Are investments in islamic REITs susceptible to forex uncertainty: wavelet analysis

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Are investments in islamic REITs susceptible to forex uncertainty: wavelet analysis?

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Abstract

Since its debut into the islamic capital markets landscape in 2005, islamic Real Estate Investment Trusts (REITs) have not shown significant progress in attracting foreign investment, limiting their potential as the ideal asset class for the Shariah compliant investor. It was suggested that a stronger local currency (Ringgit Malaysia) would encourage foreign investors to acquire Malaysian REITs as a hedge against the rising inflation that follows economic growth. This paper aims to examine the relationship between Islamic Malaysian REITs (islamic MREITs) returns and foreign exchange fluctuations. We apply the Maximum Overlap Discrete Wavelet Transform (MODWT), using wavelet function of *symmlet 8*, as well as the wavelet coherency based on Continuous Wavelet Transform (CWT) to understand the relationships sought in time dimension as well as frequency dimension. Our contribution includes a fresh perspective on the under-researched islamic REITs class of assets, as well as a multi-scale analysis of their relationship with foreign exchange movements. Our findings show that forex returns is not significantly related to the islamic REITs' returns, even though results show that it is significantly related to the REITs market index return. However, a fundamental long term relationship between islamic REITs and the foreign exchange does exist. There is evidence that the MREIT market leads the forex for a short period during the crisis recovery. Ultimately, the islamic REITs are not susceptible to forex uncertainty, implying that REIT managers need to enhance investment interests by other means.

Keywords: MODWT, REIT, i-REIT, MREIT, foreign exchange (forex), frequency, wavelet, correlation, coherence, lead-lag, contagion.

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1. Introduction

Listed Real Estate Investment Trusts (REITs) are particularly popular with fund managers and investors for their liquidity, transparency and transaction cost advantages. In an islamic investment portfolio, real estate is a favourable tangible class of assets that not only meets shariah compliance, but also hedges inflation. The offering of islamic Real Estate Investment Trust (Islamic REIT) marked an enhancement to the choice of islamic capital market products, together with the availability of Shariah approved securities, sukuks, Islamic unit trusts, Shariah indices, warrants, crude palm oil (CPO) futures.

Riding on the growth momentum of Islamic Finance, particularly in the Islamic Wealth Management sector, Malaysia was on the forefront to issue a set of guidelines for Islamic Real Estate Investment Trusts (Islamic REITs) in November 2005. These guidelines were part of the efforts to attract foreign investors into Malayisia particularly from the Middle East, flushed with liquidity after the oil price rise in 2004 and 2005. *Al'Aqar KPJ REIT* (Al 'Aqar), was the first islamic REIT to be publicly traded in the world, listed 9 August 2006. This was followed by the listing of *Al-Hadharah Boustead REIT* (Al Hadharah)*,* the first islamic plantation-based REIT, on 7 February 2007. Axis-REIT, which had been listed since 3 August 2005, became the first islamic office/industrial REIT when it was reclassified as Shariah compliant in December 2008.

Although the returns of Malaysian Real Estate Investment Trust (MREITs) are known to yield two or three times better returns compared to fixed deposit rates, it has been noted that the slow growth of MREITs is attributable to poor attraction from foreign investors.[1] Fund managers have cited the following issues as impediments to their growth: regulatory restrictions, lack of tax incentives for REITs players, lack of strata titles on commercial properties in prime locations, lack of quality REIT experts and advisors to these trusts.[2]

In defense to the claims above, from the Malaysian government's perspective, there has been many attractive features to entice foreign investors into the Malaysian REITs

[1]Based on media interviews with the Datuk Steward LaBrooy, CEO of Axis REIT and Chairman of Malaysian REIT Managers Association held 1st and 14th November, 2012.

[2] The Star, 28 July 2010.

market. The Property Sector highlights of the Malaysian Budget 2012 proposed a concessionary tax rate on dividends of non-corporate institutional and individual investors in REITs which had been effective up to 31 December 2011, to be extended for another five years from 1 January 2012 until 31 December 2016, in order to attract foreign and domestic investment.[3] As an added attraction, Budget 2008 proposed to allow foreign investors to increase their equity ownership in a REIT management company up to 70% (previously 49%). A prior incentive for REITs and Property Trust Funds (PTFs) in Malaysia was that no balancing charge or balancing allowance to be made to companies in respect of the disposal of buildings which qualify for Industrial Building Allowance (IBA) (Budget 2008).[4] Under the enhanced tax transparency system announced in Budget 2007, REIT is exempted from paying income tax if it distributes at least 90% of its income to investors.

The anticipated enhanced foreign participation with the above attractions was meant to increase competition and hence, bolster activity and efficiency within the industry. However, compared to others in region, including Singapore, MREITs are largely held by local institutions and has low foreign and retail participation. This is especially so in the islamic REITs. **Al'Aqar**'s foreign investment is currently only 3% of direct and 6.7% of indirect holdings, although at a market value of RM1.36 billion and yielding an average of 5.778%, it boasts of owning 23 healthcare centres including those in Indonesia and Australia.[5]**Al Hadharah**, on the other hand, has investment properties of RM1.3 billion, yielding an average of 5.263% to investors, and consisting of 12 oil palm plantations and 3 palm oil mills in Malaysia with a combined hectarage of 20,000 hectares (ha), but still records foreign holdings of less than 1%.[6]

In April 2010, real estate sector publication stated that the combined effect of a stronger Malaysian currency (RM) and rising inflation were pushing Malaysian REITs (MREITs) into the investment limelight and prompting anticipation of trading at higher prices, closer

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[3] Budget 2007 had announced a reduction of withholding tax for foreign investors to 20% from the previous 28% for five years (Treasury Malaysia, 2006).

[4]In such a disposal, the controlled transfer provisions would apply. As such, the REITs or PTFs are only eligible to claim IBA on the remaining tax written down value of the building.

[5]Al'Aqar Annual Report 2012 and *mreit.reitdata.com*

[6] Al Hadharah Annual Report 2012 and *mreit.reitdata.com*

to their net asset values (NAV) higher within the year. The implication made is that a stronger Ringgit Malaysia (RM) would encourage foreign invesors to acquire local REITs, a 'defensive' asset class deemed as a hedge against rising inflation which parallels a momentum in economic growth.[7]

This paper therefore seeks to study whether the low foreign investment is related to the exchange rate volatility in Malaysia. It aims to look at the returns of MREITs, with a special focus on the islamic REITS, Al'Aqar and Al Hadharah, and their relationship with the foreign exchange of Malaysia (Malaysian Ringgit to USD) at different timescales, from the daily data of 8 February 2007 to 31 December 2012. These islamic MREITs are compared to a well established conventional MREIT, namely Starhill REIT (Starhill), which has been trading in the market since December 2005, as well as the S&P Malaysian REIT index. To achieve our objective, we apply the Maximum Overlap Discrete Wavelet Transform (MODWT), using wavelet function of *symmlet 8*, to decompose the daily MREIT returns, exchange rate returns and market index returns and then recompose each scale (frequency) back into the time domain. We then regress the recomposed series of the individual REIT returns on each recomposed series of the exchange rate returns and market index returns, at each of the time scale.

In association to the above, we aim to see where there is a lead-lag relationship between the Malaysian REITs market and the Malaysian currency exchange, identifying the period and at which time frequency, of such relationship, if any. This is done by applying the MODWT based wavelet cross correlation technique, where the lead-lag can be analyzed on a scale-by-scale basis.

Finally, we seek to discern if any contagion effects exist between any of the MREITs with respect to the foreign exchange measure, as well as between the MREIT market to the local forex.

The contribution of this research is two-fold: we add a fresh perspective on the literature on a relatively new class of assets, namely the islamic REITs, AND we offer a multi-

[7]Theedgeproperty.com dated 10 April, 2010.

scale time period analysis of the relationship between Malaysian REITs returns and foreign exchange movements.

The OLS regression of the recomposed MREIT return series show that forex is not significantly related to the islamic REITs, even though it is significant to the REITs market index. However, a fundamental long term relationship between these islamic REITs and the foreign exchange does exist, revealed by the wavelet coherency methodology. There is evidence that the MREIT market leads the forex for a short period during the crisis recovery. Ultimately, the islamic REITs are not susceptible to forex uncertainty.

We have organized the rest of this paper as follows: Section 2 gives the literature review of studies related to REITs, particularly in the Asia Pacific region and relevant features in the Islamic markets. Section 3 explains the data and various wavelet techniques applied to achieve the three objectives above. Section 4 discuss the empirical results including the implications made from them. Section 5 finally concludes the findings and study.

2. Literature review

In the UK context, Cheong et al (2010) found that finance industry volatility led market volatility, and specifically identified the real estate sector to be a key source of this causal relationship. Most significantly, they discovered that the REITs subsector of the real estate industry volatility was the one that had the strongest uni-directional relationship with market-wide volatility over their 20-year sample period, driving the finance industry volatility during the global financial crisis (GFC). Milunovich and Truck (2012) studied the contagion effects between REITs and local, regional and global equity markets over the period 2004-2011 and compared results of the whole sample period with the GFC period. In contrary to Chong et al (2010), they found no contagion effects between stock and securitized real estate markets in Australian, Japanese and UK real estate markets during the GFC period.

In relation to our study, Ling et al (2003) examined whether REIT capital flows impact REIT prices and returns and whether the effect is temporary or permanent. Using the validity of the price pressure hypothesis and the permanent change in the cost of capital hypotheses with regards to securitized commercial real estate market, they studied the influence of REIT returns on capital flows into the REIT sector in the United States with a particular interest in the results pre and post 1992.[8] They found evidence that REIT equity flows were significantly positively related to the prior quarter's flows and negatively related to flows from two quarters earlier. These results imply that REIT investors may also possess herd mentality and follow momentum-trading strategies (Ling et al, 2003).

In the study made by Liu et al (2012) on the economic factors linking REIT market in the USA and Asia Pacific countries, they found no impact of currency hedging on REITs markets; when returns were switched from US denomination to local currency denomination, there was no substantial change in the time dynamics of the correlations between the markets.

When it comes to investment assets, many have researched about portfolio performance and diversification. This is no different for REITs. Comparisons between normal and crisis period performances of REITs are researched quite extensively. Boon et al (2012) analyzed Malaysian REIT performances before, during and after the 2008 financial crisis, comparing the conventional and islamic REITs. Over the period 2005-2010, the average return for all islamic REITs had under-performed the market portfolio (Boon et al, 2012). Chiang et al (2010) compared the relationship between REITs and the stock markets in four Asian markets and empirically proved that REITs are not as defensive as they are in times of stable markets, implying them not to be a good shelter during financial chaos. Outside of the region, research by Cheong et al (2010) and Milunovich et al (2012), as mentioned in Section 2 above, gave inconsistent results about the contagion effects of REITs and equity markets in the UK during the GFC. Heaney and Sriananthakumar's (2012) study on Australian real estate asset classes showed high correlations with the stock market during the GFC but no evident of the same during the Wall Street Crash of 1987.

[8] The creation of the UPREIT (umbrella partnership REIT) structure in November 1992, contributed to the boom in REITs during 1993 and 1994, along with several other regulatory and economic factors. The REIT IPOs boom peaked in 4Q1993with $5.6 billion in initial equity offerings, marking the beginning of the "modern" REIT era. (Ling et al, 2003)

Hence, to the author's knowledge, other than the limited few, such as Boon et al (2012) and Ting and M. Noor (2007) among others, there is insufficient research works on islamic REITs. Ting and M.Noor (2007) examined the special Shariah-compliant features of Islamic REITs with emphasis on the Al'Aqar and Al Hadharabah, without any empirical study.

In terms of methodology, Tsai and Chiang (2012) used the threshold error correction model to examine the relationship for real estate investment trusts (REITs) and stock, and their asymmetric adjustment behaviors in six Asian/Pacific financial markets. Their results showed significant lead-lag relationship and that previous information about stocks predicted changes in the REITs in all the Asian/Pacific markets. Liu et al (2012) applied the dynamic correlation coefficient (DCC) MGARCH model to study the time-varying correlations between REIT markets. Zhou (2013) compared five methods to find the best model to estimate β for REITs - the rolling regression, the DCC-GARCH model, the Schwert and Seguin model, the state space model, and the Markov switching model - and found the state space method to generate beta forecasts significantly more accurate than its competitors.

The usage of wavelet technology in finance have been widely explored especially in analyses related to the stock markets, and mutual funds but not many (in our limited knowledge) in the research of REITs. In & Kim (2006c, 2007), In et al. (2008) and Kim & In (2005, 2006, 2007) have all explored multi-scales correlation between different assets using the wavelet variance, wavelet correlation and cross-correlation. Using the MODWT estimator of the wavelet correlation, Kim & In (2005) explored the relationship between stock markets and inflation, concluding with a positive relationship between stock returns and inflation on a scale of one month and on a scale of 128 months, and a negative relationship between these time scales. In their study on the cross-correlation relationship between stock and futures markets, In & Kim's (2006c) findings based on the MODWT methodology suggest increasing correlation between assets as time scale increases. Similarly, Kim & In (2007) examined the relationship between stock prices and bond yields in the G7 countries, and showed that the correlation between changes in stock prices and bond yields can differ from one country to another and varies with different time scales.

Some researches have applied wavelet to discuss the behaviour of foreign exchange[9] - the non-stationary nature of foreign exchange rate series (Ramsey and Zhang, 1997), the differing foreign exchange volatility across different time zones (Gencay, Selcuk and Whitcher, 2001b), the multiresolution nature of foreign exchange in Asia (Karuppiaha and Los, 2005). Nikkinen et al (2010) applied wavelet cross-correlation techniques to analyze linkages in currency options on the euro, Japanese yen, and British pound *vis-à-vis* the U.S. dollar. Their results indicate that the expectations about the JPY/USD rate are virtually unrelated to the developments of the European currencies, while the higher-order moments of the EUR/USD and GBP/USD densities appear strongly linked with each other.

3. Methodology

The objective of this paper is to examine the relationship between Islamic Malaysian REITs (islamic MREITs) returns and foreign exchange fluctuations. In particular, three MREIT funds are examined to see whether there is a relationship between their returns and the exchange rates. Two of the MREITs are islamic REITs and the third is a well established conventional MREIT included here as a benchmark. This paper applies the Maximum Overlap Discrete Wavelet Transform (MODWT), using the wavelet function of *symmlet 8*, to decompose three variables non-decimated orthogonal components into 6 different timescales: the daily MREIT returns, exchange rates and market index returns.

3.1Data

Data used are daily price index of individual Malaysian REITs as well as Standard & Poor Malaysia REIT price index, all of which were retreived from Datastream. Exchange rates data is represented by the Bank Negara Malaysia's rate of exchange from Malaysian Ringgit to US Dollar, whilst market benchmarks are obtained from FTSE Bursa Malaysia Emas Shariah Price Index and FTSE Bursa Malaysia KLCI Price Index.

After considering the commencement dates of each of the different islamic MREITs, the date of study was chosen to be 8 February 2007, the listing date of Al Hadharah. As Axis REIT only became Shariah compliant on December 2008, it was decided to leave this

[9] Cited by Masih, Alzhrani and Al-Titi (2010)

islamic MREIT out of the analysis. Hence, the length of the study is from 8 February 2007 to 31 December2012, with 1539 observation points. Starhill REIT is used to represent the conventional MREITs as it was the first REIT to be listed in Malaysia, with diversified assets based on hotel, retail and apartment buildings worth RM1.6 billion.[10] (AR 2012).

To avoid sampling bias, we calculated daily return series (R) for each MREIT price series and MREIT price index (P), as follows:

$R_{it} = \ln (P_{it} / P_{it-1})$ for MREIT i at day t (1)

The same basis is used to calculate daily return on the market (M), both the EMAS and KLCI price indices (X), as follows:

$M_{it} = \ln (X_{it} / X_{it-1})$ for price index i at day t (2)

3.2Maximum Overlap Discrete Wavelet Technique (MODWT)[11]

In many studies, exclusive analyses is performed in the time-domain, whereas the frequency domain is simply ignored. However, there may be interesting relationships to be discovered at different frequencies: investment assets may be highly volatile at high or medium frequencies, whereas in the long run (i.e. lower frequencies), it is the market that drives asset movements.

After calculating the return series for each of the three REITs and the MREIT index, we use wavelet analysis to separate each of the return series into its constituent multiresolution (multihorizon) components. For this we apply the MODWT on the daily return series by sampling the return series at evenly-spaced points in time. We transform the return series from time domain into scale (interval) domain in order to understand the frequency at which the activity in the time series occurs. In our study, we sample the daily return series at different scale crystals (j) as follows: d1 (2-4 days), d2 (4-8 days) days, d3 (8-16 days), d4 (16-32 days), d5 (32-64 days), d6 (64-128 days) and s6 (>128 days).

[10]Starhill REIT Annual Report 2012.

[11]The description of MODWT is substantially drawn from Masih et al (2009) and Norsworthy et al (2000).

We use non-decimated orthogonal MODWT with *symmlet 8* as a wavelet function to obtain a multi-scale decomposition of the return series. The MODWT will be used with the advantage on the flexibility of the length of data (not requiring the integral power of two) as well as time invariant property. The wavelet family *symmlet 8* is chosen to get the least asymmetry property which is more appropriate for financial series. The transformed return series *r(t)* is represented as a linear combination of wavelet functions as follows:

$$r(t) \approx \sum_k s_{J,k}\phi_{J,k}(t) + \sum_k d_{J,k}\psi_{J,k}(t) + \sum_k d_{J-1,k}\psi_{J-1,k}(t) + \dots \sum_k d_{1,k}\psi_{1,k}(t) \quad (3)$$

where:

j is the number of scale crystals (intervals or frequencies)
k is the number of coefficients in the specified component

$\phi_{j,k(t)}$ and $\psi_{j,k(t)}$ are the father and mother orthogonal wavelet pair that are given respectively by

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

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

Father wavelets represent the low-frequency (smooth) parts of the series, whereas mother wavelets represent the high-frequency (detailed) parts of the series. $s_{j,k}$ and $d_{j,k}$ are wavelet coefficients that are approximated by the following integrals:

$$s_{J,k} \approx \int \phi_{J,k}(t) f(t) dt \quad (6)$$

$$d_{j,k} \approx \int \psi_{j,k}(t) f(t) dt \quad (7)$$

$s_{J,k}$ are called the ‘smooth’ coefficients that represent the underlying smooth behavior of the series, while $d_{j,k}$ are called the ‘detail’ coefficients that represent the scale deviations from the smooth process. These coefficients are measures of the contribution of the corresponding wavelet function to the total series.

After we decompose the return series into j crystals, the crystals d_j are recomposed into a time domain. The entire return series is replicated in multi-resolution decomposition as follows:

$$\hat{r}^J = D_1 + \ldots\ldots + D_J + S_J \qquad (8)$$

where D_j is the recomposed series in the time domain from the crystal d_j and S_J is the recomposition of the residue. The reconstituted return series $r^{\ J}$ contain the separate components of the original series at each frequency j. D_j represent the contribution of frequency j to the original series.

In this study, six crystals were extracted for each of the three individual MREIT return series and the MREIT index return series as well as the foreign exchange series and S&P market index returns (KLCI and Syariah EMAS). To see the contribution of crystal d_j for series r_i, the series is first transformed (decomposed) from the time to the frequency domain, then the d_j is reconstituted (recomposed) into the time domain. The resulting series in the time domain is the contribution of frequency j to the original series or the component of r_i that has frequency j, a contribution in the literal sense of equation (8).

After obtaining the recomposed series for each frequency, we run an OLS regression of each crystal (j) of MREIT on each recomposed crystal of the exchange rate, FX^j and market index M^j:

$$R_i = \alpha^{ji} + \beta^{ji1} FX^j + \beta^{ji2} M^j + \varepsilon^{ji}$$

$$= \alpha^{ji} + \beta^{ji1} D_{1j} + \beta^{ji2} D_2^j + \varepsilon^{ji} \qquad \text{for } j = 1 \text{ to } 6 \qquad (9)$$

The coefficient $\beta^{\ ji}$ is the key variable we are trying to examine. If $\beta^{\ ji}$ is essentially similar across scales j, then beta does not have any multiscale nature embedded in it i.e. there is no reason to believe that beta calculated using daily return to be different from beta calculated using weekly or monthly returns. However if β^{ji} changes across scales j, then beta is multiscale and hence return interval cannot be arbitrarily chosen.

3.3 Wavelet Cross Correlation

The estimators of wavelet cross correlation are constructed using the MODWT. Wavelet cross correlation analysis, may be used to determine the lead/lag relationship between two time series on a scale-by-scale basis.

The cross wavelet transform (XWT) of two time-series x and y is defined as $W^{XY}=W^{X}W^{Y*}$ where W^{X} and W^{Y} are the wavelet transforms of x and y, respectively, and * denotes complex conjugation. We further define the cros-wavelet power as □W^{XY}□.

The complex argument arg(W^{X}y) can be interpreted as the local relative phase between x_n and y_n in time frequency space. The theoretical distribution of the cross wavelet power of two time series with background power spectra is given in Torrence and Compo (1998). Therefore, the wavelet power spectrum can be interpreted as depicting the local variance of a time series, while cross-wavelet power of two times series depicts the local covariance between these series at each scale or frequency.

In our study, we examine the lead-lag relationship for different time periods of the MREITs index return with the foreign exchange movement. The daily return series are shown at five levels of time scales: 2-4, 4-8, 8-16, 16-32 and 32-64 days. These are depicted in the graphs of Figure 1, and explained in the next section. If the curve is significant to the right side of the graph (in other words, wavelet cross-correlation skewed to the right), it means that the foreign exchange (FX) is leading the MREIT index; skewed to left would mean the opposite. If both the 95% confidence levels are above the horizontal axes, it is considered as significant positive wavelet cross-correlation; if both the 95% confidence levels are below the horizontal axes, it is considered a significant negative wavelet cross-correlation.

3.4 Continuous Wavelet Transform (CWT) and Wavelet Coherency (WTC)[12]

The continuous wavelet transform (CWT), with respect to the ‘mother wavelet’ *Φ* *,* is a function $W_x\,(s,\tau)$ that provides wavelet coefficients, defined as

$$W_x(s,\tau) = \int_{-\infty}^{+\infty} x(t)\frac{1}{\sqrt{s}}\phi^*\left(\frac{t-\tau}{s}\right)\mathrm{d}t \qquad (10)$$

where * denotes the complex conjugate form. The mother wavelet *Φ(.)* as a prototype for generating other window functions. The term translation, τ, refers to the location of the window (indicating where it is centered). As the window shifts through the signal, the time information in the transform domain is obtained. The term scaling, *s*, refers to dilating (if □s□> 1) or compressing (if □s□< 1) the wavelet (controls the length of the wavelet by extracting frequency information from the time series). The mother wavelet is dilated or compressed to correspond to cycles of different frequencies. In this way an entire set of wavelets can be venerated from a single mother wavelet function and this set can then be used to analyze the time series.

Wavelet transforms perform what is called time-frequency analysis of signals, being able to estimate the spectral characteristics of signals as a function of time. Therefore, it can provide not only the time-varying power spectrum but also the phase spectrum needed for computation of coherence. The proviso is that this correlation may not be contemporaneous, but may involve a lead or a lag, being the magnitude measured by the phase lead.

Coherence is very important when dealing with fluctuating quantities, indicating how closely *X* and *Y* are related by a linear transformation. Coherence is like a correlation measure that indicates how strongly the two variables are related at business cycle frequencies. It ranges from 0 (no correlation; completely incoherent) to 1 (perfect correlation; completely coherent).

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[12] The description of CWT and WTC are largely drawn from Tiwari et al (2013) and Madaleno et al (2012).

Wavelet Coherency (WTC) can be 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 correlation, both in time and frequency, between two time series. Thus, WTC near one shows a high similarity between the time series, while coherency near zero shows no relationship.

In our paper, we use the wavelet coherence which measures local correlation of two time series in time-frequency domain. First, we briefly define the continuous wavelet transform, followed by the wavelet coherence. The continuous wavelet transform (CWT) $W_x(u,s)$ is obtained by projecting a mother wavelet $\Psi(.)$ onto the examined time series

$$x(t) \in L^2(\mathbb{R}) : W_x(u,s) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{s}} \psi\left(\frac{t-u}{s}\right) dt, \text{ where } 1/\sqrt{s}$$

denotes a normalization, *u* is a location parameter and *s* is a scale parameter.

Wavelet coherence could be defined the as the squared absolute value of the smoothed cross wavelet spectra, $W_{xy}(u,s)$, normalized by the product of the smoothed individual wavelet power spectra of each series i.e.,

$$R^2(u,s) = \frac{|S(s^{-1}W_{xy}(u,s))|^2}{S(s^{-1}|W_x(u,s)|^2)S(s^{-1}|W_y(u,s)|^2)},$$

where *S* is a smoothing operator. The squared wavelet coherency coefficient is in the range $0 \leq R^2(u, s) \leq 1$, values close to zero indicates weak correlation, while values close to one are evidence of strong correlation. A high wavelet coherence between two assets at the lower time scales tends to indicate contagion, whilst a high wavelet coherence at higher time scales tends to indicate a fundamental theoretical relationship between assets. Thus it provides useful tool for analysis of comovement across the financial markets. The phase difference, indicated by arrows, gives us details about delays of oscillation of the two examined time series. Arrows pointing to the right (left) when the time series are in-phase (anti-phase) or are positively (negatively) correlated. Arrow pointing up means that the first time series leads the second one, arrow pointing down indicates that the second time series leads the first one.

4. Results and policy implications

4.1Relationship between MREIT returns and the Malaysian exchange rate

The first objective of this paper is to study the relationship between MREITs returns and the Malaysian exchange rate (RM to USD), with a special focus on the islamic MREITs, Al'Aqar (ALQR) and Al Hadharah (AHBR), where the market index returns play the control variable role. To achieve this objective, we apply the Maximum Overlap Discrete Wavelet Transform (MODWT), using wavelet function of *symmlet 8*, to decompose the daily MREIT returns, exchange rate returns and market index returns and applying the OLS regression to the recomposed series of each of the six time scales. As comparison we apply the same methodology above on (i) Starhill REIT (STHL), representing conventional MREITs, and (ii) MREIT index, as a proxy for the overall Malaysian REITs market.

Table 1 summarizes the basic statistics of the variables. All sample means are positive in the sample period. Standard deviation is highest for the foreign exchange variable, indicating higher volatility than any of the MREIT returns, be it individual fund or the MREIT index. Comparing between the MREITS, the islamic MREITs are both more volatile compared to Starhill and also compared to the MREITs market. The islamic MREITs exhibit positive skewness, similar to the market indices, whereas Starhill and the MREIT market show negative skewness. Kurtosis in all cases, except forex, exceed three, which is the kurtosis level of a normally distributed random variable. Jarque Bera tests strongly reject the null of normality in all cases, as evident by their *p-values*.

Table 1. Descriptive Statistics

	AHBR	ALQR	STHL	MREIT	FX	EMAS	KLCI
Mean	0.000399	0.000195	7.76E-05	0.000244	3.273286	0.000227	0.000203
Std. Dev.	0.013502	0.013739	0.009899	0.010348	0.194208	0.00909	0.008628
Skewness	0.697968	0.094427	-0.463557	-0.15864	0.271922	-1.666139	-1.320315
Kurtosis	17.17272	16.41738	12.59774	11.39388	1.841741	21.87182	17.61868
Jarque-Bera	13005.49 (0.0000)	11546.46 (0.0000)	5962.099 (0.0000)	4524.525 (0.0000)	104.9938 (0.0000)	23549.89 (0.0000)	14151.02 (0.0000)

Note: Sample period: 8 February 2007 to 31 December 2012 (1539 observations). Significance levels are in parantheses. Skewness and kurtosis are defined as $E[(R_t - \mu)]^3$ and $E[(R_t - \mu)]^4$, where μ is the sample mean.

Using the MODWT described in the section above, we decompose the return series of Al'Aqar (ALQR), Al Hadharah (AHBR), Starhill (STHL) and MREIT index (MREIT) as well as the foreign exchange series (FX) and market index returns (KLCI, EMAS). We filter each return series into six time-scales of detail and one time-scale of approximation. The detail will contain high frequency component (short horizon) while the approximation will contain smooth part (long horizon). The six time-scales of detail from the lowest to the highest represents 2-4 days, 4-8 days, 8-16 days, 16-32 days, 32-64 day, 64-128 days. Meanwhile, the scale of approximation represents longer than 128 days.

After recomposing each series into the time domain, OLS regression is performed for each time scale. The MREIT return series under the study is regressed with the foreign exchange (FX) and market index return, at matching time scales for all three variables. The S&P EMAS Shariah index return (EMAS) is the market regressor for the Islamic MREITs; whereas, the S&P KLCI index return (KLCI) is the regressor for the returns of Starhill (STHL) and the MREIT market index (MREIT).

Table 2 shows the results of the regression analysis focusing on the different time scales. The table summarizes results to only show three time scales: d1 (2-4 days), d4 (16-32 days) and d6 (64-128 days). The regression results differ for each of the MREITs under study. For Al'Aqar, the model is only significant in time scale D6 (64-128 days) at which time the market benchmark (EMAS) is significant. Al Hadharah, Starhill as well as the MREIT index do not have a problem with specification model at all timescales. As expected, the EMAS or KLCI coefficient is significant at 5% confidence level for all timescales and all MREITs (only D6 for Al'Aqar). However, the coefficient of our focus variable, foreign exchange (FX) reveals different results. It is not at all significant in relation to both the islamic REITs. As for Starhill, it is only significant within 2 to 4 trading days and in the longer term of quarterly trading (64 - 128 days).

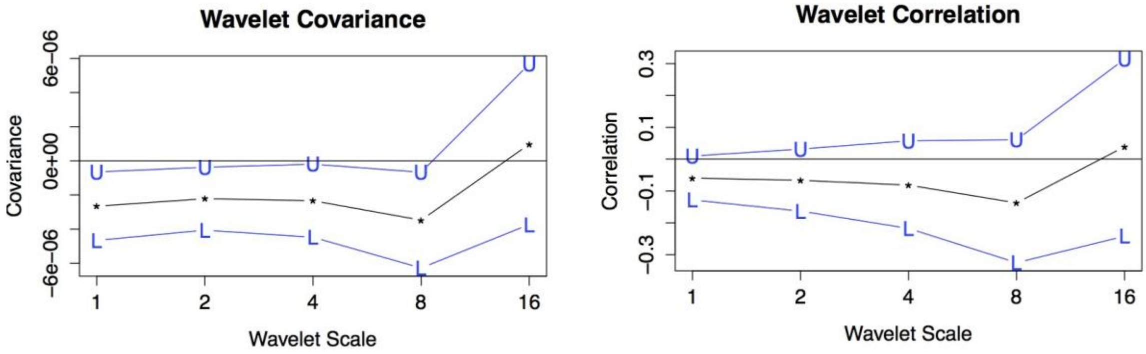
Table 2. OLS regression estimates on the wavelet domain.

		D1 (2 - 4 days)		D4 (16 - 32 days)		D6 (64 - 128 days)	
ALQR							
	C	-5.20E-06		7.24E-08		-8.02E-07	
		(0.9419)		*(0.9995)*		*(0.9863)*	
	FX	4.45E-06		3.08E-06		1.48E-06	
		(0.9126)		*(0.5927)*		*(0.1365)*	
	EMAS	0.093408		0.047155		0.142354	***
		(0.1295)		*(0.4022)*		*(0.0008)*	
	R-squared	0.002594		0.002683		0.050683	
	Prob(F-statistic)	*(0.136068)*		*(0.126989)*		*(0.0000)*	***
AHBR							
	C	-7.66E-20		4.74E-21		1.02E-20	
		(1.000)		*(1.000)*		*(1.000)*	
	FX	-3.05E-05		-4.66E-07		-4.32E-07	
		(0.46)		*(0.9664)*		*(0.7374)*	
	EMAS	0.267956	***	0.427331	***	0.183146	***
		(0.0000)		*(0.0000)*		*(0.0004)*	
	R-squared	0.02817		0.133117		0.043976	
	Prob(F-statistic)	*(0.0000)*	***	*(0.0000)*	***	*(0.0000)*	***
STHL							
	C	-2.03E-19		3.55E-12		5.67E-13	
		(1.000)		*(1.000)*		*(1.000)*	
	FX	-5.99E-05	***	-4.60E-06		-1.66E-06	**
		(0.0052)		*(0.3058)*		*(0.0525)*	
	KLCI	0.304369	***	0.299592	***	0.403804	***
		(0.0001)		*(0.0000)*		*(0.0000)*	
	R-squared	0.063309		0.132281		0.317229	
	Prob(F-statistic)	*(0.0000)*	***	*(0.0000)*	***	*(0.0000)*	***
MREIT							
	C	7.56E-12		7.23E-12		2.44E-12	
		(1.000)		*(1.000)*		*(1.000)*	
	FX	-1.54E-05		-1.19E-05	***	-1.16E-06	
		(0.5005)		*(0.0009)*		*(0.164)*	
	KLCI	0.365236	***	0.281288	***	0.337962	***
		(0.0000)		*(0.0000)*		*(0.0000)*	
	R-squared	0.06897		0.15161		0.301832	
	Prob(F-statistic)	*(0.0000)*	***	*(0.0000)*	***	*(0.0000)*	***

*Note:*This table reports the estimated coefficients of forex and market on the wavelet domain for d1, d4 and d6 timescales. Detailed results for the other time scales are not shown here and can be requested from the author. The Newey-West adjusted errors for heteroskedasticity and autocorrelation are in parentheses. *** and ** indicate significance at 5% and 1% levels, respectively. The wavelet coefficients are calculated using the wavelet function of *symmlet 8*, up to time scale 6.

To understand the MREIT market further, the wavelet covariance and correlation of this market and the Malaysian currency fluctuation is charted.

Figure 1. Wavelet Covariance and Wavelet Correlation between MREIT market and FX



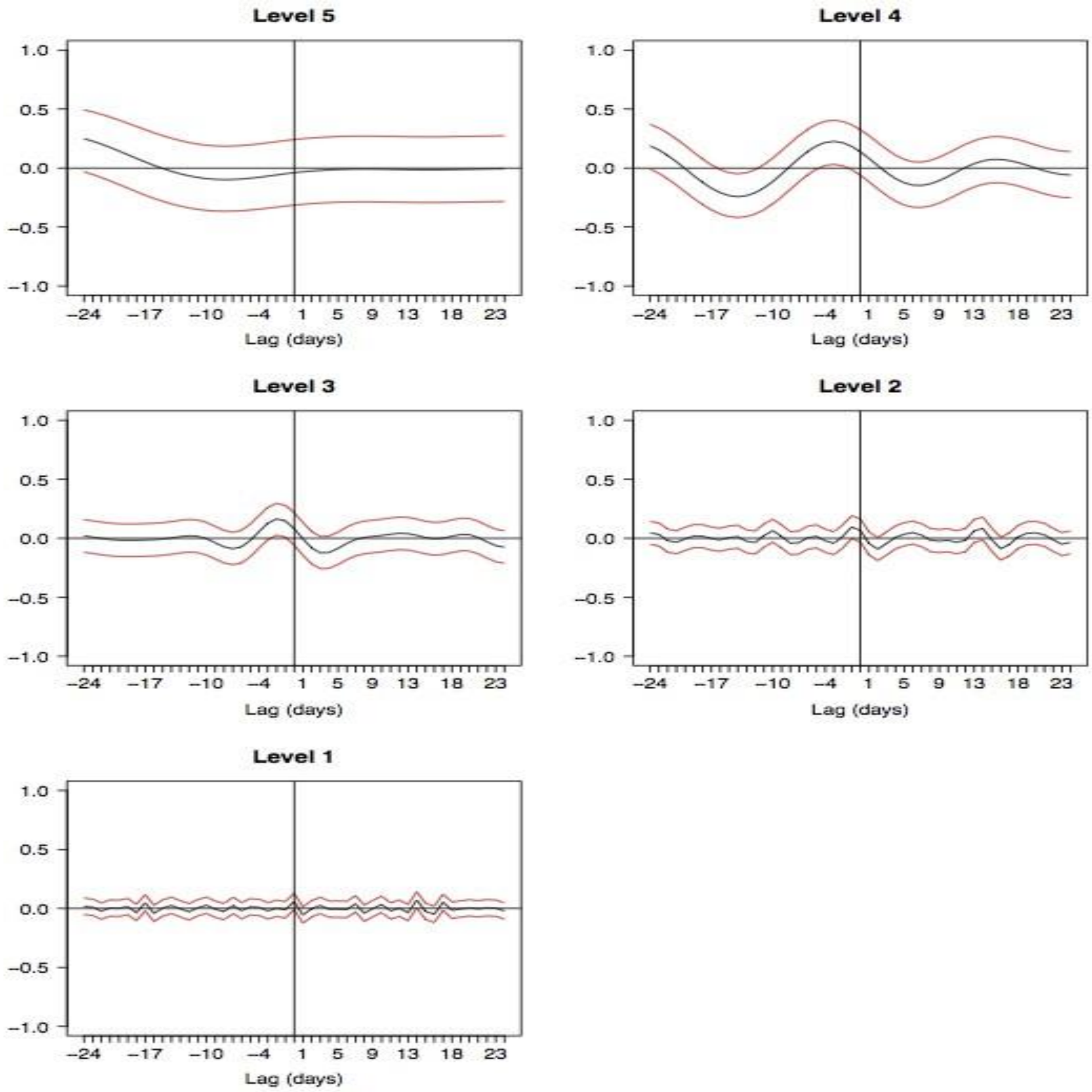
From Figure 1, the wavelet covariance and wavelet correlation between the MREIT market and the Malaysian currency in USD are fairly stable until they reach a scale of 8 days, after which they seem to increase with the time scale. These diagrams suggest that the MREITs market's significant relationship with forex begins after the scale of 8 days.

4.2Lead-lag relationship

Next, in order to examine the lead-lag relationship between the MREITs market index and the foreign exchange movement, we look at the MODWT based wavelet cross correlation between these two variables. Results are shown in Fig. 2 below.

From Figure 2, we can observe the following: there is a clear significance and hence lead-lag at the third, fourth and fifth levels; the skewness to the left means that the MREITs market leads the foreign exchange. The correlations in the fourth and fifth level also illustrate a negative wavelet cross-correlation. The lower levels of 1 and 2 display lower correlations between the two variables under study. This result is in line with the regression results for MREIT returns (Table 2 above) where FX is significant in timescale D4 i.e. 16-32 days.

Figure 2. Wavelet Cross Correlation between MREIT market and foreign exchange rates.



Note: This diagram shows the MODWT-based wavelet cross-correlation between MREIT market index returns and exchange rate movement at all periods, with the corresponding approximate confidence intervals, against time leads and lags for all scales, where each scale is associated with a particular time period. Here, the wavelet time scales of 1 to 5 correspond to changes of 2-4, 2-8, 8-16, 16-32 and 32-64 days. The red lines bound approximately 95% confidence interval for the wavelet cross-correlation. This diagram is produced by R Studio software.

4.3Contagion

Figure 3 present the wavelet coherency and phase difference of the three MREITs (Al'Aqar, Al Hadharah and Starhill) as well as the MREIT market index against the foreign exchange, from scale 1 (one day) to scale 8 (512 days, approximately 2 market years). A high wavelet coherence at the lower time scales tends to indicate 'contagion', whereas a high wavelet coherence at the higher time scales tends to indicate a fundamental theoretical relationship between them. Coherency ranges from blue (low coherency) to red (high coherency). Information on the phases shows us that the relationship between the MREITs and foreign exchange rates is not homogenous across scales, since arrows point right and left, down and up, constantly.

Figures 3(a) and (b) illustrate the co-movements of the islamic MREITs with foreign exchange, showing that their coherency is higher in the longer term (above 128 days, i.e. approximately more than one quarter). This implies a fundamental theoretical relationship between these islamic MREITs and the foreign exchange, albeit at different degrees. Al Hadharah (figure 3(b)) shows greater intensity of co-movement with forex throughout the sample period, shown as a red stretch. Al'Aqar's coherence with FX (figure 3(a)) is however reduced from an intensity of 0.8 (red) to 0.6 (yellow) from the period early 2009 until end 2011.

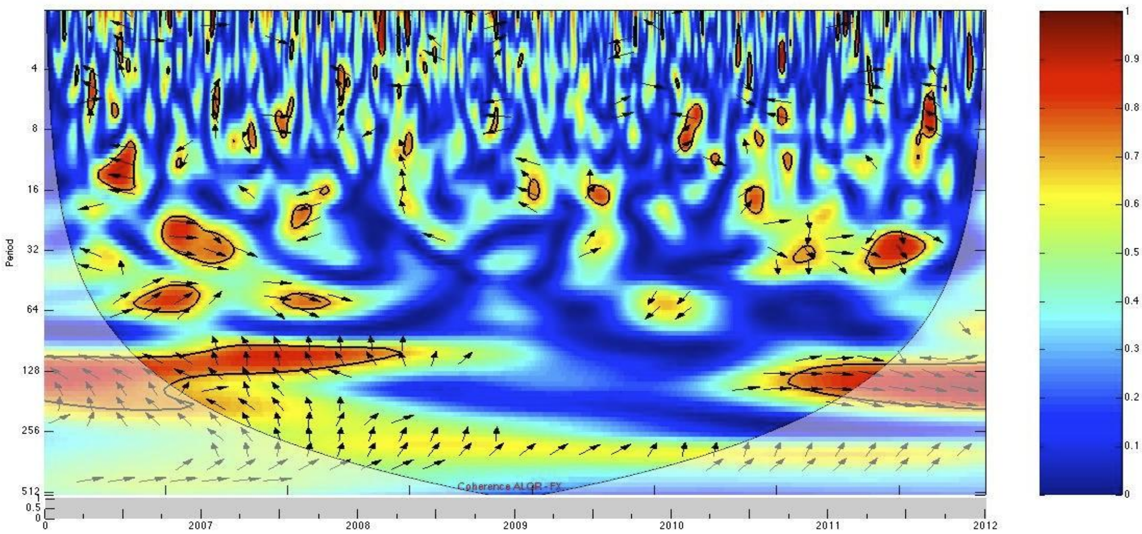
Al Hadharah Boustead REIT, is wholly dependent on the plantations whose prices in turn highly depend on the CPO commodity prices; these prices are a reflection of global demand for the commodity which are very susceptible to foreign currency changes. **Al'Aqar KPJ REIT**, on the other hand, is wholly dependent on the performance of the KPJ Group, a healthcare focused group whose portfolio of business include hospital management, healthcare technical services, hospital development and commissioning, nursing and healthcare professional continuous education, pathology services, central procurement and retail pharmacy (Dusuki, 2008). Hence, forex movements play a small role in its returns as the business focus depends very little on trading of financial assets, other than for the longer term scale exceeding 64 days.

During the debt crisis period from mid-2008 and 2011, the coherence intensity level to exchange rates in the longer term, was 0.6 for healthcare-based Al'Aqar (figure 3(a)), as well as for the MREIT market index (figure 3(d)). Looking at the shorter time scale (32-64 days), there is evidence of some contagion. The upward left arrows are clear for Al Hadharah and Starhill indicating these MREITs lag behind forex (figures 3(b) and 3(c)). However, their individual coherence behaviour is not reflected in the market index as there is no short term coherency between the index and forex (completely blue) during the crisis. This can be explained by affects of the global finance crisis.

Other than this crisis period, Starhill shows little coherence with the foreign exchange other than a long-term fundamental relationship of 60% coherence (shown in yellow). In November 2009, Starhill went through a rationalization exercise to position itself as a fully-fledged global hospitality REIT. At this time the main property in Starhill's portfolio was The Residences at the Ritz-Carlton Kuala Lumpur, i.e. high-end service apartments especially for expatriates. Hence forex volatility would affect rental income during the debt crisis as foreign companies take cost reduction measures in sending representations to the Malaysia, a credible explanation for the contagion observed. We also detect that some disposals were made in 2010 (Starhill Gallery and some shopping lots at Lot 10 Shopping Centre), most plausibly as restructuring measures were underway to overcome the debt crisis period. By the end of 2011 had acquired all of its local properties in the present portfolio.[13]

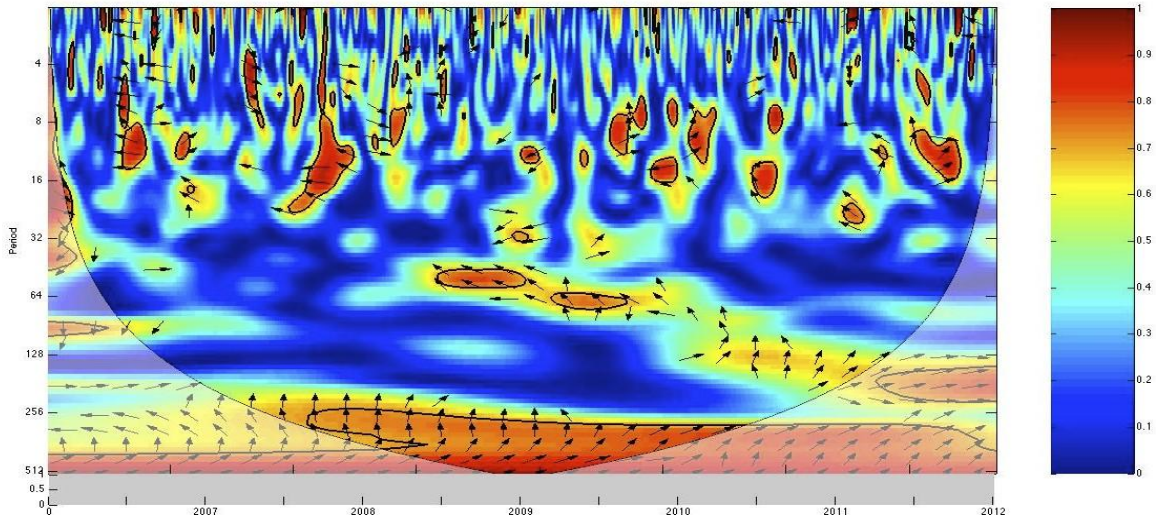
Figure 3. Wavelet Coherence and Phase Difference plots between MREITs and FX

(a)WTC (ALQR, FX)

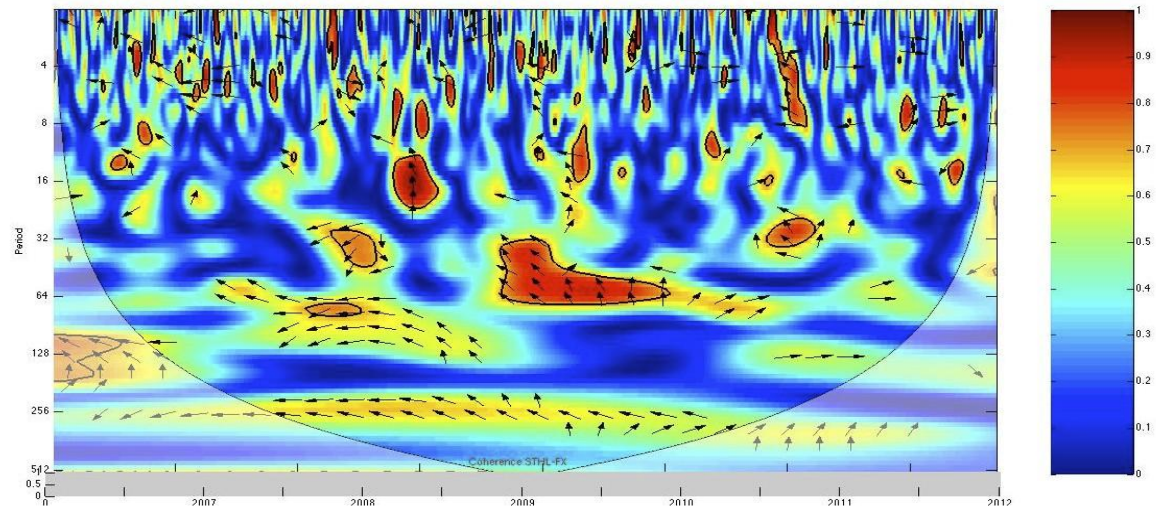


[13]Starhill REIT Annual Report 2012

(b)WTC (AHBR, FX)



(c)WTC (STHL, FX)



(d)WTC (MREIT, FX)

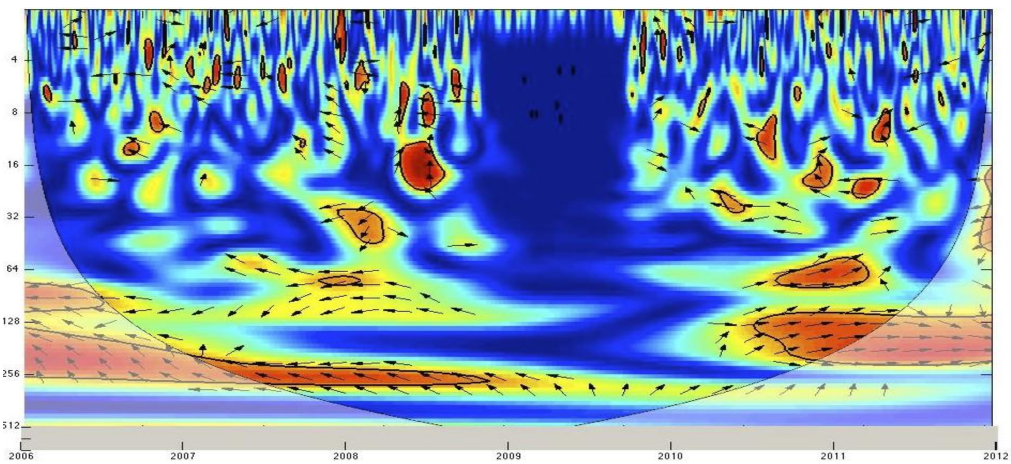


Figure 3(d) shows that the overall MREITs market has no coherence at all with forex in the shorter time scales during the crisis period. This index actually represents 16 REITs, consisting of the following asset types: 6 retail/mall, 6 office/ industrial, 2 diversified, 1 plantation and 1 healthcare[14] - i.e. predominantly of commercial sectors. Hence, the fundamental theoretical relationship with forex evident throughout the sample period, with reduced intensity during the crisis period (2008-2010), is a credible observation. Until 2009 the arrows point upward left in the longer-term scale, implying that fundamentally forex led the REITs market, however the arrow directions change from mid 2010. The phase difference is evident for time scales 64 days to 256 days (quarterly until a full trading year), but the MREIT index begins to lead FX after the crisis and eventually lead-lag relationship is no longer showing much prominence.

This is where the results from the MODWT are enhanced. The OLS regression shows the significance of forex in the MREIT market in timescale d4 (16-32 days) and the cross correlation between them identifies with this, i.e. that MREIT leads FX in timescales exceeding 8 days. Now the continuous wavelet transform method shown in figure 3 (d) reflects this relationship in more detail as we can separately see during which years the coherence and/or lead-lag holds. Evidence here shows that MREIT does lead forex but this is evidently so only after 2010, in the longer-term frequencies (> quarterly) but this lead-lag relationship is no longer significant after mid 2011 as further recovery is made from the crisis.

5. Conclusions

Undoubtedly, it is of great interest to investors and financial market regulators to analyse how vulnerable the capital markets are to different financial shocks. The objective of our paper is firstly to investigate whether there is any significant relationship between the islamic Malaysian REITs (islamic MREITs) and the foreign exchange movements. Empirically, we use the MODWT to decompose each variables' time series into different time scales, and the recomposed MREITs series were regressed on recomposed series of foreign exchange and the market index. From the OLS regression, the foreign exchange

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[14]mreit.reitdata.com

variable is not significant in any of the time scales of the islamic REITs, but only to the MREIT index and Starhill, though at differing time scales.

From the wavelet coherency findings, we observe that the islamic REITs have a fundamental theoretical link to foreign exchange, but at varying intensities. Al Hadharah shows a powerful long term coherence with forex, as its yields are dependent on the palm oil commodity prices, which in turn are susceptible to exchange rate movements. Al 'Aqar, being dependent on the performance of the healthcare operations, does have a fundamental relationship with forex movements but to a lesser degree as compared to Al Hadharah.

We then relate this to the relationship between the MREIT index returns with foreign exchange returns. The MODWT wavelet based cross correlation between them reveals the MREIT market leads the forex movement in the higher time scales of above 8 days, enriching the results given by the OLS regression of the recomposed series above. The wavelet coherency results tell us that overall, there is a fundamental theoretical relationship between each MREIT and the foreign exchange, as the level of coherence is high in the higher time scales (>128 days). During the 2008-2010 crisis, there was very little coherence between the MREIT market and forex other than the theoretical relationship, but evidence shows that the MREIT market takes the lead after the debt crisis.

Ling et al (2003) explains a potentially alternative explanation for the relationship between REIT capital flows and returns, as they may not be causally linked, but rather respond to common information, such as the fundamental economic variables.

Implications from the results show that MREITs, and particularly islamic REITs, are not susceptible to exchange rate movements. While this implies that MREITs can be a good hedge against exchange rate fluctuations in the long run, the way to boost foreign interest in the islamic REITs would be to demonstrate growth, either organically or by way of acquisition and thus strengthening their income base.

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APPENDICES

Appendix 1.

Listed real estate investment trusts (REITs) in Malaysia
(As at 28 February 2013)

No.	Funds Under Management	Trustee	Management Company
1	AmFirst Real Estate Investment Trust	Maybank Trustees Berhad	AmARA REIT Managers Sdn Bhd
2	Axis Real Estate Investment Trust *	OSK Trustees Berhad	Axis-REIT Managers Berhad
3	AmanahRaya Real Estate Investment Trust	CIMB Islamic Trustee Berhad	AmanahRaya-REIT Managers Sdn Bhd
4	Atrium Real Estate Investment Trust	CIMB Commerce Trustee Berhad	Atrium REIT Managers Sdn Bhd
5	Al-Hadharah Boustead REIT *	CIMB Islamic Trustee Berhad	Boustead REIT Managers Sdn Bhd
6	Al-`Aqar Healthcare REIT *	AmanahRaya Trustees Berhad	Damansara REIT Managers Sdn Bhd
7	CapitaMalls Malaysia Trust	AmTrustee Berhad	CapitaMalls Malaysia REIT Management Sdn Bhd
8	Tower Real Estate Investment Trust	AmTrustee Berhad	GLM REIT Management Sdn Bhd
9	Hektar Real Estate Investment Trust	AmTrustee Berhad	Hektar Asset Management Sdn Bhd
10	IGB Real Estate Investment Trust	AmTrustee Berhad	IGB REIT Management Sdn Bhd
11	Starhill Real Estate Investment Trust	Maybank Trustees Berhad	Pintar Projek Sdn Bhd
12	Pavilion Real Estate Investment Trust	AmTrustee Berhad	Pavilion REIT Management Sdn Bhd
13	Amanah Harta Tanah PNB	AmanahRaya Trustees Berhad	Pelaburan Hartanah Nasional Berhad
14	Quill Capita Trust	Maybank Trustees Berhad	Quill Capita Management Sdn Bhd
15	Sunway Real Estate Investment Trust	OSK Trustees Berhad	Sunway REIT Management Sdn Bhd
16	UOA Real Estate Investment Trust	OSK Trustees Berhad	UOA Asset Management Sdn Bhd

* Islamic Fund

Source: Securities Commission Malaysia