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Investigating the Influence of *Shariah* Compliance on the Level of Currency Exposure across Time Scales:An Application of the Wavelet Approach

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Abstract Currency exposure is defined as the risk where firm value is sensitive to changes in foreign exchange movement. Several studies have been devoted to measure the extent of foreign exchange exposure of Malaysian corporations. However, previous efforts have ignored the potential of *Shariah* compliance and time scale effects on the measurement. Motivated from these specification problems, the study investigated the influence of *Shariah* compliance on the level of multi-scale exchange rate exposure using the Maximal Overlap Discrete Wavelet Transformation ($MODWT$) approach. The study focused on a sample of 12*Shariah* compliant firms (SCF) and 12 non-*Shariah* compliant firms ($NSCF$)listed under the Food and Beverage industry in Malaysia from July 2005 till August 2018.As a result, the study found that the level of *Shariah* compliance had a negligible impact on the level of exchange exposure. The study also found that the level of currency exposure increased from low to high time scale, indicating that widened investment intervals entail greater exchange risk for both SCF and $NSCF$. In terms of policy implication, the study infers that the SCF and $NSCF$ share almost identical exchange risk profiles which uphold the law of one price. In fact, there is no basis to expect different risk management routines in dealing with exchange risk between the two groups. However, the study stresses the importance of incorporating the time scale factor in managing exchange risk for both groups.

Keywords Currency Exposure; Maximal Overlap Discrete Wavelet Transformation (MODWT), *Shariah* Compliant firms (SCF), Non-*Shariah* Compliant Firms ($NSCF$)

Mathematics Subject Classification 91C15

1 Introduction

Ever since the occurrence of the 1997 Asian Financial Crisis and the 2008 Global Financial Crisis, the issue of sensitivity of firm value to exchange rate fluctuation has gained significant importance among firm managers and market players. Foreign exchange risk becomes one of main sources of market risk over time especially to multi-national corporations with significant portions of foreign sales and cross-border operations. Any change in exchange rate value can significantly affect a firm's projected revenues, production and operational costs, competitiveness, growth and market share. The effect has far reaching implications for corporations operating in developing regions due to its enhanced economic openness and the lack of hedging intensities compared to western economies. Exchange rate risk plays an important role in international asset pricing [1]. According to Adler and Dumas [2], currency exposure is defined as the sensitivity of a firm's value against changes in exchange rate value which can be measured under the regression framework.

Significant development of the Islamic financial market in emerging countries such as Malaysia over the past few decades has motivated the interest in the study. Malaysia strives to be the leading provider of Islamic financial products and services ranging from personal needs to corporate facilities. The Islamic financial system provides a substitute to the conventional system by promoting an interest-free system as well as prohibition against activities that violate *Shariah* principles. The rapid development of Islamic finance is not surprising as the government's initiative has been supported by the large population of Muslim residents in the region. As a result of accommodative government policies towards the promotion of the Islamic financial system, the size of the Islamic capital market had reached MYR 1.88 trillion or 61% of the total market capitalization in Malaysia at the end of 2018. According to the Securities Commission of Malaysia, *Shariah* compliant stocks listed on Bursa Malaysia accounted for 77% of total securities covering both the main market and ACE market in May 2019. Given the significant demand of *Shariah* compliant products, the relevant authorities have established a standard classification for listed *Shariah* compliant stocks.

The study focused on the extent of influence that *Shariah* compliance has on a company's level of exchange rate exposure. Malaysian firms provide an excellent sample for the study due to its vast international trade activities and the significant growth potential of Islamic finance in the country. One main criteria for a firm to be recognized as being *Shariah* compliant is that the company must demonstrate minimal use of debt (debt over total asset <33%). Theoretically, under the international Fisher effect theory, there is a strong association between interest rate and exchange rate. A change in interest rate has a direct impact on exchange rate, thus highly geared firms (debt-dependent) should be more sensitive to exchange risk. Given this, we postulate that the level of exchange rate exposure faced by *Shariah* compliant firms should be less than non-*Shariah* compliant firms

In terms of specification, several past efforts in gauging exchange rate exposure in western and developed economies discovered lower level of exposure ([1],[3]). While several reasons of minimal exchange rate exposure are predominantly attributable to the widespread use of hedging practices by multinational, least studies have focused on the potential effect of time scales on exchange exposure measurement. Under financial risk management, there are short term and long term exchange risk. Past studies have ignored the potential bias of time scale as a majority of studies focused only on a single time series domain. Findings from a single time domain might be biased as the extent of exchange rate exposure might change across different time intervals and this has strong implications on the risk management routine of a firm. It is known that the financial market is very dynamic and contains heterogeneous market players with different expectations and investment horizons. Therefore, information on the multi-time dimensional exchange rate exposure is important for less informed risk managers to avoid incorrect judgment in risk management decision making. Different time horizons contain different levels of risk which require varied hedging strategies. Given this, there is a need to fragment a given single time domain series into a multi-scale series to produce timely and true level exchange risk for a specific time domain. The ability of the wavelet technique in unveiling multi-scale associations of various financial relationships motivates the study to adopt the same technique with greater emphasis put on currency risk. Further explanations on the wavelet technique used in the study will be explained in detail in the methodology section

The rest part of the paper is organized as follows; Part 2 provides literature review related to currency exposure for both developed and developing regions, Section 3 explains data and method used in the study, and Section 4 discusses the findings from the analysis. Part 5 summarizes the whole finding and explains gaps for future studies.

2 Literature Review

Any change in foreign currency value has a substantial effect on a firm's profitability and operations. The effect is much more prevalent for firms that have vigorous global networking covering sales, resources, subsidiaries, plants and operations Economic exposure focuses on unanticipated changes in the exchange rate to overall firm's cash flows. On the other hand, transaction exposure focuses on specific foreign contractual commitment which can be easily hedged using short term derivative tools such as currency forward, currency swaps, currency options and currency futures. Besides, it can be managed using money market hedge procedures by taking the offsetting position (foreign lending and borrowing) in the money market. Managing economic exposure is not as straightforward as managing transaction exposure. It covers the long term commitment of managing risk and requires strong operational strategies such as having diverse foreign subsidiaries, lead-lag strategy, cross hedging, and many more.

So far, several empirical works on currency exposure have been largely focused on developed economies. Most studies of western economies found that the level of exposure is small and regards this phenomenon as the currency puzzle. For instance, Jorion [3] only found a considerably small portion (5%) of U.S. firms being affected by changes in trade weighted index due to the widespread use of hedging activities, strong resources and economies of scale. For Malaysia, to date there is quite a number of studies conducted including [4] [5], [6] [7] [8],[9],[10]. Bacha *et al.* [4] embarked on a study which examined the effect of exchange regime switch on the level of exposure of listed Malaysian firms from 1990 till 2005. The study found that 71% of the sample firms were affected by exchange risk when the U.S. dollar became the major source of exposure. Furthermore, the study found minimal impact of *de facto* peg of the Malaysian Ringgit to the USD (at MYR3.80/USD) on the level of exchange risk. Abdul Wahab *et al.* [5] and Abdul Wahab [6] investigated the influence of financial derivative use on the level of exposure of selected Malaysian firms from 1993 till 2015. However these studies found insignificant impact of foreign currency derivative (FCD). These studies concluded that the use of financial derivatives as a means of risk management practice does not reduce the level of economic exposure. However FCD is very much useful for short term transactional exposure. Parsley and Popper [7] also examined the phenomenon in the Asia Pacific region using a considerably large sample of corporations from 1990 till 2002. The study discovered that Indonesian, Thai and Malaysian firms faced significant exposure. The study also discovered that most Asian firms were highly susceptible to changes in the USD. Chen and So [8] conducted an analysis on 129 multinational corporations in the Asia Pacific region. The study found that the level of exposure was more prevalent during the Asian Financial Crisis (AFC) compared to the pre-and post-AFC periods A recent study by Wan Suhaimi *et al.* [9] investigated the asymmetry property of exchange rate exposure of 207 non-financial firms from 2005 till 2016 in Malaysia. The study found that exposure was asymmetry in terms of sign of exposure where a large number of exposed firms exhibited negative exposure therefore highlighting the importing position of the sample firms. Using the same set of sample firms, Wan Suhaimi *et al.* [10] investigated the time variant nature of exchange rate exposure of Malaysian firms during the 1997 Asian Financial Crisis (AFC) and the 2007 Global Subprime Crisis (GSC). The study found that the 1997 AFC produced greater level of exposure than the 2007 GFC which signaled better market advancement and improved hedging practices after the AFC.

Shariah compliant firms (*SCF*) use minimal levels of debt to support their operations. In other words, the financing of *SCFs'* operational activities must be supported by equity-based financing. From here, it provides preliminary information that *SCFs'*level of exposure is hypothetically lower than non-*Shariah* compliant firms (*NSCF*). The strong relationship between exchange rate and interest rate is explained using the International Fisher effect (IFE) theory. The theory explicitly tells us that the exchange rate movement is aligned with interest rate differentials between two asset classes. Thus, we argue that firms which are highly dependent to debt as means of their operational financing are more prone to be significantly affected by exchange rate movement. However, this theoretical expectation requires further investigation as exchange rate movement can be influenced by many factors and not solely dependent on the level of debt used by firms.

3 Data and Methodology

3.1 Data

The study involved daily stock returns data on 24 food and beverage firms, along with daily FBM-KLCI market returns and daily exchange rates for four major trading currencies of Malaysia covering the United States Dollar (USD), the Euro (EUR), the Great British Pound (GBP) and the Japanese Yen (JPY). The study employed direct quotations for exchange rate prices where the foreign currency value is denominated in term of the Malaysian Ringgit (MYR). The data period chosen was July 2005 till August 2018 which provided a considerably large scale of information. The starting date of July 2005 was chosen because the Malaysian government had opted to abolish the *de facto* peg and allowed the currency to run under a managed floating system. The floating system allows it to avoid the tendency for multicollinearity problems, a common problem happens under the fixed system. All the data were extracted from the Thompson Reuters *Datastream* terminal.

Screening of *Shariah* compliance is ruled by the Syariah Advisory Council (SAC) under the auspices of the Securities Commission of Malaysia (SC). *Shariah* compliant firms need to consistently maintain the *Shariah* compliance standard in every aspect of their business operations because the SAC will regularly review the *Shariah* compliance status every year [11]. Certification of *Shariah* compliance can be further segregated into two categories which are business activities and financial position. In terms of business activities, it should be noted that the *Shariah* compliance status is evaluated at every single stage of business operation and supply chain. A firm is deemed to achieve *Shariah* compliance status when the business satisfies the 95% threshold of business activities (5% tolerance is allowed by the SAC). In terms of financial position, the *Shariah* compliance status was measured based on certain financial ratios which were (i) total interest-bearing debt over total assets and (ii) total interest generating asset over total assets. The tolerance level was bench marked at 33% and firms should produce lower than this ratio to be *Shariah* compliant.

3.2 Method

The novelty of the study lies upon the adoption of the wavelet technique to study the scaling properties of exchange rate exposure. The study is motivated to adopt the wavelet technique to address the specification bias of the homogeneity assumption conducted in previous studies. Accordingly, previous studies assumed that the extent of exchange risk exposure remains identical, therefore disregarding heterogeneity in investment holding periods. Specifically, the assumption of previous studies says that the time scale does not play any significant role in explaining exchange rate exposure where daily, weekly and monthly time domains will have the identical level of exchange risk. This assumption seems to be unrealistic since markets contain diverse market players with different expectations and holding periods. To overcome this, the wavelet analysis is used to decompose a given time series to a scale-by-scale basis. The study employed a special decomposition method namely the Maximal Overlap Discrete Wavelet Transformation (MODWT) to fragment the chosen series into wavelet scales. The benefit of using the wavelet analysis lies in the fact that it does not need to fulfill any specific distribution assumption and the technique provides ability to inspect the level of exposure following different time frequencies namely day-by-day, month-by-month and year-by-year. This information provides valuable information to market players as it reflects the varied decision-making time scales among investors [12]. For this study's case, the original returns series were decomposed into five wavelet crystals namely *d1* (2-4 days), *d2* (4-8 days), *d3* (8-16 days), *d4* (16-32 days) and *d5* (32-64 days). This study also highlighted the influence of *Shariah* compliance in the estimation by adopting sub-group analysis where sample firms were segregated based on their *Shariah* compliant status.

To avoid the non-stationary problem of trended stock prices (P_t), exchange rates (X_t:USD, EUR, GBP, JPY) and market index ($P_{m,t}$), the study transformed all the series through first level logarithmic differencing. All the series were converted into return series where stock return at time t is measured as $R_t = \ln(P_t/P_{t-1})$, market return at time $t, R_{m,t} = \ln(P_{m,t}/P_{mt-1})$ and exchange rate return at time $t, R_{X,t} = \ln(X_t/X_{t-1})$. Next, in order to realize multiscale exposure, the study applied a special class filter namely the Daubechies least asymmetric wavelet filter of length 8 [*LA(8)*] to produce wavelet scales. The study adopted a discrete time analysis because the data has finite length of duration and it provides more meaningful results. The decomposition of a given series into the unit of wavelet coefficients involved a father wavelet and a mother wavelet. The detailed part is called the mother wavelet (d_k) and the unit of smooth coefficients is called the father wavelet (s_k). The process of decomposition can be explained using the wavelet decomposition tree as shown in Figure 1.

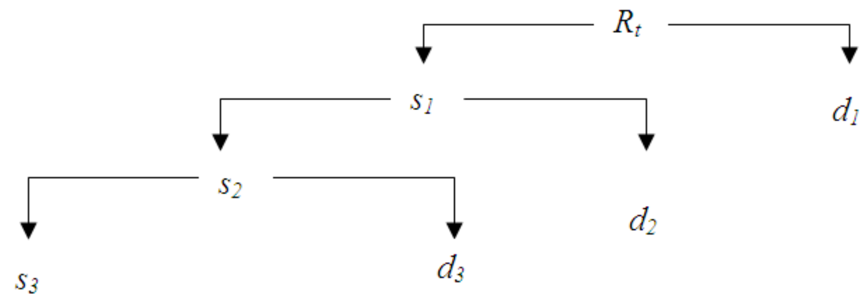

Figure 1: Wavelet Decomposition Tree

It should be noted that MODWT contains a zero phasing property which could generate more meaningful interpretation of timing for each wavelet scale. In other words, the decomposition process from the MODWT wavelet scale could perfectly align with the original time series without the need for down-sampling of the filtered output at each scale j. Accordingly, the original series of R_t contained low resolution information. The filtering process began at first scale $j = 1$ and the finer resolution functions of s_1 and d_1 were produced based on the Daubechies least asymmetric wavelet filter of length 8 [*LA(8)*]. As the filtering process proceeded to scale$j = 2$, finer resolution functions of s_2 and d_2 were produced. The process was repeated dependent on the number of maximum integer J such that 2^J is less than the total observations. As the exchange risk measurement provides meaningful interpretation for the monthly time horizon, the study chose a maximum scale of $J = 5$ (32-64 days) as recommended by Masih *et al.*[11]. To sum it up, orthogonal wavelet series approximation for a given series$R_t$is defined as the summation of father wavelet coefficients ($s_{J,k}$) and mother wavelet coefficients ($d_{j,k}$) as follows:

$$R_t \approx \sum_k s_{J,k}\phi_{J,k}(t) + \sum_k d_{J,k}\psi_{J,k}(t) + \sum_k d_{J-1,k}\psi_{J-1,k}(t) + \ldots + \sum_k d_{1,k}\psi_{1,k}(t), \quad (1)$$

where father wavelet-transformed coefficients and mother wavelet-transformed coefficients can be further defined as;

$$s_{J,k} \approx \int \phi_{J,k}(t) R_t dt, \quad (2)$$

$$d_{j,k} \approx \int \psi_{j,k}(t) R_t dt. \quad (3)$$

$\phi_{j,k}(t)$ and $\psi_{j,k}(t)$ can be further explained by the following equation

$$\phi_{j,k}(t) = 2^{-j/2}\phi\left(\frac{t-2^j k}{2^j}\right) \text{ for } j = 1 \text{ to } J, \quad (4)$$

$$\psi_{j,k}(t) = 2^{-j/2}\psi\left(\frac{t-2^j k}{2^j}\right) \text{ for } j = 1 \text{ to } J, \quad (5)$$

where

j represents the number of crystals/scales,
k denotes the number of coefficients,
$\phi_{j,k}(t)$ refers to father scaling function,
$\psi_{j,k}(t)$ refers to mother scaling function.

One should note that the term $2^{-j/2}$ in Equations (4) and (5) maintains the basic functions of $\phi(t)$ and $\psi(t)$ to be at 1. The shift or translation parameter is referred to the term $2^j k$. Any change in j and k ultimately changes the basic functions. For frequency partitioning, the scale factor 2^j plays a significant role where the greater j causes the scale factor 2^j to become larger and the scaling function $\phi_{j,k}(t)$ to become shorter and more spread out. The translation parameter $2^j k$ is matched with scale factor 2^j, implying that when $\phi_{j,k}(t)$ becomes larger, the translation step will be larger too. The father wavelet coefficient ($s_{J,k}$) represents the smooth component of the series (high scale) while mother wavelet coefficients ($d_{J,k}, d_{J-1,k}, d_{J-2,k} \ldots, d_{1,k}$) visualize detailed components of the series (low scale). Let us denote that

$$S_{J,k} = \sum_k s_{J,k} \phi_{J,k}(t), \tag{6}$$

$$D_{J,k} = \sum_k d_{J,k} \psi_{J,k}(t), \tag{7}$$

$$D_{j,k} = \sum_k d_{j,k} \psi_{j,k}(t) \text{ where } j = 1, 2, 3, \ldots, J-1. \tag{8}$$

Thus, Equation (1) above can be recomposed as the sum of the following

$$R_t = S_{J,k} + D_{J,k} + D_{J-1,k} + \ldots + D_{1,k}. \tag{9}$$

The recomposed equation (9) was produced by a special *Rstudio* library called *waveslim*. One should be noted that the transformation of a single time domain into multiple time-scale domains involved Equations (1) to (9) for one return series. The same procedure needed to be replicated for the other 24 stock return series, market return and exchange rate changes. The replication process involved a loop programming structure that repeated a sequence of instructions (Equations (1) to (9)) so that a time scale dependent return series could be generated for each time scale. Once all scale-dependent variables were produced for each time scale (j), all decomposed series were then regressed using the residual model of Jorion [3] to measure the extent of scale dependent betas (exchange rate exposure) using a time series regression model as follows:

$$R_t^j = a_t^j + \beta_M^j R_M^j + \beta_{USD}^j R_{USD}^j + \beta_{EUR}^j R_{EUR}^j + \beta_{GBP}^j R_{GBP}^j + \beta_{JPY}^j R_{JPY}^j + e_t^j \quad j = 1, 2, ..., 5. \tag{10}$$

Following Equation (10), the scale dependent beta coefficient for each exchange rate (X) can be estimated as follow:

$$\beta_X^j = \frac{cov(R_t^j, R_{X,t}^j)}{\sigma_X^2}. \tag{11}$$

Equation (10) estimates the β_X^j coefficient for all currencies by regressing the recomposed scale crystal j of individual stock return R_t^j on each recomposed scale crystal exchange rate return R_X^j and market return R_M^j. The relevance of time scale is dependent on the magnitude and the significance of beta exposure across time scale. The indifferent beta values across all scales infer the homogeneity of exposure between short-term and long-term investors. However, if the homogeneity assumption is violated, it then has significant impact on risk pricing. If the level of exposure is found greater under high scale (low frequency), it infers that long-term investment intervals entail greater risk premiums and should be compensated with greater returns. For robustness check, the study embedded GARCH(1,1) into the regression model to correct for any heteroscedasticity (non-constant error variance) problem as used in past studies ([4], [9], [10]). It was done to avoid losing too many degree of freedoms suffered under the higher order autoregressive conditional heteroscedasticity (ARCH) model. The GARCH(1,1) specification was embedded into Equation (10) once a regression was found to suffer a heteroscedasticity problem. The specification for GARCH(1,1) is as follows:

Mean equation:

$$R_t^j = a_t^j + \beta_M^j R_M^j + \beta_{USD}^j R_{USD}^j + \beta_{EUR}^j R_{EUR}^j + \beta_{GBP}^j R_{GBP}^j + \beta_{JPY}^j R_{JPY}^j + e_t^j \quad j = 1, 2, ..., 5.$$

GARCH(1,1) equation:

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e_{t-1}^2 + \upsilon_t, \tag{12}$$

where

α_0 is the intercept, α_1 and α_2 are parameters,

h_t is conditional variance at time, t,

e_{t-1}^2 stands for squared error term at time $t-1$,

υ_t denotes residual.

4 Results and Discussion

This part provides the results for the multiscale relationship between stock returns and exchange rate changes for both *SCF* and *NSCF*. The scaling coefficients (father wavelet) provide smooth behavior and the detailed coefficients (mother wavelet) represent deviations from the smooth coefficient. The estimated scaled-coefficients (positive and negative) and the percentage of exposed firms at 5% significance level are explained in Table 1. The coefficient β_X^j gauges the contribution of exchange rate changes (X) on individual stock returns R_t^j within a specific time scale j. Firstly, it is clearly observed that the mean beta exposure values changed non-monotically across time scales. Specifically, there is a gradual increase of beta coefficients from the low wavalet scale to the high wavalet scale for both *SCF* and *NSCF*. This implies that the long term horizon entails greater exchange risk compared to short term. This result violates the homogeneity assumption stated in previous studies and favours the multiscale tendency of exchange rate exposure. The enhanced level of exchange rate exposure in a lengthy time scale is expected under the context of relationship between risk and trading intervals as widened time intervals usually embrace greater risks compared to short term intervals. The increase of beta coefficients from low to high scale also suggests that the high frequency component (low scale of mother wavelet) has negligible impact on firm value compared to high variability of exchange rate movements within widened trading intervals.

Table 1: Multiscale Exchange Exposure of Food and Beverages Firms in Malaysia from July 2005 – August 2018

SCF/ NSCF	**Scale**	**USD**				**EUR**				**GBP**				**JPY**			
		f	**%**			**f**	**%**			**F**	**%**			**f**	**%**		
		{1}	**{2}**	**Mean Beta** (+)	**Mean Beta** (-)	**{3}**	**{4}**	**Mean Beta** (+)	**Mean Beta** (-)	**{5}**	**{6}**	**Mean Beta** (+)	**Mean Beta** (-)	**{7}**	**{8}**	**Mean Beta** (+)	**Mean Beta** (-)
SCF	**D1**	2	17%	0.2478	-0.1193	2	17%	0.0736	-0.1009	3	25%	0.1122	-0.0664	3	25%	0.0539	-0.0591
	D2	4	33%	0.1432	-0.0475	4	33%	0.0433	-0.2476	3	25%	0.1299	-0.0925	6	50%	0.0801	-0.1238
	D3	8	67%	0.2259	0.0000	7	58%	0.1588	-0.2089	5	42%	0.1322	-0.0869	10	83%	0.0571	-0.1718
	D4	8	67%	0.4413	-0.1216	7	58%	0.2356	-0.0987	10	83%	0.1412	-0.2283	5	42%	0.1025	-0.0969
	D5	8	67%	0.2594	-0.2449	10	83%	0.1852	-0.0754	5	42%	0.0665	-0.1824	6	50%	0.1010	-0.1153
	S5	9	75%	0.2212	-0.2776	10	83%	0.1781	-0.3946	7	58%	0.2694	-0.1172	8	67%	0.2889	-0.1286
NSCF	**D1**	2	17%	0.0910	-0.1390	1	8%	0.0863	-0.0875	2	17%	0.0736	-0.0878	4	33%	0.0414	-0.0803
	D2	1	8%	0.0559	-0.1264	4	33%	0.0679	-0.1045	2	17%	0.1067	-0.0682	5	42%	0.0570	-0.0707
	D3	9	75%	0.2090	-0.1732	8	67%	0.1616	-0.1009	6	50%	0.1030	-0.1736	7	58%	0.0865	-0.1375
	D4	10	83%	0.2783	-0.0973	8	67%	0.1645	-0.3745	8	67%	0.1555	-0.2732	8	67%	0.1529	-0.1203
	D5	6	50%	0.2825	-0.1693	10	83%	0.2909	-0.2175	8	67%	0.2746	-0.1586	9	75%	0.0786	-0.1581
	S5	8	67%	0.1828	-0.2650	8	67%	0.1145	-0.1975	7	58%	0.2559	-0.1035	9	75%	0.0855	-0.1990
t-stat				1.3116	0.5294			-0.041	-0.1087			0.4429	0.3789			0.7705	0.4716
Prob.				0.2190	0.6109			0.9681	0.9156			0.6673	0.7127			0.4662	0.6484

Table 2: Foreign Exchange Exposure of Food and Beverages Firms in Malaysia (OLS with GARCH(1,1) Specification)

SCF/ NSCF	**Scale**	**USD**				**EUR**	**GBP**							**JPY**			
		f	**%**			**f**	**%**			**F**	**%**			**f**	**%**		
		{1}	**{2}**	**Mean Beta** (+)	**Mean Beta (-)**	**{3}**	**{4}**	**Mean Beta** (+)	**Mean Beta (-)**	**{5}**	**{6}**	**Mean Beta** (+)	**Mean Beta (-)**	**{7}**	**{8}**	**Mean Beta** (+)	**Mean Beta (-)**
SCF	**D1**	2	17%	0.2478	-0.1193	2	17%	0.0736	-0.1009	3	25%	0.1122	-0.0664	3	25%	0.0539	-0.0591
	D2	3	25%	0.0966	-0.0277	3	25%	0.0433	-0.2476	3	25%	0.1299	-0.0925	4	33%	0.0801	-0.1238
	D3	8	67%	0.2040	0.0000	7	58%	0.1588	-0.2089	5	42%	0.1322	-0.0869	10	83%	0.0571	-0.1718
	D4	7	58%	0.3764	-0.1033	8	67%	0.2356	-0.0987	10	83%	0.1412	-0.2283	5	42%	0.1025	-0.0969
	D5	8	67%	0.2282	-0.2449	10	83%	0.1852	-0.0754	8	67%	0.0665	-0.1824	7	58%	0.1010	-0.1153
	S5	12	100%	0.3403	-0.1992	11	92%	0.1781	-0.3946	11	92%	0.2694	-0.1172	12	100%	0.2889	-0.1286
NSCF	**D1**	2	17%	0.0910	-0.1390	1	8%	0.0863	-0.0875	2	17%	0.0736	-0.0878	4	33%	0.0414	-0.0803
	D2	1	8%	0.0559	-0.1264	4	33%	0.0679	-0.1045	2	17%	0.1067	-0.0682	5	42%	0.0570	-0.0707
	D3	9	75%	0.2090	-0.1732	8	67%	0.1616	-0.1009	6	50%	0.1030	-0.1736	7	58%	0.0866	-0.1375
	D4	10	83%	0.2792	-0.0973	9	75%	0.1611	-0.3745	9	75%	0.1858	-0.2444	8	67%	0.1529	-0.1180
	D5	10	83%	0.3382	-0.2216	10	83%	0.1948	-0.2676	9	75%	0.2410	-0.0889	9	75%	0.0821	-0.1551
	S5	12	100%	0.1727	-0.2719	12	100%	0.1625	-0.4186	12	100%	0.1827	-0.1372	12	100%	0.2651	-0.2195

Secondly, a more interesting result appeared from observing the statistical significance of currency where in general, all currencies exhibited high levels of firm exposure to currency changes (>50% of exposed firms) at the high scale. The results of the multiscale tendency of mean beta coefficients and significance of betas stress the fact that the exchange risk is highly concentrated in higher wavelet scales compared to lower scales. Besides that, the prevalence of exchange risk of all currencies is driven by the fact that all sample countries are major trading partners of Malaysia for food and beverage products and services. Thirdly, in terms of *Shariah* compliance, it appears that the level of exposure was found to be mixed between *Shariah* compliant firms (*SCF*) and non-*Shariah* compliant firms (*NSCF*) across all scales. To stress on the findings, the study conducted an independent two-tailed t-test to compare the mean of exposure between *SCF* and *NSCF*. Based on the large p-values of t-test results shown at the bottom of Table 1, there is an insignificant difference of exposure between the two groups across all currencies. It seems that *Shariah* compliance has a negligible influence on the level of exposure. This finding has strong implication based on several reasonings. First, it is argued that the risk management routine by both *SCF* and *NSCF* is not significantly different. *SCFs* also apply financial hedging, especially in the use of currency derivatives. These activities are permissible by Islamic jurists as long as there are no profit-seeking activities from the derivatives. Secondly, although *SCFs* do not subscribe to debt in operations, the profit rate from financing activities is nonetheless benchmarked to the KLIBOR. Perhaps, the law of one price prevails where two classes of assets contain identical levels of exchange risk.

To ensure consistency of the findings, the researcher re-run the multiscale regression by embedding the GARCH(1,1) specification into the estimation. The GARCH(1,1) was ran when an individual estimated regression was found to suffer from a heteroscedasticity problem for each time scale. Equation (10) was re-run where the standard error followed the GARCH(1,1) specification as stated in Equation (12). The estimated regression with GARCH(1,1) results are shown in Table 2. It was found that there is little influence of *Shariah* compliance status on the level of exposure. The results displayed in Table 2 are consistent with results in Table 1, making the results robust and reliable. The study also provides graphical representation of exchange rate exposure across time scales for both *SCF* and *NSCF* in Figures 2(a) to 2(d). It could be seen that there are gradual increases in positive exposure from *D1* to *D5* for *SCF* in Figure 2(a), and the same fashion is exhibited by *NSCF* in Figure 2(b). In terms of negative exposure, on average it could be seen that the *SCF* and *NSCF* share almost identical patterns where the level of exposure decreased from the low scale to high scale in Figures 2(c) and 2(d). As a conclusion, visual inspection of Figures 2(a) to 2(d) corroborates the findings in Tables 1 and 2, therefore reaching the same conclusion that the level of exchange risk expands as the time scale increases.

5 Concluding Remarks

The main purpose of the study is to investigate whether the level of currency exposure of *Shariah* compliant firms (*SCF*) and non-*Shariah* compliant firms (*NSCF*) holds over different time scales. Based on the findings, it seems that the *Shariah* compliance status has minimal influence in determining the level of currency exposure for the overall period. It could be concluded that both assets (*SCF* and *NSCF*) share almost identical exchange risk profile, therefore supporting the law of one price. Additionally, there is no basis to expect that the

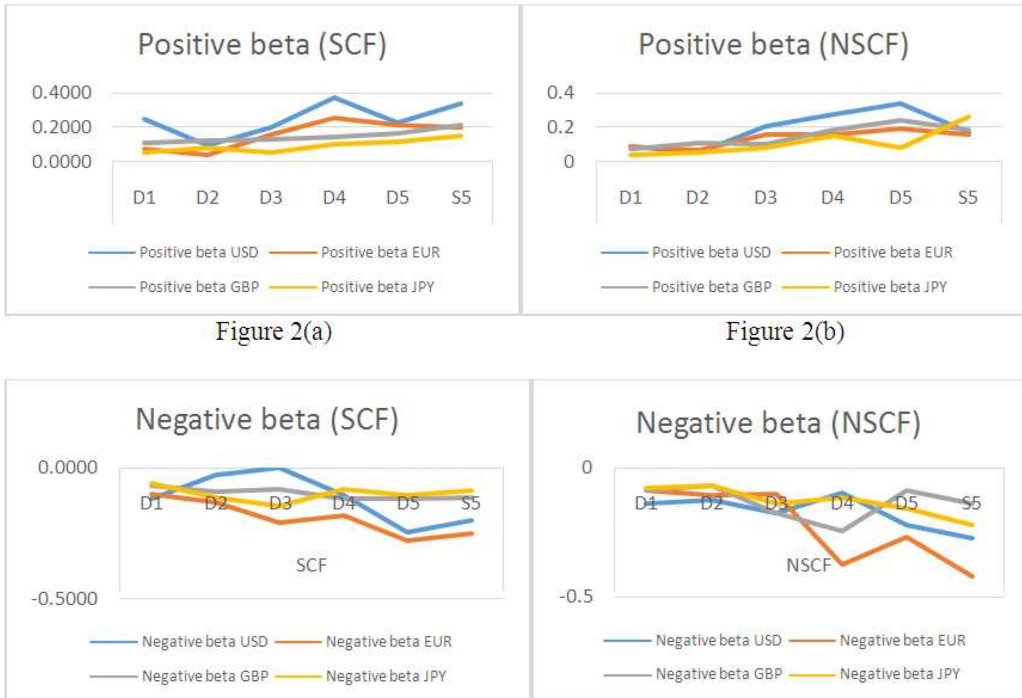

Figure 2(a) Figure 2(b)

Figure 2(c) Figure 2(d)

Figure 2: Trend of Multiscale Exchange Rate Exposure for SCF and NSCF

exchange risk management routine of *SCF* would be different than *NSCF*. Therefore, the extent of exchange risk should be examined from other aspects such as trade activities, business profiles, hedging routines and macroeconomic conditions. In terms of scaling the property of exchange rate exposure, the MODWT method had successfully showed that there was non-monotonic change in the exchange rate exposure across different wavelet scales. Specifically, the wavelet results showed that the incidence of exposure is concentrated at the higher scale for both groups, indicating that long holding investment periods entail greater exchange risk. For optimal hedging, firm managers should devote vigorous risk management strategies to mitigate exchange risk under higher time scales. Since the study is limited to a single sector i.e., food and beverage, it is suggested that future studies should embark on testing the incidence of multiscale exchange rate exposure in other economic sectors so that more generalized results could be generated for future reference.

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