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# Exchange rate volatility and financial performance of agriculture firms in Malaysia: An empirical analysis using GARCH, wavelet and system GMM

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**Abstract:**

The insurgence of exchange rate volatility over the years has gained the attention of not only scholars but also policy makers around the world. This paper investigates the influence of exchange rate volatility to the financial performance of agriculture firms in Malaysia. Authors use the system GMM dynamic panel techniques, wavelet coherence technique and GARCH (1, 1) for the period of 2001 and 2015. The findings show that the volatility of exchange rate of Malaysian Ringgit (RM) has a negative impact on the financial performance of agriculture firms in Malaysia. The ARME and AVA demonstrate a positive impact on the financial performance at 1% significance level for the full sample. The findings also reveal that financial performance, exchange rate, consumer price index, and interest rate comove while using the wavelet coherence.

**JEL Classifications:** C32; O13; O47

**Keywords:** Exchange rate volatility, financial performance, Malaysian agriculture firms, system GMM, GARCH, wavelet coherence technique

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Business and Economic Horizons

## 1. Introduction

Malaysia's economy is relatively small; therefore, the rapid economic development of Malaysia can be inhibited by a quite small market proportions as well as low Gross Domestic Product (GDP) per capita. In order to achieve rapid financial growth the international trade is the only solution to the problem of small economy (Wong & Lee, 2016).

Economic growth is triggered by exports; for Malaysia the exports composition was moved largely to industrial products from agriculture and mining produces in the 1980s. Up till now agriculture is an indispensable sector in Malaysian economy. For years, the agricultural sector has been the spinal pillar of Malaysian economy by producing goods to domestic consumption as well as generator of foreign remittances. What is more, the agriculture delivers the primary employment for the people living in the countryside. This sector gives work to over 1.6 million people. This sector generates more than 23% of the overall export proceedings that is about 7.2% of Malaysia's GDP (EPU, 2016). Nevertheless, the share of the agricultural sector in the Malaysian economy, regardless of an upsurge in total value, is declining each year. For instance, the share of the agriculture in GDP has dropped to 22.9 in 1980 from 29.9% in 1970; then it made 18.7% in 1990 and 8.4% in 2000.

The major objective of our study is to examine the link between exchange rate volatility and financial performance of the agriculture firms in Malaysia.

The study uses the GARCH modelling process consolidated with the system GMM dynamic panel techniques. The recent wavelet coherence technique is used to study the effect of both nominal and real exchange rate volatility on both the long-run and short-run trade dimensions of Malaysia.

This paper is organized as follows: Section 1 is the introduction; Section 2 reviews the relevant literature; then the Section 3 presents the data and the empirical basis of this study; later, Section 4 discusses the results found from the econometric tests, and Section 5 concludes the paper.

## 2. Literature review

The effect of exchange rate volatility on global trade is a vital concern in business and economics (Bahmani-Oskooee & Aftab, 2017; Chi & Keow, 2016; Hall, Hondroyiannis, Swamy, Tavlas, & Ulan, 2010; Ouyang, Rajan, Li, Professor, & Kuan, 2016; Wong & Lee, 2016; Yoshino, Kaji, & Asonuma, 2016; Zakaria, 2013). The rationale for scrutinizing the influence of exchange rate instability on international trade is that such volatility brings ambiguity in global trades. This uncertainty brings deterioration in international trade and economic prosperity. Exporters and importers face insecurity of their costs and returns because the exchange rate risk might their international trade (Ahmed, 2017; Caporale, Menla Ali, & Spagnolo, 2015). Asteriou, Masatci, & Pılbeam (2016) argue that decrease of the exchange rate volatility leads to increase in the foreign trade. The researchers found a negative impact of exchange rate volatility to real exports (Aghion, Bacchetta, Ranciè Re, & Rogoff, 2009; Chi & Cheng, 2016; Ouyang et al., 2016; Wong & Lee, 2016).

Despite the fact that theory advocate the negative association between exchange rate unpredictability and foreign trade (see for example, Hung Yip & Nguyen, 2012; Hutson & Laing, 2014), the studies put forward that this hypothetical argument may not generally be valid (Al-Shboul & Anwar, 2014; Krapl & Salyer, 2017; Ye, Hutson, & Muckley, 2014). Slavtcheva (2015), Ye, Hutson, & Muckley (2014) show that such influence depends on the norms of forwarding markets, hedging tools, firms structure, risk preferences and degree of financial integration. Al-Shboul & Anwar (2014), Hung Yip & Nguyen (2012) suggest that if a sound forward market is present and the organization has a clear vision on the revenues in the future exchange rate, the situation should be different, the size of trade will not be disturbed.

Huang & Yang (2014), Reus & Mulvey (2016) found that there is an indirect influence of exchange rate unpredictability on foreign trade. If the forward risk premium and the trade balance are positive, importers will be gainers while the exporters will be the losers. Interestingly, the positive connection between exports and exchange rate volatility was found by many authors (Ca' Zorzi, Muck, & Rubaszek, 2016; Capelle-Blancard & Havrylchyk, 2016; Caporale et al., 2015; Lothian, 2016).

Ahmad, Rhee, & Wong (2012), Al-Shboul & Anwar (2014), Asteriou, Masatci, & Pilbeam (2016) showed that some factors and techniques such as assets reallocation, substitutions, and income effects help to manage risks as well as to ensure the firm's specific gains from international trade. Bahmani-Oskooee, Iqbal, & Khan (2016), Hutson & Laing (2014), Lee & Jang (2011) showed that net effect (either negative or positive) of the exchange rate volatility depends on the related strengths of the revenue and substitution impacts.

Some researchers examined the short-run and long run relationship between exchange volatility and trade performance. The empirical results revealed that there was a statistically significant and negative long-run relationship between exchange rate volatility and trade performance in eight Latin American countries (Bahmani-Oskooee et al., 2016; Chen & Chang, 2015). On the other hand, examining five industrialized economies (USA, UK, Japan, France, and Germany), the researchers found the same relationship and showed that volatility had no significant influences on trade movements (Allen & Gandiya 2004). Studies using the M-GARCH model (Hutson & Laing, 2014) observed the empirical hypothesis for the same five developed countries (Lahmiri, 2017); the results found that exchange rate volatility had a significant influence on export flows for each country. On the other hand, some researchers found mixed results for these five countries. The results showed that volatility sign is positive for France, Germany, and Japan though negative for the UK and USA.

Huffman, Makar, & Beyer (2010) used both aggregate and sectoral export data from the European Union to Ireland; they argued that exchange rate volatility had a positive and significant effect in the long run but no effect in the short run. Sekkat & Varoudakis (2000) used different panel data econometric methods such as fixed effects, pooled OLS, system GMM and first difference GMM equation. They explored the impact of exchange rate volatility on exports in the Central Franc African (CFA) and non-CFA countries of Africa; they used GARCH model to generate the exchange rate volatility time series. They showed that the other estimation techniques did not provide better results than the system GMM technique. Exchange rate volatility had a negative relationship with exports of equal panels of countries; but the influence of the non-CFA nations on the panel was larger than the one of the CFA. The study determined that fiscal policy actions and appropriate monetary policies could prevent the rising movement in exchange rate volatility. Andries, Ihnatov, Praru, & Tiwari (2015) observed the relationship between Malaysian exchange rate and stock price index using MGARCH-DCC and wavelet approach. In the case of Malaysia, for both Islamic and conventional stock indices, the study showed that there was negative relationship between exchange rate and stock prices index.

Aftab & Rehman (2017) studied the impact of exchange rate volatility in Malaysia and Singapore in the context of industry-level trade. They used monthly data for the period of 2000-2014. They used GARCH and ARDL tools and showed that there is a moderate effect in short run but very few effects in the long run. Khin, Thambiah, & Teng (2017) showed long-run and short-run relationship between price forecast and trade volume. The result revealed the price forecast decreased trade in the short run, but increased it in the long run as well as increased the trend of rubber market in Malaysia. Wong & Tang (2016) studied the effects of exchange rate variance on export demand for semiconductors which is the largest sub-sector of the electronics industry in Malaysia. They found that the erraticism of the real exchange rate had some effects on semiconductor exports both in the short run and the long run.

Zakaria (2013) examined the effects of exchange rate volatility on Malaysia's total real exports to the major trading partner countries (US, UK, Japan, and Singapore). The results showed that Malaysian exports to the US are negatively and significantly related to exchange rates volatility; while Malaysian exports to Japan is positively and significantly related to exchange rates volatility. On the other hand, Malaysian exports to Singapore and UK were found not to be significantly related to the volatility in the exchange rates. The findings of this study established an ambiguous relationship between exchange rates volatility and export performance.

Karakaş & Erdal (2017) employed panel data approach and IGARCH techniques for investigating the effects of real effective exchange rate (REER) and its volatility (REERV) to the Turkey's agricultural foreign trade. The researchers showed that there are significant relationships among REER, import and export; but there is no significant relationship between agricultural export and REERV. Caporale, Ali, Spagnolo, & Spagnolo (2017) used GARCH and Markov switching model to observe the effect of equity and bond inflows on exchange rate volatility for developed, developing and emerging countries.

Most of the researchers found an adverse impact of exchange rate uncertainty on international trade, but they have given less concentration on the studies using nominal exchange rate volatility.

Besides previous studies also employed gravity, error correction, and long-run cointegration modelling techniques which reported inconsistent results regarding the relationship between exchange rate volatility and financial performances.

## 3. Methodology

### *3.1 Dynamic panel data analysis*

This study employs the System Generalized Method of Moments (GMM) estimator proposed by Arellano & Bond (1991). The Ordinary Least Squares (OLS) levels and within-groups estimator results are biased and inconsistent for panel data because of the omission of unobserved time-invariant country effects. The OLS does not represent the viable coefficient of the lagged dependent variable which has a tendency to be one-sided upwards, and the lagged dependent variable is positively correlated with the permanent impacts in dynamic panel regressions. While the within-groups estimator, which considers the unobserved nation particular impacts, additionally infers biased and inconsistent estimates over a fixed-time period. Since the within-groups estimate of the coefficient is superior to OLS, yet it evaluates that the coefficient of the lagged dependent variable has a tendency to be one-sided downwards. Therefore, this investigation applies the system GMM estimator. This excludes the bias and yields a proficient and reliable parameter estimates in a regression, in which the regressors are not entirely exogenous. In addition, system GMM estimator conquers the issues of fixed impacts and endogeneity of regressors, other than eliminating the dynamic panel bias. When contrasted with difference GMM estimator, the system GMM estimator is more proficient, allowing for more instruments through an extra supposition, in which the main contrasts of instruments are uncorrelated with the fixed impacts. A system with the first equation in levels and the transformed equation in first differences composed the system GMM estimator. The lagged first differences of the regressors and the lagged levels of the regressors are added as instruments for the original and the transformed equation, respectively.

Our model specification regarding the relationship between exchange rate volatility and financial performance of agriculture firms in Malaysia is formulated as follows:

$$Y_{i,t} - Y_{i,t-1} = \alpha Y_{i,t-1} + \beta X'_{i,t} + \mu_i + \varepsilon_{i,t} \tag{1}$$

Where, $Y_{i,t}$ stands for the logarithm of financial performance of agriculture firms in Malaysia (the financial performance as a dependent variable is measured by return on assets (ROA), return on equity (ROE), and return on invested capital (ROIC)); $X'_{i,t}$ represents a vector of variables which influence the financial performance. These variables consist of an independent variable which is the real exchange rate of Malaysian ringgit (RM) and control variables. The $i$ stands for number of agriculture firms in Malaysia; $t$ - time series; $\mu_i$ and $\varepsilon_{i,t}$ represent the unobservable and firm-specific effect respectively. Equation (2) specifies in more detail the econometric model to be estimated.

$$Y_{i,t} = \alpha Y_{i,t-1} + \beta X'_{i,t} - + \mu_i + \varepsilon_{i,t} \qquad (2)$$

And Equation (3) explains in detail all the variables in this study.

$$Perf_{i,t} = \alpha + Perf_{i,t-1} + ER_{i,t} + GDP_{i,t} + CPI_{i,t} + ARME_{i,t} + AVA_{i,t} + \mu_i + \varepsilon_{i,t} \qquad (3)$$

Where, $Perf_{i,t-1}$ - financial performance of agriculture firms with proxies of ROE, ROA, and ROIC as dependent variables; $ER_{i,t}$ - the exchange rate measure (with the foreign currency being the U.S. dollar); $GDP_{i,t}$ is market value of all final goods and services the per capita; $CPI_{i,t}$ - changes in the price level of market basket of consumer goods and services purchased by households; $ARME_{i,t}$ - agriculture raw materials exports (% of merchandise exports); $AVA_{i,t}$ - agriculture value added (% of GDP). The exchange rate volatility can stimulate GDP growth and CPI growth which in turn influences the financial performance. This means that the three variables may have a bilateral relationship.

### *3.2 The GARCH estimation for exchange rate volatility*

We apply the GARCH models to explore the effect of exchange rate volatility on the economic performance of Malaysian agricultural. We check whether the requirement conditions are fulfilled or not before smearing the GARCH models. Firstly, we checked the Malaysian Ringgit actual exchange rates data in terms of US dollar to see if they are stationary. Secondly, we checked the ARIMA fitted model for Malaysian Ringgit actual exchange rates in terms of US dollar. We choose the model with the lowest Akaike information criterion (AIC) as well as the Schwartz information criterion (SIC). We tested whether the model carries the problem of serial correlation or not. We also checked the effects of ARCH that displays if the model has the difficulties of heteroscedasticity that means volatility gathering in the data residuals. To estimating the volatility in the data, we employ the GARCH/ARCH method if it suffers from heteroscedasticity and it may have autoregressive structure. The conditional variance is the accurate volatility measurement about a variable and exchange rate volatility which is surveyed as the conditional variance of exchange rate level. This is prepared from periodic data as well as the conditional variance that assumed a model and set of information. Gaining the exchange rate conditional variance, the study practices GARCH (1,1).

Specification is as follows:

$$RER_t = \phi_0 + \sum_{i=1}^{n} \phi_i RER_{t-1} + u_t \qquad (4)$$

$$\sigma_t^2 = \Phi + \sum_{i=1}^{p} \vartheta u_{t-1}^2 + \sum_{i=1}^{q} \psi \sigma_{t-1}^2 , \quad (5)$$

Where, RER is the real exchange rate; $RER_{t-1}$ stands for the previous exchange rate; $u_t$ presents the error term; $\sigma_t^2$ is the one-period fast estimate for the exchange rate variance on the basis of past information or volatility; $\sigma_{t-1}^2$ is the previous volatility (GARCH) and $u_{t-1}^2$ represents the previous information about volatility (ARCH). The equation (5) is termed as the equation of conditional variance. The GARCH (1, 1) is used to produce the volatility of exchange rate series for periodic data.

### *3.3 Wavelet coherence (WTC)*

Wavelet coherency is defined as "the ratio of the cross-spectrum to the product of the spectrum of each series, and can be thought of as the local (both in time and frequency) correlation between two time-series" (Aguiar-Conraria et al., 2008, p. 2872). It is possibly like the correlation. The example is: if the wavelet coherence is near to 1, it suggests a high relationship is situated between the observed time series. Again, if coherency is near to 0, it means there is no relationship among the variables. Furthermore, the time series variance is explained through the wavelet power spectrum as well as the covariance that takes the cross wavelet power among the two time series at each frequency or measure. The wavelet recommends the sizeable power spectrum existence if a time series variance is large. The two (2) time series wavelet coherence is defined as:

$$R_n^2(s) = \frac{|S(s^{-1}W_n^{XY}(s))|^2}{S(s^{-1}|W_n^X(s)|^2) * S(s^{-1}|W_n^Y(s)|^2)^2} \quad (6)$$

Where, $S$ is the smoothing operator as a convolution in scale and time. Devoid of smoothing, coherency becomes identically one at all times as well as scales:

$$S(W) = S_{scale}(S_{time}(W_n(s))) \quad (7)$$

Where, $S_{time}$ represents smoothing in time and $S_{scale}$ represents smoothing along the wavelet scale axis. The scale convolution is done with a four-sided window. The time convolution is performed with a Gaussian according to Torrence & Compo (1998). For the Morlet wavelet, an appropriate smoothing operator is specified as

$$S_{time}(W)\big|s = (W_n(s) * c_1 - 1^2 /^{2s2}) \ \big|s \tag{8}$$

$$S_{scale}(W)\big|n = (W_n(s) * c_2 \prod (0{,}6s) \ \big|n \tag{9}$$

Where, $\prod$ is the square function; $c_2$ and $c_1$ are standardized constants for the Morlet wavelet. The 0,6 factor is the empirically resolvable scale design relation length (Torrence & Compo, 1998). Together, the complications in practice are done separately as well as the standardized coefficients are resolvable statistically. Because, for wavelet coherency hypothetical deliveries have not been imitated yet. One has to trust on the Monte Carlo simulation approach to evaluate the arithmetical importance of the estimated wavelet coherency. We will emphasize on the wavelet coherency instead of the wavelet cross spectrum following Aguiar-Conraria & Soares (2011). The wavelet coherency benefits are considered as the power spectrum standardizes the two time series and the wavelets cross spectrum can display powerful peaks even for the independent processes recognition proposing the chance of spurious importance trials (Aguiar-Conraria & Soares, 2011, p. 649).

## 4. Empirical results

### *4.1 Dynamic panel data analysis*

Table 1 reports the mean and standard deviation, maximum and minimum values of all the variables in the data set. The exchange rate has fluctuated during this period between 73.77 and 94.43 with an average of 9.297734 RM and a standard deviation of 13.981 from 2001 to 2015. The table shows the diagnostics measures regarding collinearity of explanatory variables in the model, and reveals that no more multicollinearity which is a high degree of correlation among the regressors. The problem arises when the regressors in the model have a linear relationship between them. As a result, all regressors in the model are free from collinearity, as the variance inflation factor is less than 10 and/or the tolerance value is greater than 0 (Neter, Kutner, Nachtsheim, & Wasserman, 1996).

TABLE 1. DESCRIPTIVE STATISTICS

| Variable | Obs | Mean | Std. Dev. | Min | Max | VIF | TV |
|---|---|---|---|---|---|---|---|
| *Perf* | 1015 | 9.297734 | 13.981 | -73.7700 | 94.4300 | - | - |
| *ER* | 1015 | 3.473357 | .2951492 | 3.05318 | 3.9055 | 2.12 | 0.471327 |
| *ARME* | 1015 | 2.343378 | .3551636 | 1.749383 | 3.16027 | 2.40 | 0.416985 |
| *AVA* | 1015 | 9.342864 | .8372116 | 8.010971 | 11.45335 | 3.38 | 0.296065 |
| *CPI* | 1015 | 102.8928 | 6.168716 | 90.9 | 112.8 | 1.35 | 0.738830 |
| *GDP* | 1015 | 4.953915 | 2.675465 | -2.525826 | 9.427665 | 1.15 | 0.869658 |

Note: Std. Dev, VIF and TV denote standard deviation, variance inflation factor and tolerance value, respectively. Mean VIF = 2.08.

Table 2 shows the correlation between exchange rate (ER) and financial performance of agricultural firms in Malaysia.

TABLE 2. CORRELATION COEFFICIENT MATRIX

| | *Perf* | *ER* | *ARME* | *AVA* | *CPI* | *GDP* |
|---|---|---|---|---|---|---|
| *Perf* | 1.0000 | | | | | |
| *ER* | 0.0606 | 1.0000 | | | | |
| *ARME* | 0.0622 | -0.2859 | 1.0000 | | | |
| *AVA* | 0.0917 | -0.6938 | 0.6500 | 1.0000 | | |
| *CPI* | -0.0848 | 0.1121 | -0.4782 | -0.2863 | 1.0000 | |
| *GDP* | 0.0027 | -0.0991 | 0.3031 | 0.2233 | 0.0249 | 1.0000 |

Source: Authors, 2017.

### *4.2 Unit root test*

The investigation utilized increased Dickey-Fuller (ADF) test to check for the unit roots in the time series data. It is observed that exchange rate volatility has unit root at the level I (0) and is stationary at first difference I (1) at 1% significance level.

TABLE 3. ADF UNIT ROOT TEST RESULTS OF MONTHLY DATA FROM 2005 TO 2015

| | ADF | |
|---|---|---|
| VARIABLES | CONSTANT WITHOUT TREND | CONSTANT WITH TREND |
| Level | | |
| *ER* | 0.430316 | 0.320071 |
| First difference | | |
| *ER* | 10.20380*** | 10.62937*** |

Note: ADF test equation includes both constant and trend terms. Asterisk represents significance level for hypothesis rejection *10 %; **5 %; ***1 %.

TABLE 4. DIAGNOSTIC TEST USING ARCH HETEROSEDASTICITY TEST

| | | | |
|---|---|---|---|
| F-statistic | 4.503191 | Prob. F(1,128) | 0.0358 |
| Obs*R-squared | 4.418119 | Prob. Chi-Square(1) | 0.0356 |

### *4.3 GARCH analysis and volatility clustering*

Table 5 presented above indicates that the residual has a significant ARCH effect; since the null hypothesis which states that there no ARCH effect is rejected. This means that Ringgit has an ARCH effect because the probability value is statistically significant at 5% level.

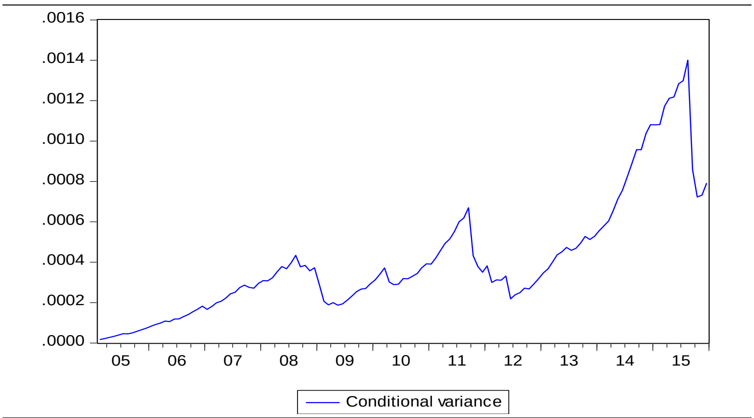
TABLE 5. GARCH MODEL ESTIMATED FOR RINGGIT (monthly)

| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.013343 | 0.000186 | 71.66598 | 0.0000 |
| *ER(-1)* | 0.988547 | 0.000265 | 3729.163 | 0.0000 |
| | | VARIANCE EQUATION | | |
| C | 3.85E-06 | 1.69E-06 | 2.279527 | 0.0226 |
| RESID(-1)^2 | -0.064801 | 0.027371 | -2.367518 | 0.0179 |
| GARCH(-1) | 1.080359 | 0.036838 | 29.32763 | 0.0000 |
| R-squared | 0.93783 | Mean dependent var | | 1.221115 |
| Adjusted R-squared | 0.937350 | S.D. dependent var | | 0.086863 |
| S.E. of regression | 0.021742 | Akaike information criterion | | -5.188925 |
| Sum squared residuals | 0.060980 | Schwarz criterion | | -5.079185 |
| Log likelihood | 344.8746 | Hannan-Quinn information criterion | | -5.144 |
| Durbin-Watson statistic | 1.767087 | | | |

In addition, the null hypothesis which states that there is no GARCH effect is rejected; therefore, we accept an alternative hypothesis that confirms the presence of GARCH effect. Furthermore, Figure 1 underneath demonstrates that the times of low volatility of Ringgit is trailed by the times of low unpredictability for drawn out period; additionally, the times of high volatility is trailed by the times of high volatility for a prolonged period which uncovered that the graph of exchange rate volatility is cluster and volatile.

### *4.4 Estimation results*

FIGURE 1. MALAYSIAN RINGGIT (RM) EXCHANGE RATE VOLATILITY



The coefficient of exchange rate volatility has a negative sign and is statistically significant level at 5%. The backhanded relationship between the exchange rate volatility and financial performance of agricultural firms in Malaysia demonstrates that volatility in the exchange rate would result in the decrease in performance of agricultural firms. Agricultural firms would be cautious of their buying capacities; they would prefer keeping their earnings for future expenditures.

### *4.5 System GMM*

There are two models in Table 6: model 1 is static one with independent and dependent variables; while model 2 applies the dynamic model that captures similar explanatory and endogenous variables. On the basis of Hausman test, the study accepts the fixed effects model which is a static model rather than a random effects model. Applying the fixed effects model, the outcome indicates its insignificance in most of the regressors, which gives a sign that the model is not appropriate when all required diagnosis are done.

Only the consumer price index (CPI) is statistically significant, that means the CPI has a negative significant impact on the financial performance of agriculture firms in Malaysia. The other variables such as ARME, AVA, and GDP have a less statistically significant relationship with the financial performance at 1%, 5% and 10% significance.

TABLE 6. ESTIMATION OF FINANCIAL PERFORMANCE EQUATIONS WITH OLS, FIXED EFFECTS, AND SYSTEM GENERALIZED METHOD OF MOMENTS (GMM)

| VARIABLE | PROXY | FIXED EFFECTS MODEL (1) | SYSTEM GMM MODEL (2) |
|---|---|---|---|
| *Lagged perf* | | | .456356*** (.002628) |
| *ER* | | .197203 (1.727087) | 3.047941*** (.1628823) |
| *ARME* | | -.4285541 (1.513043) | .2098542*** (.0589322) |
| *AVA* | | 1.534725 (.7613352) | 2.026977*** (.0466611) |
| *GDP* | | -.0295183 (.1389886) | .1258494*** (.0144946) |
| *CPI* | | -.1607702*** (.0657576) | -.0946524*** (.0067159) |
| *Constant* | | 11.96665 (13.38702) | -16.43408*** (1.248192) |
| Hansen-Sargan test: | | | |
| | Wald-$\chi^2$ | | 35.37065 |
| | p-value | | 0.9897 |
| Arellano-Bond test for autocorrelation: | | | |
| | AR(1) p-value | | 0.0018 |
| | AR(2) p-value | | 0.4233 |
| F- stat. | | | |
| No. of observations | | 1015 | 929 |

In the dynamic model, the two-step system GMM has been applied rather than the difference GMM due to its limitations. The difference GMM overcomes the inefficiencies of the fixed effects model. However, difference GMM cannot solve the endogeneity problem which arises from the correlation between lagged dependent variable and the error term. To obtain results which are free from bias and inconsistency, instruments are required to remedy the endogeneity. Therefore, the system GMM which has enough instruments overtakes the difference GMM because the difference GMM has weak instruments. In addition, the system GMM does not necessarily assume that panel data are normally distributed. On the other hand, the application of system GMM stipulates certain preconditions. First, system GMM is only consistent when there is no second-order autocorrelation within the error item, and secondly, when the model is not over-identified (i.e. when the instruments are valid). Therefore, the table reports two tests: the Arelano-Bond test of first- and second-order autocorrelations in the residuals and the Hansen-Sargan test of overidentification.

Table 6 resents that the null hypothesis of the no first-order autocorrelation in the two-step system GMM is rejected. Alternatively, the null hypothesis of the no second-order autocorrelation in the two-step system GMM has failed to be rejected. According to the p-value of the Arelano-Bond test of second order autocorrelation, it must not be rejected the null hypothesis implying that there is no second-order autocorrelation.

This underlines the importance for the application of a dynamic panel data model in which several variables are instrumented; using the lags of these variables to remove the autocorrelation in the second-order. Moreover, the consistency of GMM estimator depends on the validity of the assumption that the error terms must not reveal autocorrelation and on the validity (exogeneity) of its instruments. To validate these assumptions, STATA gives two sets of specification tests. The first set constitutes the Sargan-Hansen test of overidentification. The Sargan test is a test for the validity of instruments and is asymptotically distributed as $\chi2$ under the null of valid instruments. If p-value > .05, we confirm the validity of instruments. AR (2) is a test for the second-order serial correlation and is asymptotically distributed as N (0, 1) under the null of no serial correlation. If p-value >0.05, we confirm that there is no serial correlation at order two in the first-differenced errors and the model is well specified at level 1% significant.

In the two-step system GMM, the results showed that the exchange rate has a positive effect on the financial performance at a significant level of 1%. This means that the local currency depreciation has an implication on the produced locally products which becomes cheap. This encourages an increase in exports; therefore, the financial performance of export-oriented companies will rise on one hand. The finding is consistent with the theoretical expectation. And empirical studies also show that exchange rate volatility influences the levels of sales: sales decrease as the rate of exchange appreciates while sales increase as the rate of exchange depreciates. Subsequently, it can be inferred that the mixed effect of exchange rate movement has significant effects on the firm's survival. That is, the real exchange rate effect has substantial implications for the sales, employment and profits of firms (Chi & Keow, 2016).

Therefore, companies in the agricultural sector in Malaysia should take necessary actions to achieve a more efficient cost control to improve their financial performance. The coefficients of industry-specific control variables including ARME and AVA show a positive impact on the financial performance at 1% significance level for the full sample of all the agricultural companies operating in Malaysia. If ARME and AVA increase by 1%, the financial performance increases by 0.209 and 2.02 units respectively. The implications suggest that an increase (decrease) in these expenses reduces (increases) the financial performance of companies operating in Malaysia. In addition, it is argued that the agricultural companies operating in Malaysia had not reached the highest peak (maturity level) and started to decline. Therefore, the study urges that attention must be paid on efficient cost control of ARME and AVA which in turn ensures desirable profits for the agriculture sector in Malaysia..

Looking into the macroeconomic variables, GDP growth rate and inflation have a significant impact on the financial performance of companies operating in Malaysia but only in the two-step system GMM. It has been found that the GDP growth rate has a positive impact on the financial performance of companies operating in Malaysia, while inflation has a negative impact on the performance of the financial performance of companies operating in Malaysia. 1% increase in GDP would impact 12.5% on the financial performance of companies operating in Malaysia, whereas 1% rise in inflation would decrease the performance of financial performance by 9%.

### *4.6 Wavelet coherence*

Figures 2-4 show cross-wavelet coherency for the examined variables in the time-frequency domain.

In wavelet coherence, there are arrows that represent wavelet phase differences showing the direction of cause-effect relationships among the variables. The right(→) and left(←) arrows indicate in-phase and out-of-phase respectively. The in-phase arrow signifies a positive association suggesting that the economic series move jointly in the same direction, while the out-of-phase arrow shows a negative relationship indicating that variables move in opposite directions over specific time and different frequency scales. The right-up (↗) and right-down (↘) arrows suggest positive relationships among variables in which second variable leads and first variables leads respectively. On the other hand, left-up (↖) and left-down (↙) show negative associations among series which the first variable leads and second variable leads accordingly.

*Return on invested capital (ROIC) versus exchange rate (ER)*

Figure 2 indicates the wavelet coherence between return on invested capital (ROIC) and exchange rate (ER), consumer price index (CPI), and interest rate (IR). The plots in the figure show results that the relationship between the return on invested capital (ROIC) and exchange rate (ER) is significant and positive as exchange rate leads. However, the return on invested capital (ROIC) is negatively correlated with the interest rate (IR) as the return on invested capital (ROIC) leads. In addition, it has a significant and negative relationship with the consumer price index (CPI) as the return on invested capital (ROIC) leads. The wavelet coherences increase at lower frequency bands at 64-128 days.

FIGURE 2. WAVELET COHERENCE (ROIC)

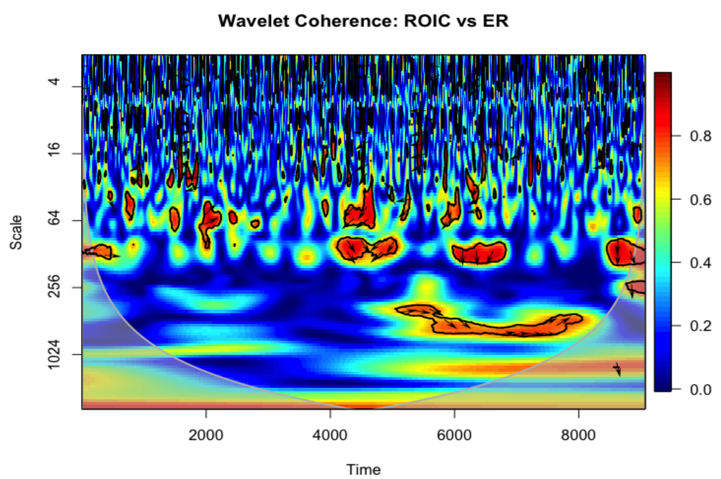
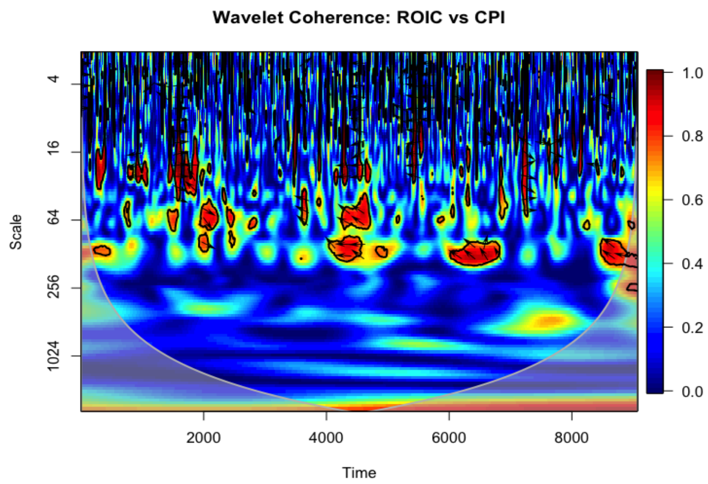
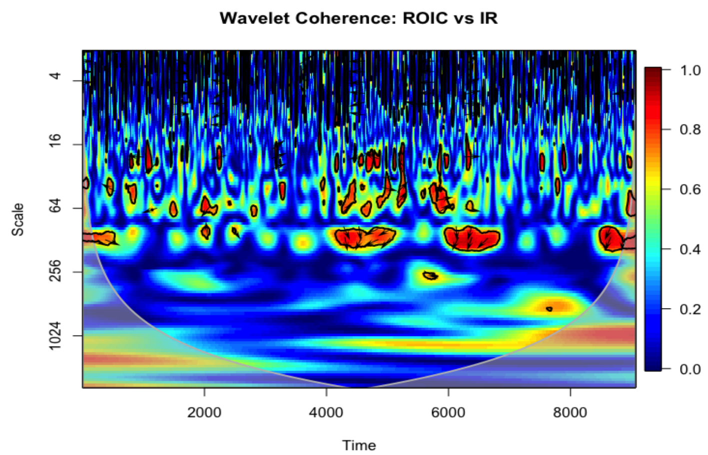


FIGURE 2. WAVELET COHERENCE (ROIC)




Note: The full black contour indicates the 5% significance level in contradiction to red noise, which is measured from Monte Carlo simulations applying phase-randomized surrogate series. The cone of influence, which designates the region hit by edge effects, is also presented with a light black line. The horizontal axis shows time, while the vertical axis displays the frequency which has two regions. The region with a low frequency has the higher scale and the region with a high frequency has the lower scale. The regions with red colors inform about strong dependence between the time series, while the regions with blue colors indicate that the interdependence between time series is less significant. The color code for coherency ranges from blue (low coherency - close to zero) to red (high coherency - close to one). The phase difference between the two series is shown by arrows. Arrows indicating to the right imply that the variables are in the phase (move in one direction). Arrows indicating to the left imply that the time series are in anti-phase phase (move in opposite directions). Right-up and left-down directions of arrows indicate that the second variable is leading (first variable is lagging). Right-down and left-up directions of arrows indicate that the first variable is leading (second variable is lagging).

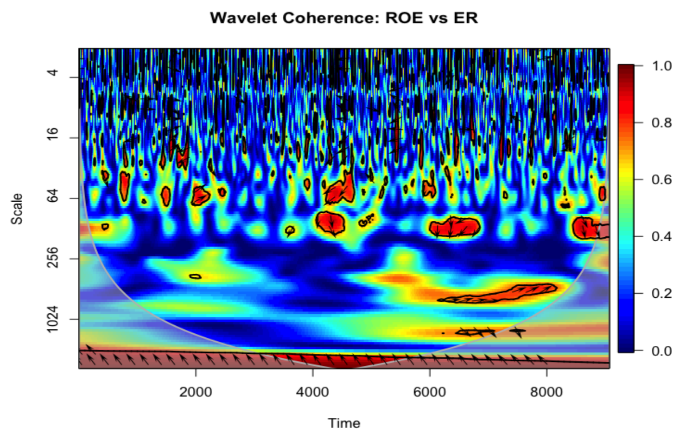


*Return on equity (ROE) versus exchange rate (ER)*

Figure 3 indicates the wavelet coherence between the return on equity (ROE) and exchange rate (ER), consumer price index (CPI), and interest rate (IR). The Figure 3 reveals that the relationship between the return on equity (ROE) and exchange rate (ER) is negative and statistically significant. Likewise, ROE is negatively correlated with the consumer price index (CPI). In both plots, the return on equity (ROE) leads at lower frequency bands at 64-128 days. Moreover, the return on equity (ROE) correlates negatively with the interest rate (IR) as the interest rate (IR) leads at lower scales of 64-128 days.

FIGURE 3. WAVELET COHERENCE (ROE)



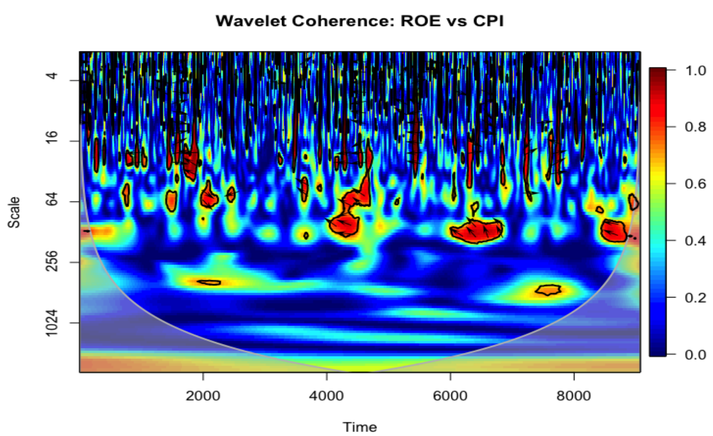
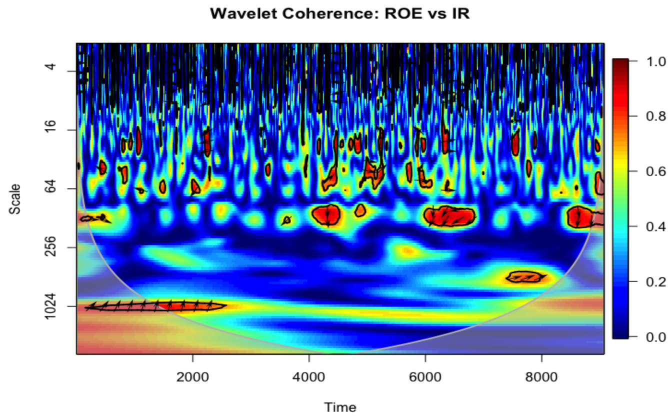



FIGURE 3. WAVELET COHERENCE (ROE)




Note: See note in the Figure 2.

*Return on assets (ROA) versus exchange rate (ER)*

Figure 4 explains the wavelet coherence between return on assets (ROA) and exchange rate (ER), consumer price index (CPI), and interest rate (IR). The plots reveal that the return on assets (ROA) has negative associations with exchange rate (ER), consumer price index (CPI) and interest rate (IR). In the first plot (ROA vs ER) and third plot (ROA vs IR), the return on assets (ROA) leads, while consumer price index (CPI) leads as shown in the second plot (ROA vs CPI). The wavelet coherences show moderate and statistically significant relations among the pair series concentrating at scales of 16-128 days.

FIGURE 4. WAVELET COHERENCE (ROA)

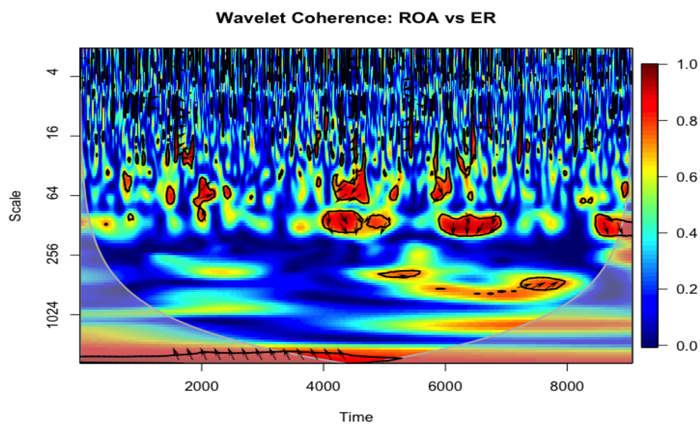
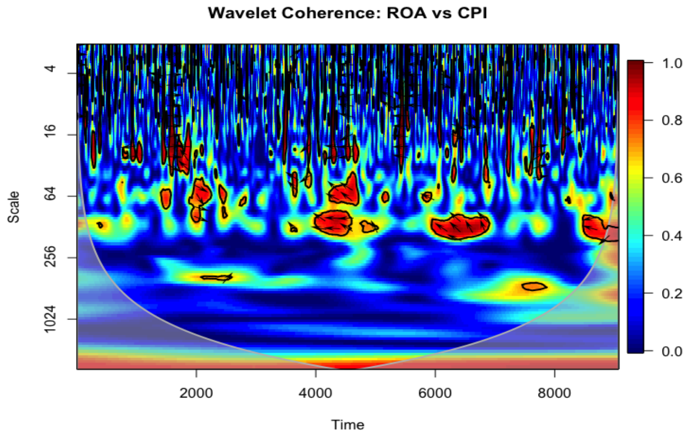
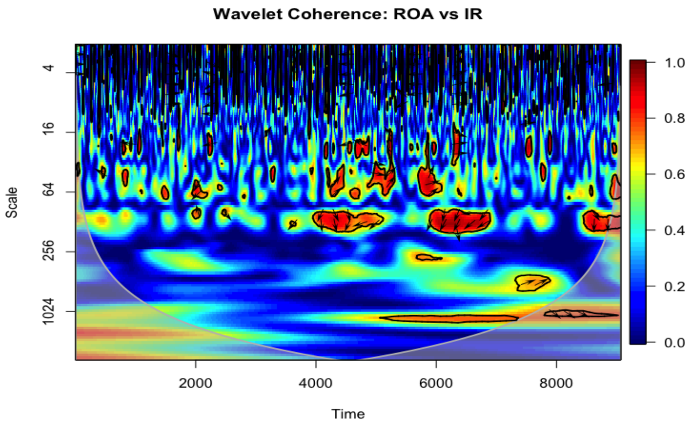


FIGURE 4. WAVELET COHERENCE (ROA)




Note: See note in the Figure 2.

## 5. Conclusions

The exchange rate volatility and uncertainty growth affect the decisions of policy makers around the world on international trade and investment, as well as the financial performance of firms. This study examines the effect of exchange rate volatility on the financial performance of agriculture firms in Malaysia. The study employs a novel econometric model in order to retrieve accurate empirical results that contribute the literature of exchange rate volatility and macroeconomic factors by using the two-step system GMM model of dynamic panel because of the nature of data.

This research also uses the GRACH (1,1) model to capture the exchange rate volatility; and wavelet coherence is applied in the study to get insights to the co-movements of variables, and to determine the leading and lagging variables and direction of movement.

The study reveals that the volatility of exchange rate of Malaysian Ringgit (RM) has a negative impact on the financial performance of agriculture firms in Malaysia. The study shows that the RM had low volatility in some periods followed by a high volatility in other periods. The uncertainty in the exchange rate of RM would have an adverse implication in the financial performance of agriculture on firms. Also, this has a negative impact on their purchasing abilities thus enabling them to keep their money income for future expectations. This result is in line with our hypothesis which suggests that the volatility of exchange rate, for example, the Malaysian Ringgit (RM) has a negative effect on financial performance.

Moreover, the results revealed that exchange rate depreciation has a positive effect on the financial performance at 1% significance level; local currency weakening increases exports because locally produced products become cheap. Consequently, the financial performance of export-oriented companies will rise on one hand; on the contrary, the financial performance is decreased by purchases of necessary raw materials. Therefore, the result is in concordance with the theory of expectation.

Results of our study are consistent with other empirical studies on exchange rate volatility. The real exchange rate volatility has substantial implications for the sales, employment and profits of firms (Chi & Keow, 2016). The factors like ARME and AVA show a positive impact on the financial performance at 1% significance level for the full sample of all the agricultural companies operating in Malaysia. A 1% increase in GDP would impact 12.5% on the financial performance of companies operating in Malaysia, whereas a 1% rise in inflation would decrease the performance of financial performance by 9%.

The study also shows that financial performance [with the proxies of return on assets (ROA), return on invested capital (ROIC), and return on equity (ROE)] comoves in the wavelet coherence examination with the exchange rate (ER), consumer price index (CPI), and interest rate (IR). ROIC (Figure 2) has comovement with the ER, CPI, and IR. ROIC is negatively correlated with the IR as the return on invested capital (ROIC) leads. ROIC is negatively correlated with CPI as the ROIC leads. On the other hand, the relationship between the return on invested capital (ROIC) and exchange rate (ER) is significant and positive as exchange rate leads. ROE-ER and ROE-CPI relations (Figure 3) demonstrate negative correlation; and ROE is leading in the both relations. ROE-IR relation proves also negative dependence; and the ER is leading variable. ROA-ER, ROA-ER and ROA-CPI relations (Figure 4) show negative dependencies. CPI leads in the ROA-CPI relation while ROA leads in ROA-ER relation. Finally, in ROA-IR relation the ROA represents the dependent variable (y) and interest rate (IR) stands for independent variable (x); given that the return on assets (ROA) leads, as shown in the third plot (ROA vs IR). In conclusion, the volatility of exchange rate of Malaysian Ringgit (RM) has a negative impact on the financial performance of agriculture firms in Malaysia and the squared wavelet coherence exhibits explicitly the movement between the variables.

This study contributes further insights on the exchange rate volatility and financial performance of agriculture firms in Malaysia as it uses the novel econometric model. Its implication will provide to firms and government comprehensive insights on the co-movement of exchange rate with some macro variables. This enables them to predict substantially the trend and impact, and, therefore, implement preventive measures rather than wait and observe what will happen.



## References

Aghion, P., Bacchetta, P., Ranciè Re, R., & Rogoff, K. (2009). Exchange rate volatility and productivity growth: The role of financial development. *Journal of Monetary Economics*, *56*, 494-513.

Aftab, M., & Rehman, I. U. (2017). Exchange rate risk and the bilateral trade between Malaysia and Singapore. Studies in Economics and Finance, (just-accepted), 00-00.

Ahmed, W. M. A. (2017). The impact of foreign equity flows on market volatility during politically tranquil and turbulent times: The Egyptian experience. *Research in International Business and Finance*, *40*, 61-77.

Aguiar-Conraria, L., Azevedo, N., & Soares, M. J. (2008). Using wavelets to decompose the time-frequency effects of monetary policy. *Physica A: Statistical Mechanics and its Applications*, 387, 2863-2878.

Aguiar-Conraria, L. & Soares, M.J. (2011). Oil and the macroeconomy: Using wavelets to analyze old issues. *Empir Econ*, 40(3), 645-655. https://doi.org/10.1007/s00181-010-0371-x

Al-Shboul, M., & Anwar, S. (2014). Foreign exchange rate exposure: Evidence from Canada. *Review of Financial Economics*, *23*, 18-29.

Allen, D., & Gandiya, F. (2004). Assessing exchange rate hypotheses within Southern Africa.

Andries, A. M., Ihnatov, I., Praru, B., & Tiwari, A. K. (2015). The relationship between exchange rates and interest rates in a small open emerging economy: The case of Romania. *Economic Modelling*, (December 2016).

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*. *58*(2), 277. doi:10.2307/2297968

Bahmani-Oskooee, M., & Aftab, M. (2017). On the asymmetric effects of exchange rate volatility on trade flows: New evidence from US-Malaysia trade at the industry level. *Economic Modelling*, *63*(63), 86-103.

Bahmani-Oskooee, M., Iqbal, J., & Khan, S. U. (2016). Impact of exchange rate volatility on the commodity trade between Pakistan and the US. *Economic Change and Restructuring*, *52*, 1-27.

Ca' Zorzi, M., Muck, J., & Rubaszek, M. (2016). Real exchange rate forecasting and PPP: This Time the Random Walk Loses. *Open Economies Review*, *27*(3), 585-609.

Capelle-Blancard, G., & Havrylchyk, O. (2016). The impact of the French securities transaction tax on market liquidity and volatility. *International Review of Financial Analysis*, *47*(331), 166-178.

Caporale, G. M., Menla Ali, F., & Spagnolo, N. (2015). Exchange rate uncertainty and international portfolio flows: A multivariate GARCH-in-mean approach. *Journal of International Money and Finance*, *54*(November 2014), 70-92.

Chen, S., & Chang, M.-J. (2015). Capital control and exchange rate volatility. *North American Journal of Economics and Finance*, *33*, 167-177.

Chi, J., & Cheng, S. K. (2016). Do exchange rate volatility and income affect Australia's maritime export flows to Asia? *Transport Policy*, *47*, 13-21.

Chi, J., & Keow, S. (2016). Do exchange rate volatility and income affect Australia' s maritime export fl ows to Asia ? *Transport Policy*, *47*, 13-21.

EPU, E. P. U. (2016). The Malaysian economy in figures, *2012*, 66.

Hall, S., Hondroyiannis, G., Swamy, P. A. V. B., Tavlas, G., & Ulan, M. (2010). Exchange-rate volatility and export performance: Do emerging market economies resemble industrial countries or other developing countries? *Economic Modelling*, *27*(6), 1514-1521.

Hansen, L. P. (2007). Generalized method of moments estimation. *University of Chicago*, 1-14.

Huang, C.-H., & Yang, C.-Y. (2014). European exchange rate regimes and purchasing power parity: An empirical study on eleven eurozone countries ☆. *International Review of Economics and Finance*, *35*, 100-109.

Huffman, S. P., Makar, S. D., & Beyer, S. B. (2010). A three-factor model investigation of foreign exchange-rate exposure. *Global Finance Journal*, *21*, 1-12.

Hung Yip, W., & Nguyen, H. (2012). Exchange rate exposure and the use of foreign currency derivatives in the Australian resources sector. *Journal of Multinational Financial Management*, *22*, 151-167.

Hutson, E., & Laing, E. (2014). Foreign exchange exposure and multinationality. *Journal of Banking and Finance*, *43*(1), 97-113.

Karakaş, G., & Erdal, G. (2017). The effect of exchange rate volatility on Turkey's agricultural foreign trade. Turkish Journal of Agriculture-Food Science and Technology, 5(6), 668-675.

Khin, A. A., Thambiah, S., & Teng, K. L. L. (2017). Short-term and long-term price forecasting models for the future exchange of Malaysian natural rubber market. International Journal of Agricultural Resources, Governance and Ecology, 13(1), 21-42.

Krapl, A., & Salyer, R. (2017). The effects of fair value reporting on corporate foreign exchange exposures. *Research in International Business and Finance*, *39*, 215-238.

Lahmiri, S. (2017). Modeling and predicting historical volatility in exchange rate markets. *Physica A*, *471*, 387-395.

Lothian, J. R. (2016). Purchasing power parity and the behavior of prices and nominal exchange rates across exchange-rate regimes. *Journal of International Money and Finance*, *69*, 5-21.

Neter, J., Kutner, M.H., Nachtsheim, C.J. and Wasserman, W. (1996) *Applied Linear Statistical Models*. 4th Edition, WCB McGraw-Hill, New York.

Ouyang, A. Y., Rajan, R. S., Li, J., Professor, V., & Kuan, L. (2016). Exchange rate regimes and real exchange rate volatility: Does inflation targeting help or hurt.

Reus, L., & Mulvey, J. M. (2016). Dynamic allocations for currency futures under switching regimes signals. *European Journal of Operational Research*, *253*, 85-93.

Sekkat, K., & Varoudakis, A. (2000). Exchange rate management and manufactured exports in Sub-Saharan Africa. *Journal of Development Economics*, *61*(1), 237-253.

Slavtcheva, D. (2015). Financial development, exchange rate regimes and productivity growth: Theory and evidence. *Journal of Macroeconomics*, *44*, 109-123.

Torrence, C., & Compo, G. P. 91998). A practical guide to wavelet analysis. *Bull. Am. Meteorol. Soc.*, 79, 61-78.

Wong, H. T., & Lee, H. A. (2016). Exchange rate volatility and exports of Malaysian manufactured goods to China: An empirical analysis. *International Journal of Business and Society*, *17*(1), 145-149.

Ye, M., Hutson, E., & Muckley, C. (2014). Exchange rate regimes and foreign exchange exposure: The case of emerging market firms. *Emerging Markets Review*, *21*, 156-182.

Yoshino, N., Kaji, S., & Asonuma, T. (2016). Exchange rate regime switching in Malaysia and Singapore in response to China's move to a basket peg: A DSGE analysis. *Journal of Asian Economics*, *46*, 17-37.

Zakaria, Z. (2013). The relationship between export and exchange rate volatility: Empirical evidence based on the trade between Malaysia and its major trading partners. Journal of Emerging Issues in Economics, Finance and Banking, 2(2), 668-684.web