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Does a held-to-maturity strategy impede effective portfolio diversification for Islamic bond (*sukuk*) portfolios? A multi-scale continuous wavelet correlation analysis

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Abstract

The Islamic bonds or sukuk market is one of the fastest growing segments of the nearly US\$2trillion global Islamic finance industry. However, lack of trading in secondary sukuk markets is a peculiar feature in this sector and both institutional and retail sukuk investors are known to adopt a held-to-maturity investment strategy. Consequently, there is a critical gap in literature in studying the portfolio diversification opportunities available to sukuk investors and evaluating these in the light of held-to-maturity strategies. This paper (using recently available data and continuous wavelet transform methodologies) has made an initial attempt to study the portfolio diversification strategies for Islamic bond (*sukuk*) portfolios across heterogeneous investment horizons using the Malaysian and the Gulf Cooperation Council (GCC) sukuk markets as a case study. Our findings critically indicate that returns between local currency sukuk in different markets have low levels of long-term correlations, thus enabling portfolio diversification benefits. However, international currency sukuk issued in different markets exhibit high levels of long-term correlations which impede portfolio diversification benefits for held-to-maturity investments. A similar impediment is also witnessed in the domestic market context where diversification is intended by investing in different types of domestic sukuk. Overall, our findings critically highlight the feasibility of held-to-maturity sukuk investment strategies from a portfolio diversification perspective.

Keywords: Portfolio Diversification, Sukuk, Islamic Bonds, Continuous wavelet analysis

JEL Classification: G11; G12; G24; C63; Z12

1. Introduction

The Islamic bonds or sukuk market is one of the fastest growing sectors of the global Islamic finance industry. During 2008-2013, the sukuk market has grown at an annualised average rate of 19.3%, taking the sukuk outstanding portfolio to nearly USD 270 billion (KFHR, 2014). However, lack of tradability in secondary markets for sukuk instruments has been a longstanding concern among the Islamic finance industry stakeholders (Harvey and Cosgrave, 2012). It is often regarded that both institutional and retail sukuk investors generally hold the sukuk certificates till their maturity (Mahmood, 2012). A number of factors drive¹ this trend in the sukuk markets including among others: lack of sufficient supply of quality sukuk papers to satisfy the ever growing demand (Halim, 2012); Shariah considerations which may restrict the ability of the sukuk notes to be traded at values other than par (Najeeb, 2013); lack of infrastructural facilities to allow sukuk instruments to be traded (Mahmood, 2012); and also unavailability of benchmark yields to gauge the correct pricing for sukuk instruments in order to enable trading (Najeeb and Vejzagic, 2013). Given these market conditions, sukuk investors by and large adopt a held-to-maturity strategy on sukuk investments. However, how does this strategy hold from a portfolio diversification perspective?

The appeal of a financial asset to investors from a portfolio diversification perspective depends crucially on its returns being less correlated with other asset returns (Miyajima et al, 2012). However, despite the widespread use of world bond instruments as an asset class for investments, surprisingly little empirical research has been done on studying the portfolio diversification benefits

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¹ We do not dwell in detail on the reasons for the lack of trading in sukuk markets as that is beyond the objectives of the paper.

of fixed-income instruments (Hansson et al, 2009). Bulk of the literature is dedicated to testing the validity of portfolio diversification models for stock and equity portfolios. Only very few empirical works have examined linkages in bond markets (Yang, 2005).

Among the existing empirical studies on bond diversification, the results are inconclusive and represent a number of different perspectives, thus calling for further research in this area. Some writers have found low correlations between world bond markets thus enabling effective portfolio diversification opportunities to investors (for e.g. Levy and Lerman (1988), DeGennaro et al. (1994), Clare et al. (1995), Yang (2005), etc.). However, others have reported strong correlations in the very same markets that would limit any portfolio diversification benefits (for e.g. Iben and Litterman (1994), Solnik et al (1996), Barassi et al. (2001), Smith (2002), etc.).

As a reconciliatory explanation for the mixed results, it had been further identified in literature that correlations amongst markets are evolving through time due to changes in interdependence across markets (Engle, 2002). As a result, more recent papers examine asset returns to identify shifting patterns in correlations between markets which then have an impact on portfolio diversification strategies (for e.g. Hunter and Simon (2005), Kim et al. (2006), Cappiello et al. (2006), Ciner (2007), Hansson et al (2009), etc.).

However, recent theoretical studies have added a new dimension to portfolio diversification research that market returns are not only time varying (evolving through time), but may also be dependent on time scales highlighting the importance of investment horizons (Gencay et al, 2002). The implications from such theoretical insights are that heterogeneity in investment horizons (for e.g. trading daily, weekly, monthly, holding till maturity, etc.) could potentially affect portfolio diversification opportunities thus making a 'one size fits all' diversification strategy inappropriate.

The literature on portfolio diversification benefits for Islamic fixed-income instruments is even more scant in comparison to the conventional bond markets. Most studies focus on comparing and contrasting the sukuk structures with conventional bonds and empirical studies, which are only a handful, look towards assessing the risk and return profiles between the two (for e.g. Zin et al. (2011), Ariff and Safari (2012), Hassan (2012), Lahsasna and Lin (2012), Godlewski et al. (2013), etc.). To the best of our knowledge, there are no papers which critically study the portfolio diversification opportunities available to sukuk investors and also evaluate these opportunities in the light of held-to-maturity strategies adopted by sukuk investors. The absence of this research has mainly been due to unavailability of historical sukuk returns data in the past that could permit such a study. Moreover, the ability to evaluate the held-to-maturity strategy from a portfolio diversification perspective requires applying modern empirical methodologies such as wavelet analysis which have only recently been introduced in the field of financial modelling.

Consequently, this paper makes the initial attempt (to the best of our knowledge) to study the portfolio diversification strategies for Islamic bond (sukuk) portfolios across heterogeneous investment horizons using the Malaysian and the Gulf Cooperation Council (GCC) sukuk markets as a case study. The sampling of these two markets is based on the fact that these two markets accounted for over 90% of the sukuk outstanding portfolio as at end-2013 (KFHR, 2014).

The paper attempts portfolio diversification research from two perspectives: international sukuk markets portfolio diversification and domestic sukuk market portfolio diversification. In the first approach, the paper identifies international portfolio diversification opportunities by considering correlations between the Malaysian sukuk returns and the GCC sukuk returns. In the second approach, the paper identifies domestic portfolio diversification opportunities by considering correlations between the Malaysian sovereign sukuk returns and the Malaysian corporate sukuk returns.

The unique contributions of the paper are in empirically testing for the ‘time-varying’ and ‘scale dependent’ correlations of the sukuk returns in the sample markets. Particularly, by incorporating scale dependence, the paper is able to identify whether portfolio diversification strategies vary with different investment horizons or holding periods of stocks (for e.g. weekly, monthly, quarterly, etc.) and more importantly, whether the held-to-maturity strategy of sukuk investors impedes or enables portfolio diversification. The ability to do this is facilitated by the availability of recent data and also the application of the recently introduced empirical research technique in finance: Continuous Wavelet Transform (CWT) analysis of volatility and correlations.

Our findings critically indicate that the returns on sukuk denominated in local currencies of respective issuing countries (for e.g. Malaysia and the GCC) have low international correlations, thus effectively enabling international portfolio diversification benefits for investors. Exceptions are periods when the global economy are affected by severe shocks (for e.g. Eurozone sovereign debt crisis in 2011/2012) in which cross-border market returns demonstrate convergence and as such the sukuk market returns are strongly correlated, eroding any potential portfolio diversification benefits. However, we do not find any statistically significant evidence to indicate that local currency sukuk returns are strongly correlated in the long-term and hence, the held-to-maturity strategy of sukuk investors will not impede international portfolio diversification benefits.

On the other hand, the results for international currency sukuk returns (for e.g. sukuk issued in US Dollar in Malaysia) are opposite as the results tend to indicate at the 95% confidence level that sukuk returns are strongly correlated in the long-term. Hence, the held-to-maturity strategy of sukuk investors will impede any effective international portfolio diversification opportunity when the investments are in international-currency denominated sukuk. A similar finding is also observed in a domestic market context as our results indicate that returns on Malaysian sovereign sukuk and corporate sukuk converge in the long-run, thus eroding portfolio diversification benefits. Our findings are plausibly explainable with theories and empirical results from existing studies which have analysed the portfolio diversification opportunities in the world bond markets. Overall, our findings highlight the significance of heterogeneity in investment horizons for the sukuk investors and this bears important implications for portfolio diversification strategies.

The following sections of the paper are organized as follows. Section 2 reviews the relevant literature; Section 3 lists the research objectives and proposed contributions; Section 4 briefly provides the theoretical underpinnings; Section 5 lists the empirical methodologies; Section 6 contains the data analysis and results. Section 7 provides the closing remarks; Section 8 discusses the limitations of this study and provides suggestions for future research. Finally, references make up the end of this paper.

2. Literature Review

2.1. Portfolio Diversification of Bonds

The modern portfolio theories are built upon the ground breaking seminal work of Markowitz (1959) who proposed that by holding a fully diversified portfolio, an investor is only exposed to systematic risks. This study was extended into an international context by Grubel (1968) who proposed that low correlation between returns on stock market indexes allows investors to minimize portfolio risk by international diversification. The appeal of an asset to investors from a portfolio diversification perspective depends crucially on its returns being less correlated with other asset returns and this is also applicable on bonds (Miyajama et al, 2012). However, despite the widespread use of world bond instruments as an asset class for investments, surprisingly very little research has been done on studying the portfolio diversification benefits of fixed-income instruments (Hansson et al, 2009).

Bulk of the literature is dedicated to testing the validity of portfolio diversification models for stock and equity portfolios. This includes literature on international stock market linkages (e.g., Eun and Shim, 1989; Arshanapalli and Doukas, 1993; Francis and Leachman, 1998; Bessler and Yang, 2003) and international money market linkages (e.g., Fung and Isberg, 1992; Fung and Lo, 1995). Only very few empirical works have examined linkages in bond markets (Yang, 2005). According to Burger and Warnock (2003), empirical work on bond portfolios has been impeded by the lack of availability of vital data essentially needed to contrast and compare returns on bond positions, particularly in cross-border markets. Historical returns data were only available for a few large countries and the development of emerging market bond indices did not begin until the mid-1990s. As such, Hansson et al (2009) point out that existing studies analysing bond diversification benefits have been typically been from the perspective of few developed markets such as the US, UK, Germany and Japan. Moreover, the studies have largely focused only on one bond category such as government bonds.

Among the existing empirical studies on bond diversification, the results are inconclusive and represent a number of different perspectives, thus calling for further research in this area. For instance, Levy and Lerman (1988) find that low correlations among world bond markets make international diversification of bond market portfolios beneficial. Applying a cointegration technique, DeGennaro et al. (1994), Clare et al. (1995) and Yang (2005) also did not find any long-run cointegration relationship among government bond markets of several major industrialized countries, although these papers detect short-run dependencies..

In contrast, Solnik et al (1996) report increasing correlations among several major world bond markets. Greater correlations among the markets reduce benefits of international bond portfolio diversification. Iben and Litterman (1994) show that, except for Japan, correlations among the G-7 countries have increased, although they conclude that benefits to international diversification are still possible. Barassi et al. (2001) and Smith (2002) reported existence of cointegration in several major industrialized countries suggesting that benefits of international diversification may not be valid in the long-term.

In recent years, literature has attempted to extend the study further by analyzing the time-varying properties of the correlations between bond markets. Many recent studies have empirically tested and provided evidence that the correlations across national markets may not be constant and are evolving through time (see for e.g. Longin and Solnik 1995, Yang 2005, Dacjman et al, 2012). In the context of specifically bond markets, Cappiello et al. (2006) examine if the correlations between major bond market returns have changed over time. They find that the correlations between US and German bond returns increased over their sample period from January 1987 to February 2001 and that the correlation between US and Japanese bond returns remained close to zero. Hunter and Simon (2005) examine the lead-lag and contemporaneous relationships between 10-year US government bond returns and 10-year UK, German, and Japanese government bond returns. The results indicate that the correlations between US and both UK and German bond market returns increased substantially over the sample period, while the correlations between US and Japanese government bond returns diminished over the same period. However, the correlations remain significantly below (absolute) one, indicating that the benefits of international bond diversification have not been eroded over the sample period. Kim et al. (2006) use government bond index data and also show that there are time-varying linkages and convergence between the Euro-zone markets and Germany.

More recently, Ciner (2007) examined the dynamic linkages between international government bond markets and detected that in the last many years, the international bond indexes are cointegrated, suggesting that there is increased comovement between the markets. This implies that the benefits of international diversification may not be as significant as suggested in prior work. And finally, Hansson et al (2009), using a sample of bond indices from 11 developed countries and

10 emerging markets, find increasing correlations within both government bonds as well as corporate bonds in developed markets over time during the sample period of 1997–2006. The overall level of correlations between these asset classes is relatively high. Only emerging market debt differs by still offering lower correlations both within the asset class as well as with respect to other types of bonds.

In a summary, the literature studying bond market linkages and its resulting impact for bond portfolio diversification strategies have remained inconclusive with results reporting contradicting evidence of the relative benefits of international bond diversification for investors from different countries. Hence this subject needs further investigation.

2.2. Uniqueness of Islamic bonds (Sukuk)

Sukuk are commonly referred to as Islamic bonds although they are more correctly translated as Islamic investment certificates (Tahmoures, 2013). Sukuk investments represent a distinct class of securities issued by sovereign and corporate entities (Godlewski et al, 2013). Unlike conventional bonds, sukuk instruments need to have underlying tangible assets as subject matter and the sukuk certificate represents the ownership of these underlying assets, usufructs (benefits), services, or investments (Ahmad and Rusgianto, 2013). The Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) officially defined Sukuk as certificates of equal value representing undivided shares in ownership of tangible assets, usufruct and services (AAOIFI, 2003).

Sukuk instruments need to be in compliance with the fundamentals of Shariah (Islamic Law) that requires gains from investments to be earned in an ethical and socially responsible manner that comply with teachings of Islam (DeLorenzo, 2000). As such, sukuk structures undergo a screening process to ensure they are free from prohibitive elements as dictated by Shariah. The common elements screened for are *riba* (interest rates), *gharar* (uncertain outcomes), *maysir* (gambling), prohibited commodities (liquor, pork, etc.) and fulfilment of contractual requirements as required in Islamic Law of Contracts (Rosly, 2005). Shariah advocates socially responsible investments that forbid fixed interest earnings while encouraging profit-sharing, partnership, leasing and sale-based contracts (Girard and Hassan, 2008). Consequently, conventional debt-based instruments such as treasury bills, corporate bonds, certificates of deposits and preferred stocks are prohibited to be used as means of incomes or source of funds (Merdad et al, 2010).

The Sukuk market is one of the fastest growing sectors of the multi trillion global Islamic finance industry. During the last five years, the sukuk market has grown at an annualised average rate of 20%, taking the sukuk outstanding portfolio to nearly USD 270 billion (KFHR, 2014). Although sukuk were first issued in the 1980s, nearly all growth has come within the past decade (Godlewski et al, 2013). As such, the volume of quantitative studies on sukuk instruments is very limited.

Most studies focus on comparing and contrasting the sukuk structures with conventional bonds and empirical studies, which are only a handful, look towards assessing the risk and return profiles between the two. For example, Zin et al. (2011) explored the practices and prospects of the sukuk market in Malaysia and discussed the differences between sukuk and conventional bonds in the Malaysian market. Ariff and Safari (2012) examined the differences between sukuk and conventional bonds by investigating the presence of a causal link between the performance of sukuk and conventional bonds bearing similar yields and ratings. Their results found no causal link. Hassan (2012) conducted his research on the comparison of Sukuk and bonds by assessing differences related to the diversification of fixed-income portfolios with and without sukuk instruments. The author assessed the value at risk (VaR) of sukuk compared with the VaR of conventional bonds of the same issuer. The results highlighted that there is a gain in diversification of bond portfolios by adding Sukuk. Lahsasna and Lin (2012) focused on Shariah issues in the structuring of sukuk in the Malaysian market considering specifically issues such as late payment

penalty, trading of debt based sukuk, purchase undertaking in equity based structures and ownership status in asset based transactions.

More recently, Fathurahman and Fitriati (2013) analysed the yields on sukuk and conventional bonds listed in the Indonesian stock market. Their findings indicate that the yields on sukuk instruments differed from the yields on comparable conventional bonds and yields on sukuk were greater than conventional bonds in at least three of the ten groups studied. Godlewski et al. (2013) investigated the reaction of the Malaysian market investors to the announcements of sukuk and conventional bonds issues. The stock market is neutral to announcements of conventional bond issues, but it reacts negatively to announcements of sukuk issues. Godlewski et al. (2013) assigned this result to the great demand for Islamic investment certificates and to the adverse selection promoting sukuk issuance by lower-quality debtor firms.

The literature on portfolio diversification benefits for Islamic fixed-income instruments is even more scant in comparison to the conventional bond markets. As evident from the review above, most authors have focused on contrasting and comparing sukuk instruments with comparable conventional bonds. However, to the best of our knowledge, there are no papers which critically study the portfolio diversification opportunities available to sukuk investors and also evaluate these opportunities in the light of held-to-maturity strategies adopted by sukuk investors.

A longstanding concern with the global sukuk market has been the lack of trading of sukuk instruments in the secondary markets (Harvey and Cosgrave, 2012). Sukuk issuances have been successful, and oftentimes oversubscribed, but the lack of trading has led to investors holding on to the buy-and-hold attitude of the instruments until maturity (Mahmood, 2012). The lack of trading in the secondary markets is on account of a number of factors including among others: no established secondary market platforms for active trading; few or no market makers; lack of regulatory support; lack of harmonisation in Shariah principles which facilitate cross-border trade of sukuk; differing Shariah interpretations creating difficulties in compliance of instruments across all markets; demand exceeding supply of high quality sukuk issues compelling investors to hold till maturity as an alternative cannot be readily bought in the secondary market; and also unavailability of benchmark yields to gauge the correct pricing for sukuk instruments in order to enable trading (Mahmood, 2012). Given these market conditions, sukuk investors by and large adopt a held-to-maturity strategy on sukuk investments (Halim, 2012).

Empirical efforts to analyse the interdependence of the sukuk markets have remained absent, mainly due to the unavailability of financial data until recently that could permit such a study. Moreover, the ability to evaluate the held-to-maturity strategy from a portfolio diversification perspective requires applying modern mathematical functions such as wavelet analysis which have only recently been introduced in the field of financial modelling. Studies have found that investment holding periods (for e.g. 2 days, 6 days, 30days, etc.) have an impact on the volatilities and correlations dynamics of asset returns. This type of research is relatively new and there are only a few empirical papers that incorporate time-scaling in examining volatilities and correlations.

Gencay et al (2001) were one of the earliest proponents of the time scaled dependence of returns and correlations in financial markets. In and Kim (2013) have combined a cluster of their papers using wavelet time-scaling in finance to produce a book just published. Dacjman et al (2012), in their recent study on co-movement dynamics between the developed European stock markets of the United Kingdom, Germany, France and Austria also find evidence in favour of scale dependence for stock market returns. In Islamic finance, one of our earlier papers, Najeeb et al (2014), convincingly demonstrates how portfolio diversification strategies vary in Islamic equity markets given heterogeneous investment horizons. Hence, future studies are recommended to consider the time scale properties in modelling volatilities and correlations and with this approach, we are in position to evaluate the held-to-maturity strategy of sukuk investors.

3. Research Objectives and Contributions

The literature reviewed earlier indicated how little research has been done on studying the portfolio diversification benefits of fixed-income instruments. Bulk of the literature is dedicated to testing the validity of portfolio diversification models for stock and equity portfolios. The existing literature studying bond market linkages and its resulting impact for bond portfolio diversification strategies have also remained inconclusive with results reporting contradicting evidence of the relative benefits of international bond diversification for investors from different countries. Hence this subject needs further investigation.

The literature on portfolio diversification benefits for Islamic fixed-income instruments is even more scant in comparison to the conventional bond markets. Most studies focus on comparing and contrasting the sukuk structures with conventional bonds and empirical studies, which are only a handful, look towards assessing the risk and return profiles between the two. Notably, it has been established that sukuk investors by and large adopt a held-to-maturity strategy on sukuk investments given the thin trading frequency of sukuk in the secondary markets. To the best of our knowledge, there are no papers which critically study the portfolio diversification opportunities available to sukuk investors and also evaluate these opportunities in the light of held-to-maturity strategies adopted by sukuk investors. The absence of this research has mainly been due to unavailability of historical sukuk returns data until recently that could permit such a study. Moreover, the ability to evaluate the held-to-maturity strategy from a portfolio diversification perspective requires applying modern empirical methodologies such as wavelet analysis which have only recently been introduced in the field of financial modelling.

As a result, this paper (using recently available data and recent empirical methodologies) endeavours to make a humble first attempt to study the portfolio diversification strategies for Islamic bond (sukuk) portfolios using the Malaysian and the Gulf Cooperation Council (GCC) sukuk markets as a case study. These two markets accounted for over 90% of the sukuk outstanding portfolio as at end-2013 (KFHR, 2014). The specific research questions of this study are as follows:

1. Are there **international portfolio diversification** benefits from sukuk investments between the Malaysian and the GCC sukuk markets?
2. Are there **domestic portfolio diversification** benefits from sukuk investments between the Malaysian corporate and Malaysian sovereign sukuk markets?
3. How do the portfolio diversification benefits change given different **investor holding periods** (e.g. 2-4 days, 4-8 days, 8-16 days, etc.)?

The results from each of the research questions are expected to have significant implications for investors and fund managers in their decisions concerning sukuk portfolio allocations and investment horizons. More importantly, the results will help in contributing towards a newly emerging branch of literature that considers the portfolio diversification opportunities for sukuk portfolios while also evaluating the held-to-maturity strategy of sukuk investors.

4. Theoretical Background

The theoretical foundations assumed in this paper draw upon from the seminal works of Markowitz (1959) 'Modern Portfolio Theory' and Grubel (1968) 'Internationally Diversified Portfolios'. The Nobel Prize winning contributions of Markowitz shaped the modern portfolio theory where the volatility of a portfolio is less than the weighted average of the volatilities of the securities it contains given that the portfolio consists of assets that are not perfectly correlated in returns. The variance of the expected return on a portfolio can be calculated as:

$$\sigma_p^2 = (\sum W_i^2 \sigma_i^2 + \sum \sum W_i W_j \text{Cov}_{ij})$$

Where the sums are over all the securities in the portfolio, W_i is the proportion of the portfolio in security i , σ_i is the standard deviation of expected returns of security i , and Cov_{ij} is the covariance of expected returns of securities of i and j . Assuming that the covariance is less than one (invariably true), this will be less than the weighted average of the standard deviation of the expected returns of the securities. This is why diversification reduces risk.

Drawing from Markowitz's model, Grubel (1968) applied the modern portfolio theory to explore the potential benefits of holding long-term international assets. Grubel modelled international portfolio diversification benefits between two countries A and B as follows:

$$E(r_{a,b}) = W_a R_a + W_b R_b$$

$$V(r_{a,b}) = W_a^2 \sigma_a^2 + W_b^2 \sigma_b^2 + 2W_a W_b \text{Cov}_{ab}$$

Where $E(r_{a,b})$ is the expected returns on portfolio invested in Country A and B with investment weights of W_a and W_b and $V(r_{a,b})$ measures the variance on the portfolio. The crucial factor here is the Cov_{ab} and the lower the covariance between countries A and B, the greater would be diversification benefits. Grubel found that if US investors allocate a part of capital to foreign stock markets, they could achieve a significant reduction in portfolio risk and better portfolio return opportunities.

5. Methodology

An understanding of how volatilities and correlations between asset returns change over time including their directions (positive or negative) and size (stronger or weaker) is of crucial importance for both the domestic and international investors with a view to diversifying their portfolios for hedging against unforeseen risk. The dynamic conditional correlations (DCC) enable a determination of whether the shocks to the volatilities in asset returns are substitutes or complements in terms of taking risks.

Meanwhile, co-movements between financial asset returns may not only be time varying, but also time scale dependent (Gencay et al., 2001). The domestic and international financial markets are composed of investors having heterogeneous time scale or investment horizons or asset holding periods (such as, 1-2 days, 2-4 days, 4-8 days, etc). The heterogeneous players in the financial markets are: intra-day traders or speculators, hedge funds, portfolio managers, regulators or central bankers, pension and insurance fund managers, etc. The implication of heterogeneity in investment horizon or financial asset holding periods is that the true dynamic relationship between different aspects of capital market activities will be unveiled only when the asset prices are decomposed into different time scales or investment horizons or asset holding periods (In and Kim 2013). This analysis can be done with the help of different wavelet transforms such as, discrete wavelet transform (DWT), maximum overlap discrete wavelet transform (MODWT), and continuous wavelet transform (CWT) and the correlation between two CWT generally known as the wavelet coherence. In this paper, we use the CWT method as this allows us to pinpoint changes (both when they occur and how) across different time scales in the interdependence between financial variables.

5.1. Continuous Wavelet Transform (CWT)

A number of authors have recently begun to use the continuous wavelet transform (CWT) in economics and finance research (for e.g. see Vacha and Barunik (2012), Madaleno and Pinho (2012), Saiti (2012), among others). The CWT maps the original time series, which is a function of just one variable time-separate into function of two different variables such as time and frequency. The CWT maps the series correlations in a two-dimensional figure that allows the researcher to

easily identify and interpret patterns or hidden information. The analysis of correlation between two CWT is generally known as the wavelet coherence. These figures would indicate the extent of correlation between two variables with both time and time scale/frequency changing.

For the CWT, we use the Daubechies (1992) least asymmetric wavelet filter of length $L=8$ denoted by LA (8) based on eight non-zero coefficients. In choosing the wavelet filter, we have applied the principal of maintaining a ‘balance’ between the sample size and the length of the wavelet filter (In and Kim, 2013). Previous studies on high-frequency data have shown that a moderate-length filter such as $L = 8$ is adequate to deal with the characteristic features of time-series data (see Gencay et al., 2001, 2002, In and Kim 2013). In the literature, it is argued that an LA (8) filter generates more smooth wavelet coefficients than other filters such as, Haar wavelet filter.

The continuous wavelet transform (CWT) $W_x(u, s)$ is obtained by projecting a mother wavelet ψ onto the examined time series $x(t) \in L^2(\mathbb{R})$, that is:

$$W_x(u, s) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{s}} \psi\left(\frac{t-u}{s}\right) dt$$

The position of the wavelet in the time domain is given by u , while its position in the frequency domain is given by s . Therefore, the wavelet transform, by mapping the original series into a function of u and s , gives us information simultaneously on time and frequency. To be able to study the interaction between two time series, how closely X and Y are related by a linear transformation, we need to apply a bivariate framework which is called wavelet coherence. The wavelet coherence of two time series is defined as:

$$R_n^2(s) = \frac{|S(s^{-1}W_n^{xy}(s))|^2}{S(s^{-1}|W_n^x(s)|^2) \cdot S(s^{-1}|W_n^y(s)|^2)}$$

Where S is a smoothing operator, s is a wavelet scale, $W_n^x(s)$ is the continuous wavelet transform of the time series X , $W_n^y(s)$ is the continuous wavelet transform of the time series Y , $W_n^{xy}(s)$ is a cross wavelet transform of the two time series X and Y (Madaleno and Pinho, 2012). For brevity, the paper omits the mathematical details of the method *{interested readers may refer to Madaleno and Pinho (2012), Gencay et al (2001; 2002) and In and Kim (2013)}*.

6. Data Analysis and Results

The Malaysian sukuk index returns were proxied by using the Bloomberg-AIBIM Bursa Malaysia Sovereign Shariah Index (benchmark index for Malaysian sovereign sukuk issues), Bloomberg Malaysian Sukuk Ex-MYR Index (benchmark index for foreign currency sukuk issued in Malaysia) and the Thomson Reuters-Bond Pricing Agency Malaysia Corporate Sukuk Index (benchmark index for Malaysian corporate sukuk issues). For the GCC sukuk index, returns were proxied by using the HSBC-NASDAQ Dubai GCC Sukuk Index (benchmark index for GCC sukuk issues). The choice of indices was restricted by the availability of comparable time-series data.

For the first research objective which analyses international portfolio diversification opportunities, we study the correlations between the three Malaysian benchmark sukuk indices and the GCC sukuk index. The logic behind segregating Malaysian sukuk indices into three, sovereign, corporate and foreign currency stems from the fact that Malaysian sukuk market is the largest in terms of both dollar value of issuances and number of issuances. The Malaysian sukuk outstanding

alone accounts for over 58% of the global sukuk outstanding portfolio in 2013 (KFHR, 2014). In contrast, the GCC sukuk have a limited value and volume of issuances. More critically, data for the GCC sukuk indices separated by type of issuance is not available.

For the second research objective looking at domestic portfolio diversification, we compare the Malaysian sovereign sukuk returns with the Malaysian corporate sukuk returns. Table 1 below lists the sample indices being considered in this study.

Table 1: Selected Indexes for Research

Symbol	Definition
<i>MY-SOV</i>	Bloomberg-AIBIM Bursa Malaysia Sovereign Shariah Index
<i>MY-COR</i>	Thomson Reuters-Bond Pricing Agency Malaysia Corporate Sukuk Index
<i>MY-FCY</i>	Bloomberg Malaysian Sukuk Ex-MYR Index
<i>GCC-SKI</i>	HSBC-NASDAQ Dubai GCC Sukuk Index

We collected daily time series closing price data for all sample sukuk indices from 1st November 2010 till 31st October 2013. The sample period was constrained since the Malaysian Bloomberg sukuk indices data begin only from 1st November 2010. The respective data has been sourced from the Bloomberg terminal and the Thomson-Reuters Eikon database. The sukuk indices returns were calculated as differences of the logarithmic daily closing prices of indices $\{ln(pt) - ln(pt-1)\}$ where p is an index value. Table 2 presents some descriptive statistics of the data.

Table 2: Descriptive Statistics of Indices Returns Series

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Obs
MY-SOV	0.00003	0.00010	0.00212	-0.00679	0.00074	-3.76108	23.89681	756
MY-COR	0.00016	0.00015	0.00128	-0.00398	0.00024	-8.14397	13.44872	756
MY-FCY	0.00003	0.00019	0.00469	-0.00961	0.00142	-1.68402	8.69056	756
GCC-SKI	0.00008	0.00007	0.00961	-0.01530	0.00175	-1.73938	16.14233	756

We use modern wavelet transformations to analyse the time-varying and time-scale dependent returns correlations among our sample indices and provide inferences on portfolio diversification benefits based on our research objectives.

6.1. International Portfolio Diversification

Figures 1, 2 and 3 present the estimated wavelet coherence and phase difference of Malaysian sukuk returns (sovereign, corporate and foreign currency) with the GCC sukuk market returns from scale 1 (one day) up to scale of 8 (one market year, 256 trading days) using continuous wavelet transformations (CWT). In these figures, time is shown on the horizontal axis in terms of number of trading days during the sample years 2010-2013, while the vertical axis refers to the investment horizon in terms of investors' sukuk holding periods (e.g. 2-4 days, 4-8 days, 8-16 days, etc.). The curved line below shows the 5% significance level which is estimated using Monte Carlo simulations and the region beyond this boundary is not statistically significant for interpretations at the 95% confidence level. The figure follows a colour code as illustrated on the right with power ranges from blue (low correlations which indicate weak relationship between the two time series) to red (high correlations which indicate strong relationship between the two time series).

Figure 1: Continuous Wavelet Transform – GCC-SKI and MY-SOV

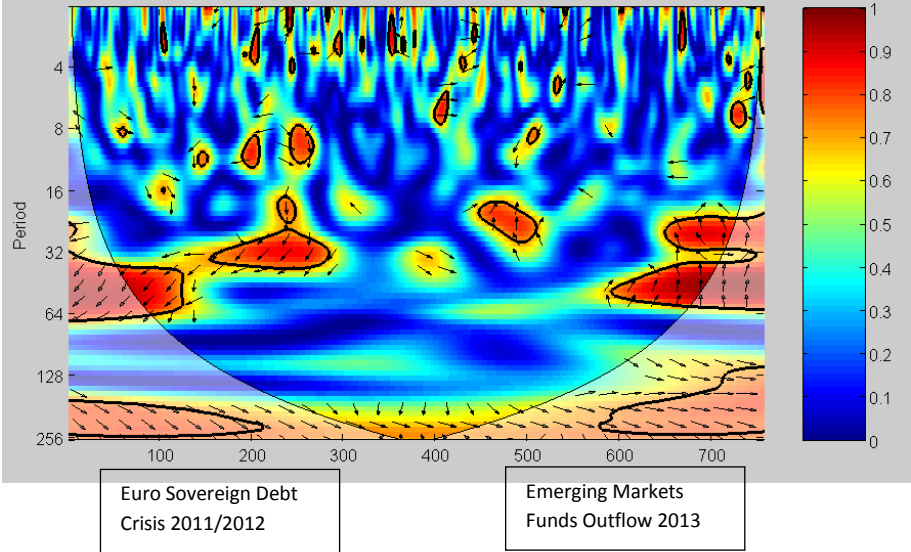


Figure 2: Continuous Wavelet Transform – GCC-SKI and MY-COR

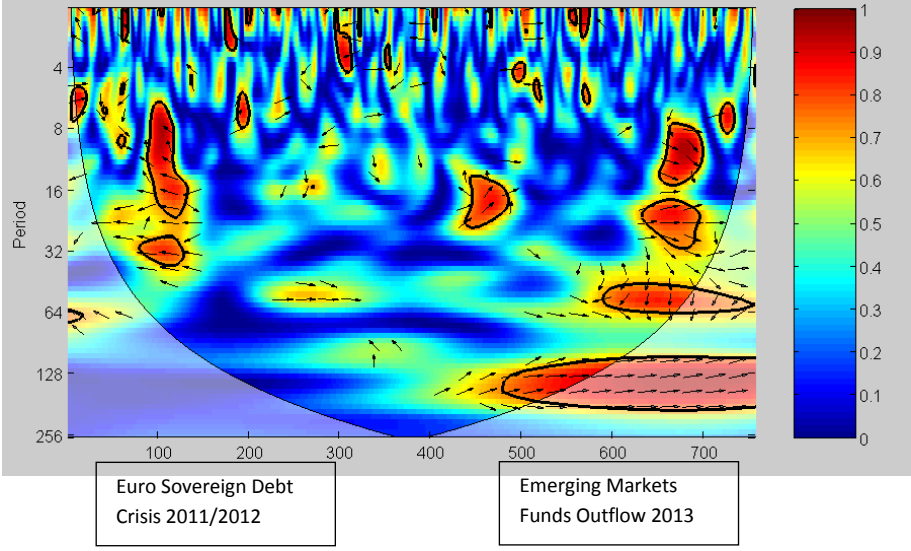
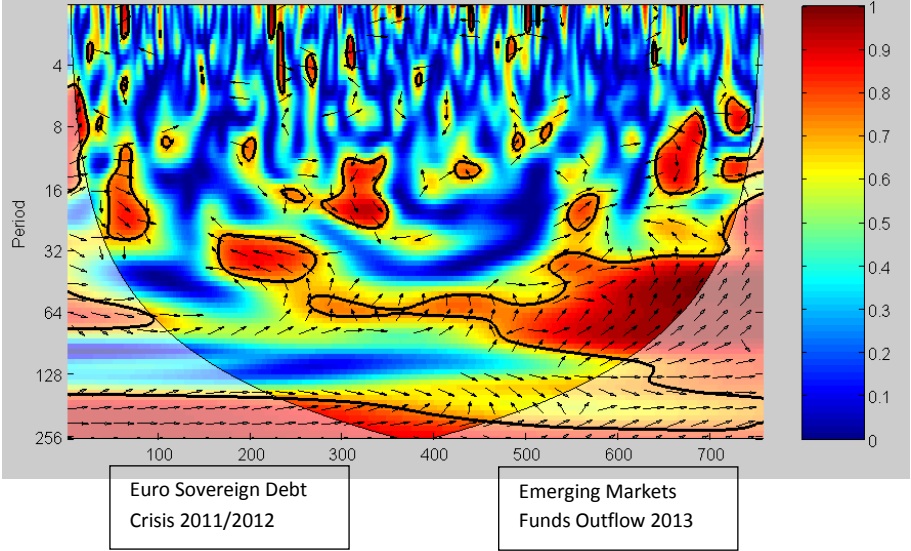


Figure 3: Continuous Wavelet Transform – GCC-SKI and MY-FCY



Analysing the GCC sukuk returns and the Malaysian sovereign sukuk returns, we find that the correlations between the two are low as evident by the greater number of blue and light blue spots on the coherence diagram. These shades indicate that the correlations between these two have remained lower than 0.5 across the sample period. Notable exceptions are brief periods in 2011/2012 and then in 2013 where investors with holding periods between 32 trading days to 64 trading days witnessed strong correlations in returns which would have eroded portfolio diversification benefits. This result is plausible as during the peak of the euro zone crisis and emerging markets volatilities in 2011/2012 and 2013 respectively, the markets react sharply in the initial outbreak of the crisis causing similar price movements across various markets and hence generating stronger correlations in returns. Various studies indicate that domestic factors are likely to be correlated with global factors to some extent, particularly in times of a large global common shock (for e.g. Eichengreen and Mody, (2000); Gonzalez-Rozada and Yeyati, (2008); Miyajima et al, (2012)). Only after a passage of time do investors gradually revert to fundamentals and avoid panic-driven investment behaviour. Other than this exception, the returns between the two sukuk indices seem lowly correlated, thus providing portfolio diversification benefits to sukuk investors.

Almost consistent observations are found when analyzing the GCC sukuk returns and the Malaysian corporate sukuk returns. The presence of greater number of blue and light blue shades on the coherence map indicates low correlations between the GCC sukuk and Malaysian corporate sukuk returns. The two exceptions, namely the Eurozone sovereign debt crisis period and the emerging markets funds outflow crisis period, also have an impact here although the investor panic-driven investment behaviour is observed across a larger scale of sukuk holding period ranging from 8 trading days to 64 trading days.

A critical finding in correlations between the GCC sukuk returns and the Malaysian sukuk returns is that there is no statistically significant evidence of stronger correlations in the long-term (128 trading to 256 trading days holding period) at the 5% level of significance. This finding critically suggests that the held-to-maturity strategy of sukuk investors will not impede any portfolio diversification benefits. The findings of low correlations in the long-term are consistent with the results in literature studying bond portfolios diversification (for e.g. Levy and Lerman (1988), DeGennaro et al. (1994), Clare et al. (1995) and Yang (2005)). The finding is also consistent with the time-varying properties of bond correlations in literature which indicates correlations are not consistent across time (for e.g. Cappiello et al. (2006), Hunter and Simon (2005), Kim et al. (2006) and Ciner (2007)). More importantly, the results are consistent with Hansson et al (2009) who, using a sample of bond indices from 11 developed countries and 10 emerging markets, had concluded that although correlations have increased in developed markets over time during 1997-2006, the emerging market debts within both government and corporate bonds still offer lower correlations.

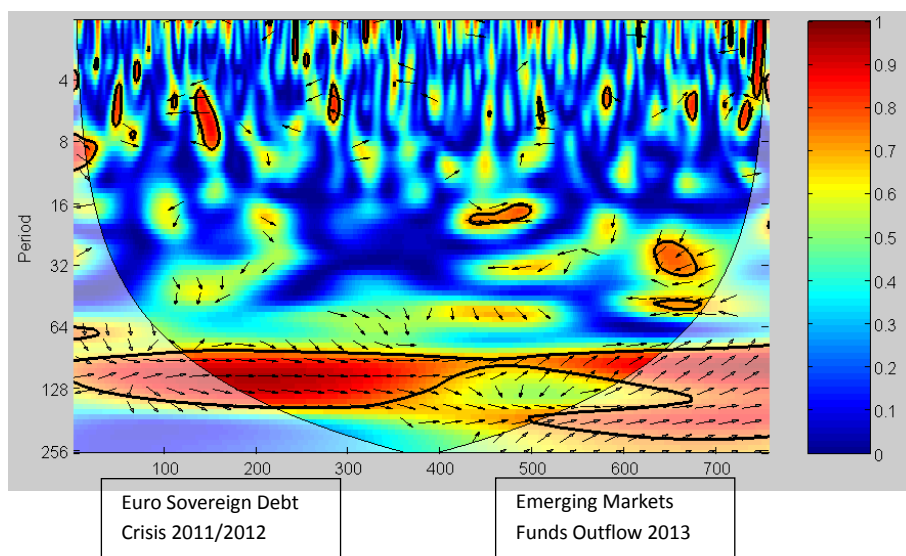
The previous two analyses involved studying local currency Malaysian sukuk investments. We extend the study by comparing the correlations of returns between the GCC sukuk index and the foreign currency sukuk issued in Malaysia. The GCC currencies are pegged to the US Dollar and hence allow ready comparison between foreign currency sukuk issued in Malaysia, mostly issued in US Dollar, and the GCC sukuk issuances. The results obtained are strikingly different. The portfolio diversification benefits at the lower scales appear to be strong given the low correlations as indicated by the blue shades on the coherence diagram in Figure 3. However, for longer-term holding periods of 32 days and beyond, the correlations are quite strong over 0.5 indicating the returns move together. This erodes portfolio diversification benefits for investors with longer holding periods. More critically, this finding suggests that held-to-maturity strategy for international currency sukuk instruments impedes portfolio diversification benefits. The results give credence to the branch of literature which argues that currency effects are important when studying bond diversifications (for e.g. Eichengreen and Hausman (1999); Burger and Warnock, (2007); Miyajima et al (2012)). This branch of literature demonstrates that domestic factors – particularly monetary

and fiscal policy – play a relatively more important role in determining investment behavior in local currency bonds as compared to international currency bonds where global factors such as US bond yields play a more important role.

6.2. Domestic Portfolio Diversification

Figure 4 presents the estimated wavelet coherence and phase difference of Malaysian sovereign sukuk returns with the Malaysian corporate sukuk market returns from scale 1 (one day) up to scale of 8 (one market year, 256 trading days) using continuous wavelet transformations (CWT). As before, in this figure, time is shown on the horizontal axis in terms of number of trading days during the sample years 2010-2013, while the vertical axis refers to the investment horizon in terms of investors' sukuk holding periods (e.g. 2-4 days, 4-8 days, 8-16 days, etc.). The curved line below shows the 5% significance level which is estimated using Monte Carlo simulations and the region beyond this boundary is not statistically significant for interpretations at the 95% confidence level. The figure follows a colour code as illustrated on the right with power ranges from blue (low correlations which indicate weak relationship between the two time series) to red (high correlations which indicate strong relationship between the two time series).

Figure 4: Continuous Wavelet Transform – MY-SOV and MY-COR



Analysing the Malaysian sovereign and corporate sukuk returns, we find that the correlations between the two are low in the lower time scales as evident by the greater number of blue and light blue spots on the coherence diagram in Figure 4. However, for longer-term holding periods of 64 trading days and beyond, the correlations are quite strong over 0.8 indicating the returns move together. This erodes portfolio diversification benefits for investors with longer holding periods. The results can be plausibly explained given the fact that the domestic bonds market is influenced by the same macroeconomic factors that would have an impact on the whole market. The whole domestic market would respond to similar macroeconomic fundamentals such as inflation, interest rates, economic growth, unemployment, etc. and in the long-run, the returns on the fixed-income instruments would mirror these fundamentals, thus leading to stronger correlations. We have illustrated this branch of literature earlier which clearly speaks about these characteristics where domestic monetary and fiscal policy has a more important influence on the domestic bond markets (for e.g. Eichengreen and Hausman (1999); Burger and Warnock, (2007); Miyajima et al (2012)).

6.3. Summary of the Results

In a summary, our findings indicate that the returns on sukuk denominated in local currencies of respective issuing countries (for e.g. Malaysia and the GCC) have low international correlations,

thus effectively enabling international portfolio diversification benefits for investors. Exceptions are periods when the global economy are affected by severe shocks (for e.g. Eurozone sovereign debt crisis in 2011/2012) in which cross-border market returns demonstrate convergence and as such the sukuk market returns are strongly correlated, eroding any potential portfolio diversification benefits. However, we do not find any statistically significant evidence to indicate that local currency sukuk returns are strongly correlated in the long-term and hence, the held-to-maturity strategy of sukuk investors will not impede international portfolio diversification benefits.

On the other hand, the results for international currency sukuk returns (for e.g. sukuk issued in US Dollar in Malaysia) are opposite as the results indicate at the 95% confidence level that sukuk returns are strongly correlated in the long-term. Hence, the held-to-maturity strategy of sukuk investors will impede any effective international portfolio diversification opportunity when the investments are in international-currency denominated sukuk. This finding is also applicable in a domestic market context as our results indicate that returns on Malaysian sovereign sukuk and corporate sukuk converge in the long-run, thus eroding portfolio diversification benefits. Our findings are plausibly explainable with theories and empirical results from existing studies analyzing the portfolio diversification opportunities in the world bond markets. Overall, our findings highlight the significance of heterogeneity in investment horizons for the sukuk investors and this bears important implications for portfolio diversification strategies.

7. Concluding Remarks and Policy Implications

The Islamic bonds or sukuk market is one of the fastest growing sectors of the global Islamic finance industry. Nonetheless, lack of tradability in secondary markets for sukuk instruments has been a longstanding concern among the Islamic finance industry stakeholders (Harvey and Cosgrave, 2012). It is often regarded that both institutional and retail sukuk investors generally hold the sukuk certificates till their maturity (Mahmood, 2012). However, to the best of our knowledge, the literature has a critical gap in terms of studying the portfolio diversification opportunities available to sukuk investors and also evaluating these opportunities in the light of held-to-maturity strategies adopted by sukuk investors. As a result, this paper (using recently available data and recent empirical methodologies) has made the first attempt to study the portfolio diversification strategies for Islamic bond (sukuk) portfolios across heterogeneous investment horizons using the Malaysian and the Gulf Cooperation Council (GCC) sukuk markets as a case study.

Our findings critically indicate that the returns on sukuk denominated in local currencies of respective issuing countries (for e.g. Malaysia and the GCC) have low international correlations, thus effectively enabling international portfolio diversification benefits for investors. Exceptions are periods when the global economy are affected by severe shocks (for e.g. Eurozone sovereign debt crisis in 2011/2012) in which cross-border market returns demonstrate convergence and as such the sukuk market returns are strongly correlated, eroding any potential portfolio diversification benefits. However, we do not find any statistically significant evidence to indicate that local currency sukuk returns are strongly correlated in the long-term and hence, the held-to-maturity strategy of sukuk investors will not impede international portfolio diversification benefits.

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findings highlight the significance of heterogeneity in investment horizons for the sukuk investors and this bears important implications for portfolio diversification strategies.

8. Limitations / Suggestions for Future Research

The most notable limitation in this research has been the sample size consisting of 757 trading days' observations or approximately 3 years of data. Furthermore, the unavailability of data which segregates GCC sukuk returns into sovereign and corporate is another limitation. Future studies are recommended to address this as more data become available with the passage of time. The analysis in this study has also relied on benchmark sukuk returns indices. Future studies may consider using actual sukuk returns data to construct optimal portfolios and then compare and contrast portfolio returns and diversification possibilities.

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