure of the paper is as follows: A literature review of thin trading and exchange rate exposure is discussed in the next section, which is followed by the data and methodology. Then, the empirical results and discussions are presented, whilst the final section elaborates the conclusions and recommendations.

Literature Review

Four decades ago the capital asset pricing model (CAPM) became the benchmark for asset pricing models to estimate asset returns and the cost of capital (Shih et al., 2014). The CAPM became one of the most popular models in finance for the assessment of assets in a portfolio which included the exchange rate exposure model (Fama and French, 2004; Galagedera, 2007). However, the estimate for the market portfolio return in a CAPM model is only a suitable measure if all the shares in a stock market are actively traded. Beta bias usually occurs in thin trading markets because of non-synchronous or infrequent trading. It mainly happens in emerging and frontier markets, especially for daily trading (Mirza and Shabbir, 2005; Saji,

2014). This is because not all securities are traded daily, which causes data collected today to be historical data from the previous day (Mohamad and Nassir, 1994; Lian, 1997; Pasaribu, 2009; Dong Loc, Lanjouw and Lensink, 2010) so there is a time lag when computing the market index at the end of a discrete time interval (Mirza and Shabbir, 2005; Sercu, Vandebroek and Vinaimont, 2008). In other words, if beta is calculated using the returns of a market index from security returns from different trading periods, the beta will be seriously biased (Boabang, 1996; Pasaribu, 2009; Pathirawasam and Idirisinghe, 2011). Furthermore, the bias estimation also happens based on the differences in the adjustment speeds of different share prices to new information (Pathirawasam and Idirisinghe, 2011). Different shares have different price adjustment speeds to new information's arrival into the market, where new information is indicated by highly traded share prices rather than thinly traded shares; the resulting new information affects the price of larger shares first, and then the smaller shares when they trade subsequently.

In literature, thin trading can generate a spurious serial correlation in the CAPM model that seriously leads to bias in the outcomes of empirical tests, thus a correction must be made (Al-Ajmi, 2015). Since the 1970s, there have been a number of studies that have suggested adjustment methods, such as those by Scholes and Williams (1977), Dimson (1979), Fowler and Rorke (1983), Fowler et al., (1989), all aimed at adjusting or correcting the biased beta. A market beta value is the weighted average of the security beta values in the market. If it is unbiased, the market beta value will be equal to one. Therefore, the bias beta testing can be accomplished by determining whether the market beta value is close to

one, or not, as indicated in the CAPM model (Dimson, 1979; Fowler and Rorke, 1983; Fowler, Rorke and Jog, 1989; Sercu, Vandebroek and Vinaimont, 2008). The adjustment techniques proposed by Scholes and Williams (1977), Dimson (1979), Fowler and Rorke (1983), otherwise known as the Dimson-Fowler-Rorke method, reduce a portion of the bias in the market portfolio beta arising from thin trading due to infrequent trading and delays to the price adjustments. Most of the studies in emerging and frontier markets support the Fowler-Rorke method in reducing the bias (Mirza and Shabbir, 2005). Studies in some emerging and frontier markets such as Malaysia (Mohamad and Nassir, 1994; Lian, 1997), Indonesia (Pasariibu, 2009), Vietnam (Dong Loc, Lanjouw and Lensink, 2010) and Sri Lanka (Pathirawasam and Idirisinghe, 2011) support the evidence of thin trading markets. Consequently, bias in the market beta risk estimator in the exchange rate exposure model may affect the inefficiency of the exchange rate exposure model's performance.

Most Asian countries are frontier and developing countries, except for Singapore, Japan and South Korea. However, the exchange rate exposure models that were applied in developed markets assumed that market efficiency occurred in the financial markets (Du, Hu and Wu, 2014). The assumptions were mostly invalid in emerging markets (Bekaert and Harvey, 2003; Aizenman, Hutchison and Noy, 2011; Bai and Green, 2011). A lack of market efficiency and high levels of government intervention in financial markets hinder the true value of the information collected from financial markets (Bekaert and Harvey, 2003; Du, Hu and Wu, 2014). For example, emerging and frontier markets may experience a thin trad-

ing phenomenon due to infrequent trading or non-synchronous trading (Fowler, Rorke and Jog, 1989; Lian, 1997; Mirza and Shabbir, 2005; Pasariibu, 2009). Due to this phenomena, using historical returns to estimate a beta risk estimator would have bias and lead to beta estimation inefficiency (Dimson, 1979; Fowler and Rorke, 1983; Fowler, Rorke and Jog, 1989; Schotman and Zalewska, 2006; Sercu, Vandebroek and Vinaimont, 2008).

Empirical studies in some emerging and frontier markets such as Malaysia (Mohamad and Nassir, 1994; Lian, 1997), Indonesia (Pasariibu, 2009), Vietnam (Dong Loc, Lanjouw and Lensink, 2010), Sri Lanka (Pathirawasam and Idirisinghe, 2011) and some Central European countries (Schotman and Zalewska, 2006) have supported the evidence of thin trading. Unfortunately, most present studies into exchange rate exposure in emerging and frontier markets have applied the standard model without making adjustments for thin trading issues (e.g., Chue and Cook, 2008; Ibrahim, 2008; Kang and Lee, 2011; Bacha et al., 2013; Du, Hu and Wu, 2014; Kang, Kim and Lee, 2016). These studies mostly used either different types of exposure models (Du, Hu and Wu, 2014) or different types of measurements for the exchange rate indexes (Chue and Cook, 2008; Bacha et al., 2013), but none of these models performed well in detecting the exchange rate exposure. Even though there is significant exchange rate exposure among firms in Asian countries, the proportion is still considered lower than anticipated by the exchange rate exposure theory (Aggarwal and Harper, 2010; Lin, 2011; Kang, Kim and Lee, 2016).

In general, the current exchange rate exposure studies in emerging and frontier markets have applied an exposure framework that has been mainly tested in developed

markets. However, the expected evidence of exposure among firms from emerging and frontier markets should differ from firms in developed financial markets due to differences in the market characteristics, such as market efficiency and government levels of intervention in the financial markets. With these issues in mind, there is a need to refine the exchange rate exposure model used in developed markets to suit the characteristics of emerging and frontier markets.

Data and Methodology

Data

All data such as monthly share prices, Standard and Poor's Broad Market Index (BMI) prices, and bilateral exchange rates were obtained from Datastream International. The bilateral exchange rates were chosen based on the respective country's three main trading partners' currencies, as of 2016. The empirical analysis in this study used monthly data starting from August 2005 to December 2016, due to the pegged value of the Chinese yuan (CNY) to the USD until July 2005. The

study used monthly data because of the following reasons. Firstly, daily and weekly data would contain too much noise and would be associated with infrequent trading where firms are experienced zero returns (Ye, Hutson and Muckley, 2014; Al-Ajmi, 2015). Secondly, since the share return proxies firm value based on the market value method (Adler and Dumas, 1984; Chou et al., 2017), the firm value could not be captured by using higher frequency data because the firm value would not fluctuate on a daily or weekly basis (Ibrahim, 2008; Lin, 2011, 2012).

Sample Firms

The present study selected countries from two different markets, namely emerging markets (Malaysia, Thailand, Indonesia and the Philippines) and frontier markets (Bangladesh, Pakistan, Sri Lanka and Vietnam) that experienced thin trading on their stock markets. The market classification was based on the Morgan Stanley Capital International (MSCI) market classification. Then, this study selected listed non-financial firms from the current constituent firms of each country's large cap index as at the end of March

Table 1: Sample Firms as at March 31, 2017

| Country | Index | Number of Firms | Non-Financial | Final Non-Financial Sample |
|-----------------|--------------------------|-----------------|---------------|----------------------------|
| Emerging Market | | | | |
| Indonesia | LQ-45 index | 45 | 35 | 24 |
| Malaysia | FTSE Bursa Malaysia KLCI | 30 | 22 | 16 |
| The Philippines | PSEi 30 | 30 | 21 | 16 |
| Thailand | FTSE SET 50 | 50 | 37 | 28 |
| Frontier Market | | | | |
| Bangladesh | DSE30 index | 30 | 24 | 10 |
| Sri Lanka | S&P SL 20 | 20 | 13 | 15 |
| Pakistan | KSE 30 | 30 | 25 | 22 |
| Vietnam | HNX 30 | 30 | 19 | 12 |

Source: Country Stock Exchange for Respective Countries

Table 2: Bilateral Exchange Rate for Sample Countries as at 2015

| Country | Bilateral Currencies |
|-----------------|---|
| Emerging Market | |
| Indonesia | USD, Chinese yuan (CNY), Japanese yen (JPY) |
| Malaysia | USD, Chinese yuan (CNY), Singapore dollar (SGD) |
| The Philippines | USD, Chinese yuan (CNY), Japanese yen (JPY) |
| Thailand | USD, Chinese yuan (CNY), Japanese yen (JPY) |
| Frontier Market | |
| Bangladesh | USD, euro (EUR), Chinese yuan (CNY) |
| Sri Lanka | USD, euro (EUR), Indian rupee (INR) |
| Pakistan | USD, euro (EUR), Chinese yuan (CNY) |
| Vietnam | USD, Chinese yuan (CNY), Japanese yen (JPY) |

Source: Worldbank

2017 for each country, thus financial firms such as banks, stockbrokers, fund managers, financial and property firms, insurance firms and brokers, investment trust, investment firms, property agencies and property developers were excluded. The financial firms may have different exchange rate exposure behavior because firms in the financial sector are highly regulated (El-Masry, 2006; Aggarwal and Harper, 2010; Alssayah and Krishnamurti, 2013), have different assets and liability structures and have easier access to hedging instruments (Chue and Cook, 2008). After the filtering process, Table 1 shows the final sample firms across the sample countries.

Unit Root Tests

The study applied the augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and the Phillips-Perron (PP) (Phillips and Perron, 1988) unit root tests to ensure none of the variables series were integrated more than because the presence of variables with causes the computed F-statistics for testing long run level relationship to be invalid. The optimal lag length was chosen based on the lowest Schwarz information criterion (SIC) value. The results of these unit roots tests are available upon request.

Econometric Model

This research adopts the augmented two-factor (Jorion, 1990) exchange rate exposure model because of three reasons. Firstly, market portfolio index returns, as the control variables for macroeconomic effects, may avoid the misspecification in Adler and Dumas's (1984) single-factor model (Jorion, 1990; Hsiao and Han, 2012). Secondly, the exposure model has been used extensively in previous studies (El-Masry, Abd-El Salam and Abdel-Salam, 2007; El-Masry, Abdel-Salam and Alatraby, 2007; Hutson, O'Driscoll and O'Driscoll, 2010; Kanagaraj and Sikarwar, 2011; Kang and Lee, 2011; e.g., Agyei-Ampomah, Mazouz and Yin, 2012; Kang, Kim and Lee, 2016), so comparisons with previous studies can be made. Thirdly, the use of market portfolio index returns as a control variable enabled the researcher to investigate the impact of thin trading on the traditional exchange rate exposure model's efficiency, because the thin trading was associated with the beta of the market's return.

Since there was a possible correlation between the market portfolio's return and the exchange rates in the model (Priestley and Ødegaard, 2007; Chou et al., 2017), this study applied the augmented exchange rate

exposure model with orthogonalized market portfolio returns as follows:

$$SR_{i,t} = \beta_{i,0} + \beta_{i,m} vm_t + \sum_{j=1}^n \beta_{i,j} ER_{j,t} + \mu_{i,t} \quad (1)$$

Where, $SR_{i,t}$ is firm i 's share return in month t , $ER_{j,t}$ is the real exchange rate return between the home currency and the main trading partner's currency in month t . We used the real exchange rate since frontier and emerging countries have significant government intervention in managing their exchange rate regimes (Parsley and Popper, 2006; Abd. Sukor, 2014; Sikarwar, 2020). The calculation of the real exchange rate was based on the international parity hypothesis (Lin, 2011; Lily et al., 2018). The exchange rate quotation was based on the direct quote from the home country's perspective (quantity of home currency per unit of foreign currency).

Meanwhile, $vm_t = (MR_t - \beta_0 + \sum_{j=1}^n \beta_j ER_{j,t})$ ($MR =$ market portfolio return) ^{$j=1$} is defined as the orthogonal market return, which captures the part of the market return that is uncorrelated with the effect of exchange rates (Priestley and Ødegaard, 2007; Agyei-Ampomah, Mazouz and Yin, 2012; Coy, 2013; Chou et al., 2017; Lily et al., 2018), and $\beta_{i,j}$ is the firm i 's exchange rate exposure coefficient corresponding to the j th main trading partner's currency. However, since the sample countries are from emerging and frontier markets, thus there is a possibility of the thin trading phenomenon causing the market portfolio's return, as in Equation (1), to have a bias beta estimator which would require correction. Testing the bias of the market portfolio's return beta values could be accomplished by determining whether the market beta value was close to one or not (Fowler and Rorke, 1983; Davidson and Josev, 2005; Pasaribu, 2009).

Thus, this study applied the DFR method to adjust the OLS beta derived from the following equation.

$$SR_{i,t} = \alpha + \beta_i vm_t + \mu_i \quad (2)$$

Where, $SR_{i,t}$ is firm i 's share return in month t ; and vm_t is the orthogonal market return. The existence of thin trading and price adjustment's speed in reacting to new information issues caused the β_i to be a bias estimator, thus it needed adjustment (Mirza and Shabbir, 2005).

The DFR corrected beta (weighted) was calculated as follows:

$$\beta_i^{DFR} = w_n \beta_i^{-n} + \dots + w_1 \beta_i^{-1} + \beta_i^0 + w_1 \beta_i^{+1} + \dots + w_n \beta_i^{+n} \quad (3)$$

The beta coefficients were obtained by regressing from the observed security return against the leading, synchronous and lagged values of the appropriate market index to obtain a set of slope coefficients as follows;

$$SR_{i,t} = \alpha_i + \beta_i^{-n} vm_{t-n} + \dots + \beta_i^{-1} vm_{t-1} + \beta_i^0 vm_t + \beta_i^{+1} vm_{t+1} + \dots + \beta_i^{+n} vm_{t+n} + \mu_i \quad (4)$$

Where $SR_{i,t}$ and vm_t were indicated earlier. The number of lag(s) and lead(s) was(were) determined by the convergence of the aggregated beta to the expected value of one (Pasaribu, 2009).

The weighting factors for adjusting the beta coefficients depended on the number of lag(s) and lead(s) as follows:

One lag and one lead

$$w_1 = w_{t-1} = w_{t+1} = \frac{1 + \rho_1}{1 + 2\rho_1} \quad (5)$$

Two lags and two leads

$$w_1 = w_{t-1} = w_{t+1} = \frac{1 + 2\rho_1 + \rho_2}{1 + 2\rho_1 + 2\rho_2} \quad (6)$$

$$w_2 = w_{t-2} = w_{t+2} = \frac{1 + \rho_1 + \rho_2}{1 + 2\rho_1 + 2\rho_2} \quad (7)$$

Three lags and three leads

$$w_1 = w_{t-1} = w_{t+1} = \frac{1 + 2\rho_1 + 2\rho_2 + \rho_3}{1 + 2\rho_1 + 2\rho_2 + 2\rho_3} \quad (8)$$

$$w_2 = w_{t-2} = w_{t+2} = \frac{1 + 2\rho_1 + \rho_2 + \rho_3}{1 + 2\rho_1 + 2\rho_2 + 2\rho_3} \quad (9)$$

$$w_3 = w_{t-3} = w_{t+3} = \frac{1 + \rho_1 + \rho_2 + \rho_3}{1 + 2\rho_1 + 2\rho_2 + 2\rho_3} \quad (10)$$

The value of ρ_s are generated from the following regression equation:

$$vm_t = \alpha_i + \rho_1 vm_{t-1} + \rho_2 vm_{t-2} + \dots + \rho_n vm_{t-n} + \mu_t \quad (11)$$

In order to investigate the exchange rate exposure after adjusting for the thin trading and price adjustment speed to new information issues, this research adopted and modified the exchange rate exposure model by Bartov and Bodnar (1994) as follows:

$$ABR_{i,t} = \alpha_0 + \sum_{j=1}^n \beta_{ij} ER_{j,t} + \mu_t \quad (12)$$

Where, $ABR_{i,t}(SR_{i,t} - \beta_i vm_t)$ is the abnormal return of firm i in month t , vm_t is the orthogonal market portfolio return, ER_t is the real exchange rate return in month t .

The DFR's adjusted beta calculated from Equation (3) incorporated in Equation (12) as follows;

$$ABR_{i,t}^{DFR} = \alpha + \sum_{j=1}^n \beta_{ij} ER_{j,t} + \mu_t \quad (13)$$

Where, $ABR_{i,t}^{DFR}(SR_{i,t} - \beta_i^{DFR} vm_t)$ is the adjusted DFR's abnormal return of firm i in month t ; $ER_{j,t}$ is the real exchange rate return between home currency and the j th main trading partner's currency in month t ; and β_{ij} is firm i 's exchange rate exposure coefficient corresponding to the j th main trading partner's currency.

Estimation Method

The estimation of equations (12) and (13) only provide the estimates of long-run coefficients. Thus, to incorporate the short-run dynamics, we adopted the ARDL bound test model as proposed by Pesaran et al., (2001). The ARDL methods provide several advantages over traditional statistical methods for investigating relationships. Firstly, the ARDL bound test method can be applied to test for a level relationship for mixed integration variables. Secondly, the method integrates the short-run and long-run impacts of the given variables simultaneously. Thirdly, the ARDL method allows for different lags for each variable in the model, which means the method is more flexible than the traditional cointegration tests (Pesaran, Shin and Smith, 2001). Fourthly, the ARDL method provides robust and consistent results from small sample sizes (Pesaran, Shin and Smith, 2001; Nkoro and Uko, 2016). Lastly, the model has few problems with endogeneity, as long as it is free of autocorrelation problems (Zubaidi, Hamizah and Masih, 2009; Nkoro and Uko, 2016). The incorporation of Equation (1) into the ARDL bounds testing approach is shown as follows:

$$\begin{aligned} \Delta SR_{i,t} = & \beta_0 + \sum_{n=1}^{p-1} \varphi_i \Delta SR_{t-n} + \sum_{n=0}^{q-1} \gamma_i \Delta vm_{t-n} + \\ & \sum_{n=0}^{q-1} (\chi_i \Delta ER_{t-n}^1 + \delta_i \Delta ER_{t-n}^2 + \phi_i \Delta ER_{t-n}^3) + \\ & \beta_1 SR_{t-1} + \beta_2 vm_{t-1} + \beta_3 ER_{t-1}^1 + \beta_4 ER_{t-1}^2 + \\ & \beta_5 ER_{t-1}^3 + \mu_t \quad (14) \end{aligned}$$

Where, $SR_{i,t}$ is the share return of firm t in month t ; vm_t is the orthogonal market return; ER_t^1 , ER_t^2 and ER_t^3 are the real exchange rate returns for the three main trading partners' currencies in month t , and p , q and r are lag orders based on the lowest AIC or SIC value for the optimal lag. Meanwhile,

the incorporation of Equation (13) into the ARDL bounds testing approach is shown as follows:

$$\Delta ABR_{i,t}^{DFR} = \beta_0 + \sum_{n=1}^{p-1} \varphi_i \Delta ABR_{i,t-n}^{DFR} + \sum_{n=0}^{q-1} (\chi_i \Delta ER_{i,t-n}^1 + \delta_i \Delta ER_{i,t-n}^2 + \phi_i \Delta ER_{i,t-n}^3) + \beta_1 ABR_{i,t-t}^{DFR} + \beta_2 ER_{i,t-1}^1 + \beta_3 ER_{i,t-1}^2 + \beta_4 ER_{i,t-1}^3 + \mu_t \quad (15)$$

Where, ER_t^1 , ER_t^2 , and ER_t^3 and are defined in Equation (14); $ABR_{j,t}$ is the abnormal return of firm t in month t ; and p and q are lag orders based on the lowest AIC or SIC value for the optimal lag.

After specifying the optimal lag model, a test for the presence of a long-run level relationship among the variables was performed using two operational tests. Firstly, following Banerjee, Dolado and Mestre (1998), the existence of a long-run level relationship was checked by testing if $\beta_1 = 0$ with t-statistic testing in equations (14) and (15). If $\beta_1 = 0$, then both equations reduced to the regression involving only the first differences, implying that there was no long-run relationship between the level variables. Secondly, following Pesaran et al., (2001), two separate statistics were employed to “bounds test” for the existence of a long-run relationship. For Equation (14), the null hypothesis of no long-run level relationship ($H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$) was tested against the alternative hypothesis of a long-run level relationship’s existence ($H_a : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$) using the Wald test (F-statistic). Meanwhile, for Equation (15), the null hypothesis of no long-run level relationship ($H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$) was tested against the alternative hypothesis of a long-run level relationship’s existence ($H_a : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$) using the Wald test (F-statistic).

Then, the computed F-statistic value

could be compared with the critical values provided by Pesaran et al., (2001). However, if the sample size is small (< 100 observations), then the critical value provided by Narayan (2005) would be applied. The two asymptotic critical value bounds provide a test for a long-run level relationship when the level variables are $I(d)$ (where, $(0 \leq d \leq 1)$ $I(0)$: a lower bound value assuming all regressors are purely $I(0)$, and an upper bound value assuming all regressors are purely $I(1)$). According to Pesaran et al., (2001), if the test statistics exceed their respective upper bound critical value, there is evidence for a long-run relationship among the level variables, irrespective of the order of integration of the variables. If the test statistics are smaller than the lower bound critical value, it is not possible to reject the null hypothesis of no long-run level relationship. However, if the computed statistic falls within the bounds, conclusive inferences may still be drawn if all the variables are known to be $I(0)$ or $I(1)$ (DeLatte and López-Villavicencio, 2012).

Once the long-run equilibrium relation’s existence was confirmed between the variables, the long-run model for the unadjusted and adjusted model was estimated using the following ARDL specifications (Lee et al., 2011; Lily et al., 2014):

$$SR_{i,t} = \alpha_0 + \sum_{n=1}^p \alpha_{1,i} SR_{i,t-n} + \sum_{n=0}^q \alpha_{2,i} vm_{i,t-n} + \sum_{n=0}^r \alpha_{3,i} ER_{i,t-n}^1 + \sum_{n=0}^s \alpha_{4,i} ER_{i,t-n}^2 + \sum_{n=0}^t \alpha_{5,i} ER_{i,t-n}^3 + \mu_t \quad (16)$$

$$ABR_{i,t}^{DFR} = \alpha_0 + \sum_{n=1}^p \alpha_{1,i} ABR_{i,t-n}^{DFR} + \sum_{n=0}^q \alpha_{2,i} ER_{i,t-n}^1 + \sum_{n=0}^r \alpha_{3,i} ER_{i,t-n}^2 + \sum_{n=0}^s \alpha_{4,i} ER_{i,t-n}^3 + \mu_t \quad (17)$$

The next step was to estimate the short-run error-correction model (ECM). This was an ARDL based model for the un-

adjusted and adjusted exchange rate exposure model, as follows (Nkoro and Uko, 2016);

$$\Delta SR_{i,t} = \alpha_0 + \sum_{n=1}^{p-1} \alpha_{1,i} \Delta SR_{t-n} + \sum_{n=0}^{q-1} \alpha_{2,i} \Delta vm_{t-n} + \sum_{n=0}^{r-1} \alpha_{3,i} \Delta ER_{t-n}^1 + \sum_{n=0}^{s-1} \alpha_{4,i} \Delta ER_{t-n}^2 + \sum_{n=0}^{t-1} \alpha_{5,i} \Delta ER_{t-n}^3 + \lambda ECT_{t-1} + \mu_t \quad (18)$$

$$\Delta ABR_{i,t}^{DFR} = \alpha_0 + \sum_{n=1}^{p-1} \alpha_{1,i} \Delta ABR_{t-n}^{DFR} + \sum_{n=0}^{q-1} \alpha_{2,i} \Delta ER_{t-n}^1 + \sum_{n=0}^{r-1} \alpha_{3,i} \Delta ER_{t-n}^2 + \sum_{n=0}^{s-1} \alpha_{4,i} \Delta ER_{t-n}^3 + \lambda ECT_{t-1} + \mu_t \quad (19)$$

There would be a significant long-run relationship if the value of λ (adjustment speed) was negatively significant. Then, the diagnostic tests (serial correlation test, heteroscedasticity) and stability tests (cumulative sum control chart (CUSUM), cumulative sum control chart of square (CUSUMSQ) and Ramsey's test) were checked to ensure the model appropriateness.

Results and Discussions

Descriptive Analysis

As expected with financial data, most of the studied variables that demonstrated skewness and high kurtosis (more than three) also showed a non-normal distribution. Moreover, both the ADF and PP unit root tests indicated that there were no series of variables which were integrated more than $I(1)$ at the five percent significance level, regardless of the constant, and the trend included in the test equations. Therefore, the ARDL bound test method could be applied in this study. Furthermore, as indicated in Pesaran et al., (2001) the ARDL model should be free from any serial correlation in the residual. The result of the serial correlation (LM) tests revealed that there was no serial correlation at a five percent level for all the sample firms. Meanwhile, most of the other diagnostic test results were also found to confirm the model's adequacy. The results of these statistical summaries are available upon request.

Table 3: Mean Market Beta Comparison among Sample Countries

| Countries | Dimson-Fowler-Rorke (DFR) Beta | | Ordinary Least Square (OLS) Beta | |
|--------------------|--------------------------------|--------|----------------------------------|--------|
| Indonesia (n=24) | Mean:1.176 | | Mean:0.973 | |
| | [11] | | [13] | |
| | < 1= 6 | > 1=18 | < 1=12 | > 1=12 |
| Malaysia (n=16) | Mean:0.889 | | Mean:0.837 | |
| | [8] | | [8] | |
| | < 1=10 | > 1=6 | < 1=10 | > 1=6 |
| Philippines (n=16) | Mean:1.121 | | Mean:0.979 | |
| | [8] | | [8] | |
| | < 1=9 | > 1=7 | < 1=8 | > 1=8 |
| Thailand (n=27) | Mean:1.122 | | Mean:0.970 | |
| | [16] | | [11] | |
| | < 1=11 | > 1=16 | < 1=14 | > 1=13 |

| | | | | |
|-------------------|------------|--------|------------|--------|
| | Mean:0.770 | | Mean:0.775 | |
| Bangladesh (n=10) | [6] | | [4] | |
| | < 1=10 | > 1=0 | < 1=7 | > 1=3 |
| | Mean:0.987 | | Mean:0.965 | |
| Pakistan (n=22) | [12] | | [10] | |
| | < 1=10 | > 1=12 | < 1=10 | > 1=12 |
| | Mean:0.986 | | Mean:0.87 | |
| Sri Lanka (n=15) | [9] | | [6] | |
| | < 1=6 | > 1=9 | < 1=9 | > 1=6 |
| | Mean:1.065 | | Mean:1.146 | |
| Vietnam (n=12) | [10] | | [2] | |
| | < 1=4 | > 1=8 | < 1=2 | > 1=10 |

Notes: The values in the brackets refers to the number of sample firms that have a particular beta nearer to one compared to other beta calculation procedures. The > 1 and < 1 value indicate the number of firms with betas (DFR's or OLS's betas) higher than and less than the benchmark beta equal to 1.

Beta Adjustment

The study results found that there was evidence that certain countries appeared to have beta biased OLS market returns. Sample firms from other countries appeared to have a downward bias, with the exception of Pakistan and Vietnam, where business beta estimators were less than one, which was compatible with the findings of the study by Brooks (2005) in the case of market thinness. The biased downward betas implied that the securities were traded less frequent toward the average securities causing a “lag” effect leading to the estimated betas being biased downwards (Scholes and Williams, 1977; Mirza and Shabbir, 2005). Thus, an adjustment was essential to have the true market beta estimators. The present study followed Pasaribu's (2009) study to calculate the DFR's beta by allowing different lags and leads to achieve a beta nearer to one. As indicated in Table 3, by setting the maximum lag and lead by three in the DFR beta adjustment method, the findings showed mixed results among the sample countries. In the emerging sample countries, only Thailand showed a lesser bias beta after the adjustment, while

the majority of the frontier countries tended to have betas nearer to one. The findings revealed that the frontier markets tended to be less efficient than the emerging markets, as the DFR approach tended to correct the bias beta (Brooks et al., 2005).

There are two potential reasons for why the OLS beta was less biased than the DFR beta in certain countries. First, there were a range of beta calculations that, based on many factors, would result in a single security, such as the measurement of returns, the choice of market index, the sampling time, and the duration of the estimation period (Davidson and Josev, 2005; Iqbal and Brooks, 2007). In addition, the efficiency of a beta adjustment can be influenced by other considerations, such as how thin a market is, market segmentation, and the stability of the beta (Brooks et al., 2005). As reported in some previous studies (e.g., Brooks et al., 2005; Saptorini and Swandari, 2012; Hasnaoui, 2014), with different sample times and countries, some approaches performed better. The OLS betas worked better than the other beta adjustment methods in some cases (e.g., Bartholdy and Riding, 1994; Davidson and Josev, 2005).

Secondly, the estimation of the abnormal return in this paper was based on a "synthetic CAPM" since the real CAPM could not be checked, due to non-observation within the actual market portfolio (Mirza and Shabbir, 2005; Ray, Savin and Tiwari, 2009). The use of a proxy portfolio would be severely biased if any securities dominated the portfolio index. In this situation, the stock portfolio return index was mostly affected by some prominent securities, which did not reflect the performance of the actual market portfolio. Therefore, this issue meant the DFR beta adjustment method did not have the true value of a beta calculation.

In the case of frontier and emerging markets, it was expected that a firm's beta risk would have bias with the standard OLS approach, given that these markets are generally less developed and suffer from non-synchronous trading problems (Scholes and Williams, 1977; Dimson, 1979; Fowler and Rorke, 1983; Mirza and Shabbir, 2005; Sercu, Van-

non-synchronous or infrequent trading and price speed adjustments, mainly in emerging and frontier markets (Mohamad and Nassir, 1994; Lian, 1997; Mirza and Shabbir, 2005; Sercu, Vandebroek and Vinaimont, 2008; Pasaribu, 2009; e.g., Dong Loc, Lanjouw and Lensink, 2010). These findings suggest the importance of getting the true value of the market beta to have a more reliable exposure model, especially in frontier and emerging markets that experience thinness trading.

Firm Specific Exposure

Starting an ARDL (p, q) with $\max p=q=9$, the optimal lag was selected using AIC or SIC for each of the firms separately. From the long-run level analysis, there was one firm from Sri Lanka which failed to reject the null hypothesis of no long-run relationship among the level variables when using the unadjusted exchange rate exposure model. Meanwhile, there was one firm each

Table 4: Number of Exposed Firms at 5 % Significance level

| Countries | Unadjusted Model | Adjusted Model |
|------------------------|------------------|----------------|
| Emerging Market (n=83) | | |
| Indonesia (n=24) | 11(45.8%) | 14(58.3%) |
| Malaysia (n=16) | 6(37.5%) | 4(25%) |
| Philippines (n=16) | 12(75%) | 8(50%) |
| Thailand (n=27) | 17(60.7%) | 22(78.6%) |
| Total (N=83) | 46(54.8%) | 48(57.1%) |
| Frontier Market (n=59) | | |
| Bangladesh (n=10) | 4(40%) | 2(20%) |
| Pakistan (n=22) | 13(59.1%) | 12(54.5%) |
| Sri Lanka (n=15) | 10(66.7%) | 11(73.3%) |
| Vietnam (n=12) | 7(58.3%) | 9(75%) |
| Total (N=59) | 34(54.8%) | 34(54.8%) |
| Overall (N=142) | 80(56.3%) | 82(57.7%) |

debroek and Vinaimont, 2008). The findings were consistent with the previous research, where a biased beta risk estimator usually happened in thin trading markets because of

from Indonesia, the Philippines and Sri Lanka which failed to reject the null hypothesis of no long-run relationship among the level variables when using the adjusted exchange

rate exposure model. Applying the adjusted exchange rate exposure model provided several interesting results. Firstly, the study's results showed that there was a significant increase in the number of exposed firms toward exchange rate movements in the case of Indonesia (45.8 percent to 58.3 percent), Thailand (60.7 percent to 78.6 percent), Sri Lanka (66.7 percent to 73.3 percent) and Vietnam (58.3 percent to 75 percent) (See Table 4). The study results seem to support the argument in the literature indicating that thin trading can cause problems in the error terms, making the estimates less reliable (Al-Ajmi, 2015). By adjusting the market beta estimators, the exchange rate exposure model became more efficient and the estimates were more reliable for further analysis (Mirza and Shabbir, 2005).

However, the study's results also showed that only a few sampled firms (less than 40 percent) were exposed to exchange rate movements in Malaysia, either using the unadjusted or adjusted exchange rate exposure model. The low number of significant exposed firms in the case of Malaysia and the Philippines could be related to several reasons. Firstly, in most cases, the sample firms' DFR beta in both countries seemed to be more biased than the OLS betas, implying OLS betas are good market risk estimators in those particular countries. In some cases, the OLS betas performed better than the other beta adjustment methods (e.g., Bartholdy and Riding, 1994; Davidson and Josev, 2005). Secondly, the sample firms actively did hedging strategies. Under a value-maximizing approach, Copeland and Copeland (1999) argued that firms were motivated to hedge in order to reduce the negative impact that the firms faced in their businesses. The scenario in the case of Malaysia and the Philippines supported the argument that larger firms were less ex-

posed to exchange rate movements because of their greater competitiveness and diversification strategies (Aggarwal and Harper, 2010), and they have sufficient personnel and knowledge to hedge their exchange rate exposures (El-Masry, Abd-Elsalam and Abdel-Salam, 2007). Firms can combine three different mechanisms for mitigating their exchange rate risk exposure (Bartram and Bodnar, 2007; Bartram, 2008; Bartram, Brown and Minton, 2010). Firstly, firms can pass the changes in costs, due to exchange rate movements, to their customers at different pass-through levels (Brissimis and Kosma, 2007; Flodén, Simbanegavi and Wilander, 2008; Cook, 2014). Secondly, firms can dynamically revise their operational structures in response to new exchange rate movements by altering their production (Bodnar and Wong, 2003; Bartram and Bodnar, 2007, 2012; Bartram, Brown and Minton, 2010).

Thirdly, firms can utilize financial products (e.g., financial derivatives and foreign currency denominated debt) as tools to minimize the exchange rate exposure (Bartram, Brown and Conrad, 2011; Chang, Hsin and Shiah-Hou, 2013; Kim and Kim, 2015). Bartram et al., (2011) indicated that firms that used derivatives had lower estimated values of total systematic risk. With these strategies, the true firm's exchange rate exposure would likely be even less than predicted by the exchange rate exposure models (Bartram and Bodnar, 2007; Bartram, 2008). In the case of Bacha et al.,'s (2013) study, their sample firms consisted of a combination of large and small firms, which suggested some of them, especially the smaller firms, had limited access to hedging tools, probably because of limited resources and knowledge of hedging strategies. Fourthly, there was a potential temporal instability of firms' risk exposure that could happen because the overall economic

Table 5. Firm-Specific Exposure by Number of Currencies at a 5 % Significance Level

| Countries | No. of currencies exposed | Unadjusted Model | Adjusted Model |
|------------------------|---------------------------|------------------|----------------|
| Emerging Market | | | |
| Indonesia (n=24) | Zero | 12(50%) | 10(41.7%) |
| | One | 10(41.7%) | 9(37.5%) |
| | Two | 1(4.2%) | 5(20.8%) |
| | Three | - | - |
| Malaysia (n=16) | Zero | 10(62.5%) | 12(75%) |
| | One | 6(37.5%) | 2(12.5%) |
| | Two | - | 2(12.5%) |
| | Three | - | - |
| Philippines (n=16) | Zero | 4(25%) | 8(50%) |
| | One | 8(50%) | 4(25%) |
| | Two | 4(25%) | 3(18.75) |
| | Three | - | 1(6.25) |
| Thailand (n=27) | Zero | 11(40.7%) | 7(25.9%) |
| | One | 10(27%) | 17(63%) |
| | Two | 6(22.2%) | 5(18.5%) |
| | Three | 1(3.7%) | - |
| Frontier Market | | | |
| Bangladesh (n=10) | Zero | 6(60%) | 8(80%) |
| | One | 2(20%) | 2(20%) |
| | Two | 2(20%) | - |
| | Three | - | - |
| Pakistan (n=22) | Zero | 9(40.9%) | 10(45.5%) |
| | One | 9(40.9%) | 9(40.9%) |
| | Two | 3(13.6%) | 3(13.6%) |
| | Three | 1(4.5%) | - |
| Sri Lanka (n=15) | Zero | 5(33.3%) | 4(26.7%) |
| | One | 4(26.7%) | 4(26.7%) |
| | Two | 5(33.3%) | 7(46.7%) |
| | Three | 1(6.7%) | - |
| Vietnam (n=12) | Zero | 5(41.7%) | 3(25%) |
| | One | 6(50%) | 7(58.3%) |
| | Two | - | 2(16.7%) |
| | Three | 1(8.3%) | - |

environment, the firms' competitive positions, the firms' operational structures and their hedging strategies all change over time (Parsley and Popper, 2006; Bartram, Brown and Minton, 2010). Thus, it is unrealistic to

assume that a firm's exchange rate exposure remains constant over time (Pierdzioch and Kizys, 2010).

Secondly, applying the adjusted exchange rate exposure model seemed to capture more

firms that would be exposed to multi-bilateral exchange rate exposure across the sample countries, except Thailand (see Table 5). For example, in the case of Malaysia, using the unadjusted exchange rate exposure model, the exposed firms were affected by only one currency. However, with the adjusted exchange rate exposure model, the exposed sample firms were affected by two currencies. Meanwhile, in the case of Indonesia, there was a slight increase in the firms exposed to and affected by two currencies. Some researchers argued that a firm can be affected by multiple exchange rate exposures (El-Masry, 2006; Parsley and Popper, 2006; El-Masry, Abd-Elsalam and Abdel-Salam, 2007; Verschoor and Muller, 2007; Agyei-Ampomah, Mazouz and Yin, 2012; Bacha et al., 2013) and applying the adjusted exchange rate exposure seemed to support the argument, rather than using the unadjusted exchange rate exposure. These finding suggests that it was important to get the true value of the market beta, to have a more reliable exposure model, especially in the emerging and frontier markets that experience thinness trading.

Thirdly, even though the different number of exposed firms, when using either the unadjusted or adjusted market beta, (56.3 percent versus 57.7 percent) is small overall, the diagnostic tests revealed that the adjusted exchange rate exposure model tended to be less problematic in its error terms. In this study, the number of exposed firms across the sample firms was still considered to be quite high when compared with some previous studies (Parsley and Popper, 2006; Abd. Sukor, 2014; Bergbrant, Campbell and Hunter, 2014; Kang, Kim and Lee, 2016). Most importantly, the CUSUM) and CUSUSQ tests indicated that the adjusted exchange rate exposure models were more stable than the unadjusted models, in most cases.

Conclusions and Recommendations

This study investigates the impact of thin trading adjustments on exchange rate exposure in Asian emerging and frontier markets. With reference to the goods market theory or the flow-oriented model (Dornbusch & Fischer, 1980), this study's results provide evidence that exchange rate movements do affect firm value. After adjusting for thin trading issues, the study's results indicate that a total of 57.7 percent of our sample firms have a significant exchange rate exposure. Thailand, Sri Lanka and Vietnam show that more than 70 percent of the sample firms were exposed to exchange rate movements after the thin trading adjustments. As indicated in Table 3, these countries indicated a higher number of sample firms that have a DFR's market beta nearer to one, implying a less biased market beta.

Thus, this current study extended the theoretical explanation on exchange rate exposure by providing evidence that thin trading could be one of the reasons behind the exchange rate exposure puzzle, especially in those countries that may experience non-synchronous trading. In other words, adjusting the thin trading in the exchange rate exposure model has strengthened the support for the exchange rate exposure theory. Thus, getting a more reliable exchange rate exposure model is important in the segmented markets, to see the true value of the risk estimator, or to unleash the firms' true exchange rate exposures.

For the practical implications, with more than 50 percent of the sample firms being exposed to exchange rate exposure, and this figure being slightly higher in some countries such Thailand, Sri Lanka and Vietnam, the findings imply that exchange rate movements

can be important factors in policy and investment decision-making. The findings may help affected parties such as policymakers, firms and investors to understand stylized exchange rate exposure and assist them to prepare proper hedging strategies to mitigate the negative impact of exchange rate movements. How the thin trading adjustment influences the efficiency of the exposure model in capturing firm exchange rate exposure also implies that these stock markets and exchange rate markets are related to each other. As a result, policymakers should align various policy variables including both the stock markets and foreign exchange rates in order to maintain their country's competitiveness.

In addition, for both financial economists and practitioners, the beta calculation is important for the application of the CAPM and the market model, since it can be used to estimate the beta value of the investment at a future time, as well as to create a well-diversified portfolio of securities where the systematic risk of a portfolio is substantially reduced. This study's results also highlight that after adjusting for the thin trading issue, there were more firms which were exposed to multi bilateral exchange rates. Thus, by understanding a potential individual's share return sensitivity toward exchange rate movements, investors may manage foreign exchange rate risks, which may affect their investment portfolio through diversification strategies with cheaper cost of capital. For instance, an investor could create a portfolio selection that has less exchange rate exposure toward multiple bilateral exchange rates, rather than rely on a portfolio index benchmark in the stock market. Moreover, the investors and portfolio managers should also consider the bias in the risk estimator because of the thin trading in segmented markets that could mean the risk estimator is undervalued or overvalued.

As indicated in the study's findings, more sample firms have a biased market beta, as in the case of Thailand, Sri Lanka and Vietnam, before adjusting for it with the DFR's beta adjustment. Therefore, adjustment is needed if the stock market suffers a severe bias that means the expected risks do not represent a true risk estimator, making their judgment about the market risk wrong.

Furthermore, the significant effect of different bilateral exchange rates in this study implies the importance of introducing multiple exchange rate rates in the exposure model. Hence, financial managers in domestic and international firms should constantly monitor the effect of multiple currencies on their share returns to mitigate their exchange rate exposure through hedging strategies. Measuring foreign exchange exposure is therefore an important task in international finance management, as exchange rate fluctuations are one of the key risk sources for businesses, especially those engaged in international operations. Knowing the stylized vulnerability to exchange rates will give insights for the financial managers as to whether their business has any future exposure to exchange rate volatility.

While most of the sample firms had less biased OLS betas compared to those with DFR betas in the case of emerging markets, any future research should apply another alternative beta adjustment to suit the emerging market's characteristics. Furthermore, an asymmetric approach should be conducted to explain the stylized exchange rate exposure in the future. While the standard ARDL model enables evaluation of the long-run relations between the studied variables, it only assumes linear or symmetric relations between them. Hence, the standard ARDL model and other techniques that presume symmetric dynam-

ics are not able to capture the potential non-linearity or asymmetry which may lie within the relationship between the share return and

exchange rate movements, which may exist because of one side hedging and the asymmetric exchange rate pass-through.

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