Assessing the viability of Sukuk for portfolio diversification using MS-DCC-GARCH.

Adekunle, Salami Saheed and Masih, Mansur

INCEIF, Malaysia, INCEIF, Malaysia

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Salami Saheed Adekunle[1] and Mansur Masih[2]

Abstract

Many of the earlier researches postulate that Sukuk, being of some fundamental difference from conventional bond, offers a diversification strategy for investors and portfolio managers. However, other works have argued that Sukuk has many properties it shares with the conventional bonds and as a result it might not be a viable strategy for portfolio diversification. In essence, the viability of Sukuk for portfolio diversification remains unresolved both theoretically and empirically. This paper therefore examines the viability of international diversification benefits of Sukuk for equity investors in conventional stock markets. A comparison of the Sukuk diversification benefits with other conventional alternatives from advanced and emerging markets was carried out. Markov regime-switching GARCH model with dynamic conditional correlations (MS-DCC-GARCH) was applied. The regime-based model provides insight to possible segmentation (or integration) of these securities from global markets during different market states for weekly return series for conventional (advanced and emerging) and Islamic stock and bond indices examined. Asymmetric shocks are observed from conventional stocks and bonds into Sukuk. Compared to emerging market bonds, Sukuk are found to display a different pattern in the transmission of global market shocks. The analysis of dynamic correlations suggests a low degree of association between Islamic bonds and global stock markets with episodes of negative correlations observed, particularly during market crises periods. Portfolio performance analysis suggests that Islamic bonds provide valuable diversification benefits that are not possible to obtain from conventional bonds

[1]Graduate student in Islamic finance at INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia.

[2] **Corresponding author**, Professor of Finance and Econometrics, INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia. Phone: +60173841464 Email: mansurmasih@inceif.org

1. Introduction

Over the past four decades there has been a sustained growth of Islamic finance especially in the Middle-East and Southeast Asian countries. Not only have Islamic equities and mutual funds attracted much global attention with a number of Islamic equity indexes now offered by global index Managerial Finance providers, the market in Islamic bonds (Sukuk) has also experienced extraordinary growth with the total issuance value growing from $5 billion in 2003 to over $130 billion in 2013 (Wall Street Journal, 2013). Although sovereigns have been the main driver of Sukuk issues, Islamic banks and corporations in the Middle-East and Southeastern Asia have played an increasingly active role in the supply of these securities in order to expand their capital positions and increase the duration of their funding sources. At the same time, persistently low yields in conventional bond markets coupled with advantageous credit fundamentals offered by Sukuk due to Sharia-based restrictions have fueled interest in these securities beyond the Middle-East and Southeastern Asia with a number of sovereigns and corporations globally slated to tap into this emerging market segment in the next several years (Mensah, 2014). Sukuk represent a distinct class of securities with both bond and stock-like features. Unlike conventional bonds, cash payments from Sukuk are based on some form of profit-sharing formula, rather than pre-determined fixed interest rates. Furthermore, Sukuk are backed by tangible assets underlying the security and thus represent ownership in real assets that are permissible to invest in under Sharia guidelines.

Additionally, the Sharia-based limitations on the nature of assets (or businesses) underlying these securities further limit the fundamental sources of risk in these securities as a result of ethical investing rules. To that end, it can be suggested that these securities exhibit segmentation from conventional markets and thus are generally immune to shocks in conventional equity and bond markets. Clearly, such a proposition would have significant portfolio diversification and hedging implications. Despite numerous studies focusing on the performance of Islamic equities and mutual funds (e.g. Hoepner et al., 2011; Hayat and Kraussl, 2011; Jawadi et al., 2014 and more recently, Balcilar et al., 2015) and on the co-movement between Islamic equity and bond markets (e.g. Aloui et al., 2015a, b), the topic of volatility interactions across the conventional equity and bond markets and Sukuk is understudied. From an investment perspective, debt securities are an indispensable part of any diversification strategy and numerous studies in the literature have examined the relationship between conventional stock and bond markets in the context of portfolio diversification (e.g. Connolly et al., 2005).

Based on the asset backed nature of Sukuk and Sharia-based limitations on the type of investments underlying these securities, it can be argued that these securities would exhibit different risk/return dynamics compared to conventional bonds. Furthermore, recent evidence suggests that Islamic bonds are negatively correlated with Islamic stocks, particularly during periods of high volatility (Aloui et al., 2015b), while Hammoudeh et al. (2014) find that Islamic stocks exhibit significant dependence with major global equity markets in the USA, Europe, and Asia. It can then be argued that Islamic bonds would exhibit negative correlation with global equity markets, further motivating a study of diversification benefits of these securities for global equity portfolios. Therefore, given these recent findings in the Islamic finance literature, a natural research question is whether these securities could be a viable alternative to conventional bonds as a diversification tool for stock portfolios.

This study has several contributions to the emerging literature on Islamic finance as well as international finance. First, we examine the risk transmissions from global debt and equity markets as well as Islamic equities to the market for Islamic bonds by employing a Markov regime-switching GARCH model with dynamic conditional correlations (MS-DCC-GARCH). Jung and Maderitsch (2014) note two channels through which volatility transmission across financial markets can occur. While the first channel relates to potentially (auto) correlated information flows, the second channel reflects spillovers of market uncertainty. To that end, extending volatility spillover tests to conventional and "Sharia-restricted" Sukuk markets provides insight to the transmission of shocks from a different perspective.

Second, utilizing a MS-DCC model, I examine the dynamic correlations between Islamic bonds and conventional equity markets. The MS-DCC model allows the oppourtunity to formally address the time-variation in volatility and correlation dynamics during different market regimes and allows us to make inferences on the potential diversification benefits of these securities for conventional equity portfolios. Finally, we examine the in- and out-of-sample performance of alternative diversification strategies by supplementing conventional and Islamic equity portfolios with conventional and Islamic bonds one at a time. By doing so, we explore whether Islamic bonds can be a viable alternative to conventional bonds in global diversification strategies.

The findings show that volatility in global debt and equity markets has opposite spillover effects on Islamic bonds. We find positive spillover effects from global equities on Islamic bonds while a negative volatility spillover is observed from global bonds into Islamic bonds. While the finding of positive spillover effects from global stock markets is consistent with the presence of common market uncertainties driving risk globally, the negative spillover effect observed from global bonds suggests that good and bad news in global debt markets have an opposite impact on return dynamics in Islamic bonds. Nevertheless, the unconventional negative spillover effect from global bonds suggests some degree of segmentation of Islamic bonds from their conventional counterparts.

The analysis of dynamic correlations generally suggests a low degree of association between Islamic bonds and global stock markets with episodes of negative correlations observed, particularly during market crisis periods. Employing alternative portfolio strategies based on the moments obtained from the MS-DCC-GARCH model, we find that developed and emerging market stock portfolios supplemented with positions in Islamic bonds yield significantly higher risk adjusted returns compared to portfolios supplemented with either emerging or developed market bonds. While the in-sample analysis yields superior diversification benefits from conventional bonds for stock portfolios in advanced and emerging markets, the out-of-sample analysis suggests that Islamic bonds can indeed serve as better diversifiers for conventional stock portfolios compared to conventional bonds. Overall, the findings suggest that Islamic bonds can provide valuable diversification benefits for conventional stock portfolios that are not possible to obtain from conventional bonds, underscoring the significance of Islamic bonds as a viable alternative to its conventional counterparts.

2. Literature review

The dynamics of market volatility and risk transmission in conventional stock and bond markets have been extensively studied in the literature. Starting with the pioneering works of Ramchand and Susmel (1998) and Ng (2000) that utilize regime-switching models in volatility models, numerous subsequent studies including Baele (2005), Gebka and Serwa (2006) and Jung and Maderitsch (2014) have examined the role of regime-dependence and structural breaks in market volatility and risk spillovers in The strand of the literature that focusses on portfolio diversification issues has mainly examined the correlation between stock and government bond returns in order to provide insight to the diversification benefits of bonds for equity portfolios. Earlier studies including Fleming et al. (1998) and Scruggs and Glabadanidis (2003) argue that government bonds can serve as safe havens, while Cappiello et al. (2006) note the presence of asymmetries in conditional correlations between stock and bonds returns, particularly during market downturns.

In the same vain, examining multiple markets, Kim et al. (2006) detect a downward trend in time-varying stock/bond correlations in advanced stock markets, while regime-based applications of Connolly et al. (2005) and Guidolin and Timmermann (2006) document negative stock/bond correlations during periods of high market volatility. In more recent studies, Chan et al. (2011), Ciner et al. (2013), and Flavin et al. (2014) further support safe haven benefits of US Treasury bonds for equity investors during periods of market stress. On the other hand, the literature on Islamic financial markets is still emerging with a heavy focus on the investment performance of Islamic equity indexes and mutual funds compared to their conventional counterparts. Studies that focus on Islamic equity indices suggest that these securities provide superior performance compared to their conventional counterparts, particularly during periods of market downturns and crisis periods (e.g. Ashraf and Mohammad, 2014; Al-Khazali et al., 2014; Ho et al., 2014).

Many of the works on Islamic bonds, including Miller et al. (2007) and Wilson (2008) suggest that Islamic bonds are structured in a way that is comparable to their conventional counterparts, which makes it easier to assess their risks and come up with risk ratings on these securities. On the other hand, Cakır and Raei (2007) offer a conflicting perspective, suggesting that these securities are different from their conventional counterparts and document significant diversification benefits of these securities in conventional bond portfolios.

The recent literature on Islamic bonds focusses on the co-movements between the equity and bond segments of Islamic financial markets. Studies including Kim and Kang (2012) and Aloui et al. (2015a) document significant dependence between these two Islamic market segments in Malaysian, and the Gulf Cooperation Council markets, respectively. However, the literature has not yet provided a comprehensive analysis of volatility interactions across conventional stock/bond markets and the market for Islamic bonds that could provide valuable insight to the potential diversification benefits of these securities suggested by Cakır and Raei (2007). From an economic perspective, the fact that Sukuk are backed by tangible assets and thus represent ownership in real assets that are permissible to invest in under Sharia guidelines differentiates these securities from their conventional counterparts.

As the Sharia based limitations on the nature of assets (or businesses) underlying these securities eliminate any businesses with involvement in activities such as alcohol, tobacco, pork-related products, gambling, entertainment, weapons, and conventional financial services and disallow activities involving speculation and short-selling (Balcilar et al., 2015), Islamic bonds can be expected to provide superior diversification compared to conventional bonds due to the limited nature of risk in these securities.

3. Methodology

The DCC model proposed in this study is constructed along the lines of Billio and Caporin (2005), Lee (2010), Chang et al. (2011), and more recently, Balcilar et al. (2016). Let Rt¼[Rsu,t, Rbd,t, Rbe,t, Rsd,t, Rse,t, Rsi, Rvd,t, Rve,t, RTb,t]0 be the (9×1) vector of returns where Rsu,t is global Sukuk total bond return; Rbd,t (Rbe,t) is the developed (emerging) market government bond return; Rsd,t (Rse,t) is the developed (emerging) market stock return; Rsi,t is the Islamic (Sharia compliant) market stock return; Rvd,t (Rve,t) is the return on developed (emerging) market volatility index; and RTb,t is the ten-year US Treasury Bill rate, respectively. The GARCH specification for the volatility spillover model follows Ling and McAleer (2003) and is specified as:

$$Rt = \phi_0 + \sum_{i=1}^{p} \phi R_{t-1} + \varepsilon_t \ - 1$$

Where Dt = diag ($h_{su,t}^{1/2}, h_{su,t}^{1/2}, h_{bd,t}^{1/2} h_{be,t}^{1/2}, h_{sd,t}^{1/2}\ \ h_{ssit}^{1/2}$) is the vector of the conditional volatility terms. The conditional mean of the return vector Rt is specified as a vector autoregressive process of order p with (9×9) parameter matrices Φi, i¼1,2,…, p. The unexplained component εt follows a GARCH specification described as εt|ψt–1~ID (0, Pt) where Pt is the time-varying variance-covariance matrix. Denoting the conditional variance matrix as Ht¼[hsu,t, hbd,t, hbe,t, hsd,t, hse,t, hsi,t, hvd,t, hve,t, hTb,t]0, we impose the following specification which allows for volatility spillover in the model

It should be noted that the non-diagonal forms of the matrices A and B allow volatility spillovers acrossthe series. Following Engle (2002), we allow conditional correlations to vary over time by specifying the variance-covariance matrix Pt¼DtΓtDt where Γt is the conditional correlation matrix.

A distinct feature of the model is that the conditional correlation matrix, Γt, follows regime-switching as governed by a discrete Markov process and is defined as Γt¼diag {Qt}–1/2Qtdiag{Qt}–1/2. In order to incorporate regime shifts into the DCC model specified in Equations (1) and (2), we follow Billio and Caporin (2005) and introduce a Markov regime-switching dynamic correlation model by specifying Qt as: Qt ¼ 1_a st ð Þ_b ½ ðstÞ_Qþaðstޞe ð2Þ t_1 þbðstÞQt_1 (3)

Where Q is the unconditional covariance matrix of the standardized residuals. In Equation (3), α (st) and β (st) are the regime-dependent parameters that control the regime-switching system dynamics where st∈ {1, 2, 3} is the state or regime variable following a first-order, three-state discrete Markov process. Note that the variances in this specification are regime-independent whereas the covariances (or correlations) are both time-varying and regime-switching [1]. As Billio and Caporin (2005) note, the specification in which all parameters are regime dependent is highly unstable due to the large number of switching parameters. Therefore, we restrict the regime dependent structure to the time-varying correlations only. Thus, the model allows both volatility spillover and regime-switching dynamic correlations. The specification is then completed by defining the transition probabilities of the Markov process as pij¼ P(st+1¼i|st¼j) where pij is the probability of being in regime i at time t+1 given that the market was in regime j at time t with regimes i and j taking values in {1, 2, 3}.

4. Empirical results

4.1 Data

The dataset consists of weekly closing prices for conventional and Islamic stock and bond market indices as well as additional risk and liquidity variables obtained from Bloomberg and DataStream for the period January 2, 2007-January 2, 2017, We differentiate between developed and emerging markets in order to separately assess volatility interactions of these markets with their Islamic counterparts. Conventional stock markets are represented by Dow Jones developed markets global stock index (DEVSTOCK) and Dow Jones emerging markets global stock index (EMRSTOCK).Conventional bond markets are represented by JPMorgan developed markets government bond total return index (DEVBOND) and JP Morgan emerging markets government bond total return index (EMRBOND). Similarly, Dow Jones Islamic stock index (ISLSTOCK) and Dow Jones Sukuk global total return index (SUKUK) are used to represent Shariah compliant stock and bond markets, respectively. Finally, global risk and liquidity related variables are represented by the CBOE volatility index (USVIX), CBOE emerging markets volatility index (EMRVIX), and ten-year US Treasury Bill rate (USTB10).

Table I provides several descriptive statistics for the variables employed in the analysis. Panel A reports the statistics for log returns and Panels B and C report the Pearson correlation coefficient estimates for the full sample and subprime mortgage crises period (December 2007-June 2009), respectively. It is observed in Panel A that emerging market stocks exhibit the largest volatility in returns compared to their developed and Islamic counterparts with 2.920, 2.222, and 2.161 percent return volatility for emerging, developed, and Islamic stocks, respectively. A similar pattern is observed in the bond market with emerging market bonds experiencing the largest volatility in returns of 1.471 percent. Interestingly, Islamic stocks and bonds have the lowest return volatility compared to conventional counterparts while Islamic stocks dominate their conventional counterparts in both risk and return.

Pearson correlation coefficient estimates reported in Panels B and C of Table I indicate that both emerging and developed stock markets exhibit high correlations with all return series except Islamic and developed market bonds as well as the US Treasury Bill returns. Interestingly, emerging market bond returns are highly correlated with emerging, developed, and Islamic equity returns while developed market bonds have relatively lower correlations with equity returns in general. On the other hand, Islamic bonds exhibit significantly low correlations with all equity indices both in the full sample (Panel B) and during the subprime crises period (Panel C). The observed low correlations among Islamic bonds and equities indicate potential diversification benefits of these securities for equity investors in general. We observe generally higher correlations among security returns during the subprime crises period (Panel C). Out of the 36 pairwise correlations reported in Table I, It is observed that 22 of them increase during the subprime crises period, with the largest increase observed in the case of emerging market stock/bond correlation. Interestingly, the only exception is Islamic bonds with lower correlations observed between Islamic bonds and equity returns during this period. Overall, the analysis of correlations suggest that Islamic bonds display possible segmentation from equity markets in general, more significantly during market crisis periods.

4.2 Estimation results

In order to identify the best fitting MS (k)-DCC-GARCH, a battery of specification tests have been performed using the filtering procedure of Hamilton (1990).

Panel A: descriptive statistics for log returns (%)

	Mean (%)	SD (%)	Min (%)	Max (%)	Skewness (%)	Kurtosis (%)	JB	Q (1)	Q (4)	ARCH (1)	ARCH (4)
SUKUK	0.086	0.943	−12.535	6.170	−6.164	87.748	154,134.625***	22.101***	50.838***	0.794	1.319
DEVBOND	0.083	0.733	−2.312	4.746	0.482	3.435	251.444***	46.669***	57.137***	0.086	29.649***

EMRBOND 0.094 1.471 –8.926 4.475 –0.979 4.399 457.109*** 24.357*** 29.715*** 17.633*** 112.555***

DEVSTOCK 0.062 2.222 –15.465 7.350 –1.215 6.217 877.423*** 13.934*** 17.304*** 44.191*** 52.553***

EMRSTOCK 0.061 2.920 –19.838 10.993 –1.085 6.192 847.680*** 20.037*** 29.119*** 13.680*** 96.213***

ISLSTOCK 0.089 2.161 –15.269 6.406 –1.239 6.348 914.345*** 14.900*** 17.220*** 45.372*** 53.097***

USVIX 0.114 10.148 –35.018 43.723 0.461 1.669 72.208*** 0.23 1.582 7.001*** 10.407**

EMRVIX 0.094 5.851 –15.562 49.286 1.975 12.028 3,151.192*** 16.220*** 17.183*** 2.253 12.477**

USTB10 3.226 1.024 1.474 5.216 0.220 –1.057 25.170*** 462.916*** 1,800.992*** 453.087*** 450.819***

Panel B: Pearson correlation coefficient estimates for the full sample

RSUKUK RDEVBOND REMRBOND RDEVSTOCK REMRSTOCK RISLSTOCK RUSVIX REMRVIX RUSTB10

SUKUK 1.0000

DEVBOND 0.0699 1.0000

EMRBOND 0.0387 0.3522 1.0000

DEVSTOCK 0.0252 0.0389 0.7200 1.0000

EMRSTOCK 0.0203 0.0790 0.7946 0.8911 1.0000

ISLSTOCK 0.0282 0.0415 0.7204 0.9843 0.9051 1.0000

USVIX 0.0011 0.1389 –0.4839 –0.7042 –0.5818 –0.7029 1.0000

EMRVIX –0.0055 0.0109 –0.6658 –0.6568 –0.6999 –0.6728 0.6505 1.0000

USTB10 –0.0271 –0.5679 0.0875 0.3749 0.2939 0.3792 –0.3604 –0.2184 1.0000

Table I. Descriptive statistics and correlations

Panel C: Pearson correlation coefficient estimates for the subprime mortgage crises period (December 2007-June 2009)

RSUKUK RDEVBOND REMRBOND RDEVSTOCK REMRSTOCK RISLSTOCK RUSVIX REMRVIX RUSTB10

SUKUK 1.0000

DEVBOND 0.0204 1.0000

EMRBOND –0.0537 0.3475 1.0000

DEVSTOCK 0.0002 0.0840 0.7661 1.0000

EMRSTOCK –0.0465 0.0744 0.8063 0.9249 1.0000

ISLSTOCK 0.0037 0.0804 0.7619 0.9836 0.9282 1.0000

USVIX 0.0511 0.0601 –0.5710 –0.7714 –0.7219 –0.7698 1.0000

EMRVIX 0.1011 0.0690 –0.6821 –0.6673 –0.7452 –0.6920 0.6450 1.0000

USTB10 0.0972 –0.6599 0.0266 0.2357 0.2552 0.2611 –0.1866 –0.1630 1.0000

Panel A provides the descriptive statistics for log returns. The ten-year US Treasury Bill rate (USTB10) is reported in terms of log percentage levels in Panel A and in percentage in Panel B. The sample period covers January 2, 2006-December 19, 2014 with n¼468 weekly observations. SUKUK stands for the Dow Jones Sukuk global total return index for Shariah compliant bonds, DEVBON for the JP Morgan developed markets government bond total return index, EMRBOND for the JP Morgan emerging markets government bond total return index, DEVSTOCK is the Dow Jones developed markets global stock index, EMRSTOCK is the Dow Jones emerging markets global stock index, ISLSTOCK is the Dow Jones Islamic (Shariah compliant) stock index, USVIX for the CBOE volatility index, EMRVIX for the CBOE emerging markets volatility index, and USTB10for the ten-year US Treasury Bill rate. In addition to the mean, the standard deviation (SD), minimum (min), maximum (max), skewness, and kurtosis statistics, the table reports the

Jarque-Bera normality test (JB), the Ljung-Box first (Q (1)) and the fourth (Q (4) autocorrelation tests, and the first (ARCH (1)) and the fourth (ARCH (4)) order Lagrange multiplier (LM) tests for the autoregressive conditional heteroskedasticity (ARCH). Panels B and C provide the Pearson correlation coefficient estimates for the full sample and for the subprime mortgage crises period of December 2007-June 2009, respectively. *, **, ***Significant at 10, 5 and 1 percent levels, respectively

Table I.

Modification suggested by Billio and Caporin (2005), followed by the smoothing algorithm of Kim (1994). We further use the Akaike, Bayesian, and Hannan-Quinn information criteria in order to compare the static DCC-GARCH as well as two-regime and three-regime MS-DCC-GARCH alternatives. Both formal tests (Panel F of Table II) and information criterion (Panel D of Table II) consistently favor a three-regime model over the static DCC-GARCH and two-regime MS-DCC-GARCH alternatives, establishing strong support for the presence of three regimes implied by the data [2].

Panel C in Table II presents several statistics describing the properties of the three market regimes. The smoothed probability estimates presented in Figure 1 suggest that the first regime largely corresponds to periods of low market volatility, while the second regime corresponds to high volatility periods surrounding large market downturns or crashes in global markets. On the other hand, the third regime, the crash regime, matches the largest crash in the Islamic bond market following the credit crunch of 2007/2008 and the global recession. Further discussion of regime properties is provided in the Appendix due to space limitation [3].Examining the volatility spillover parameters (ai, j, bi, j) relating to Equation (2) reported in Panel A of Table II, we observe a highly significant and negative spillover effect from developed bonds to Islamic bonds whereas a positive spillover effect is observed from emerging market bonds. This suggests that positive fundamentals in bond markets from advanced nations decrease conditional volatility in the market for Islamic bonds. On the other hand, uncertainty surrounding emerging bond market returns spills over to the market for Islamic bonds, implying an association of risk across emerging conventional and Islamic bond markets. In the case of volatility spillovers from stock markets to Islamic bonds, we find a significant positive spillover effect from developed stock markets to Islamic bonds whereas negative volatility spillovers are observed from emerging market stocks as well as Islamic stocks to the market for Islamic bonds. It is possible that good news in emerging equity markets (including Islamic equities) diverts global capital to these equity market segments, crowding out funds in the market for Islamic bonds, thus leading to a negative spillover effect. Formal volatility spillover tests (reported in Table AI) further support these findings, implying significant volatility spillovers from conventional developed markets to the market for Islamic bonds while spillover tests for emerging markets provide mixed evidence.

Focusing on the DCC between Islamic bonds and conventional counterparts reported in Figure 2, we observe a significant structural break in late-2008 with the correlations displaying a positive trend after this period. On the other hand, examining the correlations between Islamic bonds and equities, we observe fairly low correlation values not exceeding 20 percent in most cases. Interestingly, we observe negative correlations between Islamic bonds and conventional stock markets more significantly during the 2008global crisis period, suggesting that Islamic bonds could have served as a safe haven for equity investors during that period. Overall, our analysis of DCC clearly suggest a low degree of association between Islamic bonds and stock market returns with episodes of negative correlations observed, particularly during market crisis periods.5. Diversification benefits of Islamic bonds

5.1 Mean-variance spanning tests

In order to provide preliminary insight to the diversification potential of Islamic bonds for global equities, we first employ the mean-variance spanning tests originally proposed by Huberman and Kandel (1987) and examine whether adding Islamic bonds to equity

Panel A: variance parameters

SUKUK DEVBOND EMRBOND DEVSTOCK EMRSTOCK

Ci 0.0161 (0.0012) *** 0.3714 (0.0111) *** 0.4512 (0.0523) *** 0.2919 (0.0476) *** 1.4021 (0.2540) ***

Ai1 0.2470 (0.0024) *** −0.0251 (0.0386) 0.0657 (0.0179) *** −0.0286 (0.0273) 0.0881 (0.0428) **

Ai 2 −0.1106 (0.0037) *** 0.1174 (0.0341) *** 0.0168 (0.0648) 0.0130 (0.0577) −0.3321 (0.1555) **

ai3 0.0838 (0.0026) *** −0.0808 (0.0209) *** −0.0656 (0.0100) *** −0.0368 (0.0226) 0.0947 (0.0343) ***

ai4 0.1230 (0.0038) *** −0.1710 (0.0056) *** 0.0977 (0.0046) *** −0.2289 (0.0095) *** −0.0478 (0.0215) **

ai5 −0.0103 (0.0017) *** 0.0083 (0.0019) *** −0.1239 (0.0054) *** 0.1026 (0.0050) *** −0.0349 (0.0086) ***

ai6 −0.1801 (0.0030) *** 0.1642 (0.0048) *** 0.0854 (0.0036) *** 0.2021 (0.0076) *** 0.1523 (0.0129) ***

ai7 0.0013 (0.0008) −0.0084 (0.0027) *** 0.0049 (0.0024) ** −0.0156 (0.0041) *** 0.0020 (0.0048)

ai8 −0.002 (0.0012)* 0.0040 (0.0044) −0.0388 (0.0028) *** 0.0222 (0.0042) *** 0.0027 (0.0078)

ai9 0.0012 (0.0029) 0.0140 (0.0084)* −0.0390 (0.0117) *** 0.0043 (0.0099) −0.0066 (0.0101)

bi1 0.7905 (0.0001) *** −0.7461 (0.0234) *** 0.0528 (0.0436) −0.5214 (0.0266) *** −0.3775 (0.0861) ***

bi2 −0.2369 (0.0229) *** −0.3509 (0.0201) *** −0.2395 (0.2031) −0.8487 (0.3390) ** −0.0609 (0.5082)

bi3 0.7243 (0.0257) *** −0.1997 (0.0158) *** 0.4571 (0.0184) *** 0.1808 (0.0529) *** −1.5608 (0.0457) ***

bi4 0.4009 (0.0183) *** −0.0978 (0.0211) *** 0.0666 (0.0047) *** 0.5837 (0.0065) *** 0.5031 (0.0160) *** bi5 −0.1685 (0.0146) *** −0.1209 (0.0085) *** 0.1044 (0.0024) *** 0.0872 (0.0093) *** 0.7264 (0.0117) ***

bi6 −0.4499 (0.0148) *** −0.1267 (0.0133) *** 0.1299 (0.0034) *** 0.1932 (0.0084) *** 0.3126 (0.0136) ***

bi7 0.1373 (0.0042) *** −0.1254 (0.0088) *** 0.0969 (0.0046) *** 0.0310 (0.0041) *** 0.0670 (0.0092) ***

bi8 −0.1287 (0.0037) *** 0.2045 (0.0202) *** −0.0916 (0.0019) *** 0.0382 (0.0027) *** −0.1911 (0.0151) ***

bi9 0.3930 (0.0241) *** −0.3278 (0.0072) *** 0.0410 (0.0331) 0.0468 (0.0158) *** −0.1148 (0.0352) ***

ISLSTOCK USVIX EMRVIX USTB10

Ci 0.2781 (0.0465) *** 84.1460 (4.8962) *** −3.5523 (1.6914) ** −0.4328 (0.0890) ***

ai1 −0.0025 (0.0114) 1.0173 (0.1234) *** −0.6904 (0.0230) *** 0.1274 (0.1447)

ai2 −0.0178 (0.0514) −0.0708 (0.5503) 0.3151 (0.0776) *** −0.1346 (0.0489) ***

ai3 0.0120 (0.0183) 0.1206 (0.1711) −0.8557 (0.0401) *** 0.1920 (0.0809) **

ai4 0.1492 (0.0048) *** 0.6036 (0.0784) *** 0.0819 (0.0050) *** 0.5146 (0.0036) ***

ai5 0.0994 (0.0034) *** 0.0117 (0.0541) 0.0482 (0.0043) *** 0.0844 (0.0184) ***

ai6 −0.1966 (0.0103) *** −0.8782 (0.0388) *** −0.0238 (0.0044) *** −0.6183 (0.0490) ***

ai7 −0.0184 (0.0017) *** 0.0478 (0.0248)* 0.0505 (0.0067) *** −0.0148 (0.0103)

ai8 0.0346 (0.0032) *** −0.0641 (0.0301) ** 0.0522 (0.0144) *** 0.0838 (0.0167) ***

ai9 0.0084 (0.0089) −0.0529 (0.0569) −0.0194 (0.0327) 0.0728 (0.0197) ***

bi1 −0.6066 (0.0129) *** 2.9026 (0.1814) *** −2.7967 (0.1709) *** 0.3208 (0.2061)

bi2 0.3840 (0.1983)* −3.6005 (1.5709) ** 0.5021 (0.9562) −0.2142 (0.1069) **

bi3 −0.4545 (0.0237) *** 9.5631 (0.5990) *** −2.2089 (0.1015) *** −0.2401 (0.1595)

bi4 0.0834 (0.0033) *** 1.4441 (0.1060) *** 0.2253 (0.1267)* 1.0795 (0.0612) ***

bi5 0.3309 (0.0094) *** 1.0966 (0.0676) *** −0.8537 (0.0732) *** 0.9759 (0.0538) ***

bi6 0.5281 (0.0043) *** −2.7716 (0.0834) *** −0.9749 (0.0702) *** −2.4568 (0.1086) ***

bi7 0.0237 (0.0043) *** 0.1581 (0.0229) *** 0.7213 (0.0230) *** −0.1905 (0.0221) ***

bi8 0.0005 (0.0067) 0.7730 (0.0528) *** −0.5620 (0.0359) *** −0.0784 (0.0031) ***

bi9 0.1443 (0.0103) *** −1.6528 (0.1622) *** 0.9386 (0.2251) *** 0.7668 (0.0242) ***

Panel B: DCC parameters

A (st¼1) 0.0308 (0.0021) *** Panel C: regime properties

B (st¼1) 0.9429 (0.0090) *** in Prob. Duration

A (st¼2) 0.0166 (0.0078) ** Regime 1 280.60 0.60 7.36

B (st¼2) 0.8813 (0.0864) *** Regime 2 141.70 0.31 2.80

A (st¼3) 0.0884 (1.4083) Regime 3 43.80 0.09 3.15

B (st¼3) 0.6979 (0.2955) **

Panel D: model diagnostics

MS (3)-DCC-GARCH MS (2)-DCC-GARCH DCC-GARCH

Log L −6,435.646 −6,572.781 −7,378.9501

AIC 28.612 28.991 32.2487

HQ 29.421 29.628 32.7212

BIC 30.6665 30.609 33.4493

Table II. Estimates of the MS DCC- GARCH Model

Portfolios can improve the minimum-variance frontier [4]. For this purpose, we consider three benchmark portfolios represented by developed, emerging, and developed plus emerging stock market portfolios and test each of these portfolios against the portfolio that is supplemented with Islamic bonds. We consider seven variants of mean-variance spanning tests that include the following: Lagrange multiplier (LM), likelihood ratio, and

Wald tests (W) are regression-based tests based on Huberman and Kandel (1987). Wa is the heteroskedasticity and autocorrelation consistent version of the Wald test and is computed using the Newey-West (1987) method. J1 and J2 are the tests based on the stochastic discount factor (SDF) approach of Bekaert and Urias (1996). J3 is the SDFbased test proposed by DeSantis (1993). The findings are reported in Table III.

Panels A-C in Table III report the results for the full sample period as well as the pre- and post-2010 periods, respectively. Pre- and post-2010 panels are included in order to check the robustness of the findings. We observe that, at 5 percent significance level, all seven variants of the spanning tests reject the null hypothesis that the benchmark portfolio spans the portfolio that is supplemented by Islamic bonds. This result uniformly holds in the full sample and the post-2010 sample. However, it must be noted that spanning tests are static global tests of one portfolio against the same portfolio supplemented by other assets. Therefore, they should not be expected to hold in every sub-period. Another shortcoming of the spanning tests is their in-sample nature. To that end, our dynamic analysis presented in the next section provides a more comprehensive insight as we examine both the in-sample and out-of-sample diversification benefits of Islamic bonds using dynamic correlations in a regime switching environment.

5.2 Dynamic portfolio analysis

The dynamic portfolio analysis considers three alternative stock portfolios in order to represent the "undiversified" investor, i.e. the conventional developed stock market

Panel E: transition probabilities

Regime 1 0.864 0.132 0.004

Regime 2 0.266 0.643 0.091

Regime 3 0.002 0.315 0.683

Panel F: linearity tests

H0: MS (3)-DCC-GARCH H0: MS (2)-DCC-GARCH H0: MS (3)-DCC-GARCH

H1: DCC-GARCH H1: DCC-GARCH H1: MS (2)-DCC-GARCH

1,886.608 (0.0000) *** [0.0000] 1,612.338 (0.0000) *** [0.0000] 274.270 (0.0000) *** [0.0000]

HQ, Hannan-Quinn information criterion; BIC, Bayesian information criterion; log L, log likelihood.

This table reports

The estimates of the k-regime MS (k)-DCC-GARCH model given in Equations (1)-(3). The parameter estimates of the VAR are not reported to save space. The VAR lag order is selected by the Bayesian Information Criterion (BIC) as 1 while GARCH (1, 1) specification is utilized. The MS-DCC-GARCH model is estimated using the maximum likelihood (ML) method. The likelihood ratio statistic tests the constant parameter DCC-GARCH model under the null against the alternative MS (k)-DCC-GARCH model for k¼2, 3 and the 2-regime model against the 3-regime model. The test statistic is computed as the likelihood ratio

(LR) test. The LR test is nonstandard since there are unidentified parameters under the null. The χ2 p-values (in parentheses) with degrees of freedom equal to the number of restrictions as well as the number of restrictions plus the numbers of parameters unidentified under the null are given. The p-value of the Davies (1987) test is also given in the square brackets. Panel C reports the ergodic probability of a regime (long-run average probabilities of the Markov process), the number of observations falling in a regime (ni) based on regime probabilities, and the average duration of a regime. The models are estimated over the full sample period January 3, 2006-December 19, 2014 with 467 observations. Standard errors of the Table II. Estimates are given in parentheses. *, **, ***Significant at 10, 5, and 1 percent levels, respectively portfolio, the conventional emerging stock market portfolio, and Islamic stock portfolio.

Following a number of papers including Hammoudeh et al. (2010), Lee (2010), and hang et al. (2011), we form bivariate portfolios by supplementing each “undiversified “stock portfolio with Islamic bonds and conventional bonds one at a time and examine the risk adjusted returns corresponding to each diversified portfolio. Two alternative portfolio strategies are considered: the risk-minimizing portfolio position of Kroner and Sultan (1993) [5]; and the optimal portfolio weight of Kroner and Ng (1998) [6].

Table IV provides the summary statistics for the in-sample period covering January 3, 2006-December 13, 2013 with 414 weekly portfolio points. Panels A-C present the

1.00

0.75

0.50

0.25

0.00

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

1.00

0.75

0.50

0.25

0.00

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

1.00

0.75

0.50

0.25

0.00

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

(a)

(b)

(c)

Notes: Smoothed probability of low volatility regime (regime 1); Smoothed probability of High volatility regime (regime 2); Smoothed probability of extreme (crash) volatility regime (Regime 3). The figures plot the smoothed probability estimates of the low volatility regime (Regime 1), the high volatility regime (regime 2), and extreme (crash) volatility regime (Regime 3). The smoothed probabilities are obtained from the MS-DCC-GARCH model In Equations (1)-(3). The shaded regions in the figures correspond to the periods where The smoothed probability of the corresponding regime is the maximum

Figure 1.Smoothed probability estimates

Findings for “undiversified” stock portfolios representing an investor who is currently Fully invested in advanced, emerging, or Islamic stock markets, respectively. For Example, in Panel A, the shaded row labeled “undiversified” provides the summary Statistics for an undiversified investor who is currently fully invested in advanced stock Markets with a mean return of 0.056 percent and standard deviation of 2.314 percent.

_su,ve,t

0.0

–0.1

–0.2

2006 2008 2010 2012 2014

_su,Tb,t

0.0

–0.1

–0.2

–0.3

2006 2008 2010 2012 2014

0.3

_su,bd,t

0.2

0.1

0.0

_su,be,t

0.3

0.2

0.1

0.0

_su,sd,t

0.2

0.1

0.0

–0.1

_su,se,t

–0.1

0.2

0.1

0.0

_su,si,t

0.2

0.1

0.0

–0.1

_su,vd,t

–0.1

0.1

0.0

The figure plots the dynamic correlation estimates from the three-regime MS-DCC-GARCH model given in Equations (1)-(3). The symbol _su, j,t stands for the dynamic correlation between Islamic bond return series and series *j* at time *t*, *i*, *j* _{bd,be,sd,se,si,vd,ve,Tb}, where *bd* (*be*) stands for the developed (emerging) markets bond returns, *sd* (*se*,*si*) stands for the developed (emerging, Islamic) markets stockreturns, *vd* (*ve*) stands for the developed (emerging) markets volatility index returns, and Tb stands for the ten-year US Treasury bond rate. The correlation coefficients are regime-dependent and are directly obtained from Equations (1)-(4) using the ML estimation. Since the correlations are regime-dependent and the three sets of correlations_ij,1,t , _ij,2,t , and _ij,3,t are estimated for regimes 1, 2, and 3, we obtain _ij,t as_ij,t=p1,t_ij,1,t+p2,t_ij,2,t+p3,t_ij,3,t, where pk,t=P(st=k|_ t–1), *k*=1,2,3, is the predictive probability of being in regime *k* at time *t*

Figure 2.

Dynamic correlation estimates from the MS-DCC-GARCH model

Comparing alternative diversification strategies in Panel A, we see that Islamic bonds fail to provide significant diversification compared to advanced and emerging market bonds, implied by lower Sharpe ratios. Despite the fact that supplementing the stock portfolio with Islamic bonds generally improves risk adjusted returns, advanced, and emerging market bonds consistently offer better diversification for the global stock investor. Similar results are observed for emerging and Islamic stock market investors presented in Panels B and C, respectively. In each case, supplementing stock portfolios with Islamic bonds fail to provide as much diversification as offered by conventional bond portfolios.

The underperformance of Islamic bonds compared to its conventional counterparts during the in-sample period is most likely due to the prolonged crash observed in the Islamic bond market during the 2008-2010 period. Developed markets Emerging markets

Developed plus

Emerging markets

	Statistic	p-value		Statistic	p-value		Statistic	p-value
Panel A: full sample								
LM	146.153	o0.001	LM	304.083	o0.001	LM	142.201	o0.001
LR	175.295	o0.001	LR	491.792	o0.001	LR	169.578	o0.001
W	212.728	o0.001	W	871.650	o0.001	W	204.457	o0.001
Wa	280.357	o0.001	Wa	618.354	o0.001	Wa	291.859	o0.001
J1	9.238	0.010	J1	9.365	0.009	J1	8.582	0.014
J2	9.226	0.010	J2	9.337	0.009	J2	8.589	0.014
J3	7.233	0.027	J3	6.589	0.037	J3	6.827	0.033
Panel B: pre-2010 sample								
LM	52.091	o0.001	LM	110.136	o0.001	LM	49.307	o0.001
LR	60.005	o0.001	LR	157.198	o0.001	LR	56.318	o0.001
W	69.607	o0.001	W	235.362	o0.001	W	64.723	o0.001
Wa	147.457	o0.001	Wa	205.427	o0.001	Wa	134.369	o0.001
J1	9.225	0.010	J1	9.199	0.010	J1	7.388	0.025
J2	9.211	0.010	J2	9.182	0.010	J2	7.421	0.025
J3	6.390	0.041	J3	6.558	0.038	J3	6.625	0.036
Panel C: post-2010 sample								
LM	192.780	o0.001	LM	245.961	o0.001	LM	201.665	o0.001
LR	351.704	o0.001	LR	758.894	o0.001	LR	388.565	o0.001
W	745.650	o0.001	W	4,555.065	o0.001	W	898.825	o0.001
Wa	303.362	o0.001	Wa	1,946.453	o0.001	Wa	329.918	o0.001
J1	25.160	o0.001	J1	25.590	o0.001	J1	23.478	o0.001
J2	26.551	o0.001	J2	26.036	o0.001	J2	25.368	o0.001
J3	29.268	o0.001	J3	30.717	o0.001	J3	31.136	o0.001

The table reports the findings from seven alternative mean-variance spanning tests applied to three benchmark portfolios. The three benchmark portfolios include developed markets, emerging markets, and developed plus emerging market portfolios. Each of these portfolios is tested against the alternative that is supplemented with Islamic bonds. The mean-variance spanning tests reported in the table include the following: Lagrange multiplier (LM), likelihood ratio (LR), and Wald tests (W) are regression-based tests based on the approach of Huberman and Kandel (1987). Wa is the heteroskedasticity and autocorrelation consistent (HAC) version of the Wald test and is computed using the Newey-West (1987) method. J1 and J2 are the tests based on stochastic discount factor (SDF) approach of Bekaert and Urias

(1996). J3 is the SDF-based test proposed by DeSantis (1993). Panels A-C report the results for the full sample period and the pre- and post-2010 periods, respectively. The symbol “o” signifies less than the number it precedes

The table reports the results of the out-of-sample portfolio analysis. The out-of-sample period covers December 14, 2013-December 19, 2014 with 52 weekly portfolio points. The out-of-sample estimates are obtained as one step forecasts recursively over the out-sample period. MR and OW portfolios correspond to the risk-minimizing portfolio position of Kroner and Sultan (1993) and optimal portfolio of Kroner and Ng (1998), respectively. The shaded row in each panel represents an undiversified investor who is fully invested in the corresponding equity portfolio

Summary statistics for the out-of-sample portfolios

Islamic bonds for stock portfolios in this market segment. Overall, our findings suggest that Islamic bonds can indeed serve as better diversifiers for conventional stock portfolios compared to conventional bonds. However, conflicting performance outcomes observed for the in- and out-of-sample periods underscore the importance of dynamic diversification strategies that utilize these securities [7].

6. Conclusion

The market for Islamic bonds (Sukuk) has experienced significant growth over the past decade with a number of sovereigns and corporations globally slated to tap into this emerging market segment in the next several years. A number of papers in the Islamic finance literature argue that the Sharia-based limitations on the nature of assets (or businesses) underlying Islamic bonds limit the fundamental sources of risk in these securities as a result of ethical investing rules. To that end, it can be argued that these securities exhibit segmentation from conventional markets and thus are generally immune to shocks in conventional equity and bond markets. The first contribution of this study is to examine the risk transmissions from global debt and equity markets as well as Islamic equities to the market for Islamic bonds. The next is to estimate a Markov regime-switching GARCH model with DCC (MS-DCC-GARCH) and examine DCC between Islamic bonds and conventional financial markets. Finally, this was followed by comparison of the diversification benefits of Islamic bonds with its conventional counterparts and explore whether Islamic bonds could be an alternative diversification tool for stock portfolios globally.

The results suggest that Islamic bonds are not immune from shock and volatility spillovers from global conventional markets. Interestingly, however, volatility in global debt and equity markets has opposite spillover effects on Islamic bonds. We find positive spillover effects from global equities on Islamic bonds while a negative volatility spillover is observed from global bonds into Islamic bonds. While the finding of positive spillover effects from global stock markets is consistent with the presence of common financial market uncertainties driving risks globally, the negative spillover effect observed from global bonds suggests that good and bad news in global debt markets have an opposite impact on return dynamics in Islamic bonds. Nevertheless, the unconventional negative spillover effect from global bonds suggests some degree of segmentation of Islamic bonds from their conventional counterparts.

The analysis of dynamic correlations suggests a low degree of association between Islamic bonds and global stock markets with episodes of negative correlations observed, particularly during market crisis periods. The low degree of correlation plays a significant role in the performance of these securities as diversifiers for global stock portfolios. While the in-sample analysis yields superior diversification benefits by conventional bonds for stock portfolios in advanced and emerging markets, the out-of-sample analysis suggests that Islamic bonds can indeed serve as better diversifiers for conventional stock portfolios compared to conventional bonds. Interestingly, Islamic bonds do not provide significant diversification benefits for Islamic stocks possibly due to common fundamentals driving Islamic financial markets in general. However, Islamic bonds can provide valuable diversification benefits for conventional stock portfolios that are not possible to obtain from conventional bonds. Overall, our findings clearly underscore the significance of Islamic bonds as a viable alternative to its conventional counterparts.

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