The determinants of co-movement dynamics between *sukuk* and conventional bonds

M. Kabir Hassan[a,*], Andrea Paltrinieri[b], Alberto Dreassi[c], Stefano Miani[b], Alex Sclip[b]

[a] Department of Economics and Finance, University of New Orleans, New Orleans, LA 70148, United States
[b] University of Udine, Via Tomadini 30/A, 33100 Udine, Italy
[c] University of Trieste, Via Valerio 4/1, 34127 Trieste, Italy

ARTICLE INFO

Article history:
Accepted 22 September 2017

JEL classification:
G15
G11
D5

Keywords:
Sukuk
Islamic finance
Dynamic correlations
Diversification
Corporate bonds
Multivariate GARCH

ABSTRACT

This paper adopts a multivariate GARCH framework to examine conditional correlations and volatility linkages between *sukuk* (Islamic bonds) and conventional bond markets in Europe, the United States, and emerging markets. We find that *sukuk* and conventional investment-grade bonds have a lower reaction of conditional volatility to market shocks and higher persistence; we also find that *sukuk* returns are much less volatile than U.S. and EU investment-grade bonds. Further, we find a time-varying, positive, conditional correlation between *sukuk* returns and leading bond markets, which is driven by changing macroeconomic and market conditions. We observe that during recessions, the dynamic correlation between *sukuk* and bond markets tends to increase. Moreover, we unveil structural breakpoints in paths of dynamic correlations corresponding to external shocks, such as the sovereign debt crisis and the Federal Reserve's tapering announcements. Finally, we examine how market-wide factors affect correlations. We find significant behavioral shifts in the *sukuk*-bonds relationship, which are explained by market liquidity, crude oil prices, U.S. credit information, and stock market uncertainty. Our results have useful implications for *sukuk* issuers, portfolio managers, and risk managers in both emerging and developed markets.

1. Introduction

Low interest rates and increased volatilities are challenging the optimization of bond portfolios. As a result, investment managers seek new global strategies able to diversify traditional risks while maintaining desired profitability. *Sukuk* (*Shari'a*-compliant bonds) are "certificates representing a proportional undivided ownership right in tangible assets, or a pool of predominantly tangible assets, or a business venture" (Islamic Financial Services Board, 2009). They identify specific assets backing a transaction and temporarily transfer their ownership to the bondholders. Are their differences a potential solution for bond portfolio managers?

In this paper, we build a market-capitalization-weighted *sukuk* index to investigate volatility and dynamic conditional correlations between Islamic and conventional bond markets in Europe, the United States, and emerging markets in the period 2010–2014. Specifically, we attempt to answer two main research questions. *Do Islamic bonds behave differently from conventional bonds in terms of co-movements, dynamic correlations, and volatility? What drives changes in their dynamic conditional correlations?*

Our paper fills an existing literature gap. Few studies in finance analyze correlations of conventional bonds empirically (Cappiello, Engle, & Sheppard, 2006; Hunter & Simon, 2005). Furthermore, co-movements and correlations between conventional stocks and *sukuk* received attention only recently (Akhtar, Jahromi, John, & Moise, 2012; Hamida, 2015a, 2015b; Hamida, 2015a, 2015b), but a similar comparison with conventional bonds is not available yet. Only Maghyereh and Awartani (2016) examine the transmission of returns and volatility between *sukuk* and other bond and stock markets. Our study takes a different perspective, since we analyze volatility and dynamic correlation changes together with their determinants, including the presence of structural breakpoints. Moreover, we analyze different market regions (the United States, the EU, and emerging markets) and segments (investment-grade and high-yield instruments).

We find that *sukuk* and conventional bonds follow a similar path over the long run in terms of volatility and correlations. We also find that *sukuk* and conventional investment-grade bonds have a lower

* Corresponding author.
E-mail addresses: mhassan@uno.edu (M.K. Hassan), andrea.paltrinieri@uniud.it (A. Paltrinieri), adreassi@units.it (A. Dreassi), stefano.miani@uniud.it (S. Miani), sclip.alex@spes.uniud.it (A. Sclip).

https://doi.org/10.1016/j.qref.2017.09.003
.

conditional volatility in reaction to market shocks and higher persistence, with *sukuk* expressing less volatile returns than U.S. and EU investment-grade bonds. We provide evidence that correlations increase during recessions; however, *sukuk* tends to maintain lower dynamic correlations over the long run.

For the second research question, following Aloui et al. (2015b), we expect market liquidity, credit risk, and crude oil prices to influence correlation increases; to these factors we add a measure of stock market uncertainty. Moreover, we find important evidence of structural breakpoints in the correlation paths corresponding to the European Sovereign debt crisis and the Federal Reserve's tapering announcement.

Finally, this study links to the relevance of *sukuk*, which is the fastest growing sector of Islamic finance, with a CAGR of almost 20% over 2008–2013 and evidence of persistence at this pace (Fitch, 2016). Outstanding *sukuk* could reach $1 trillion soon (GIFR, 2012; Moody's, 2014). Non-Islamic markets are increasingly attracted to this segment: in mid-2014, the UK hosted for the first time a $3 billion issue. Demand was 10 times the supply. Luxembourg and Honk Kong have since followed.

The remainder of the paper is organized as follows. Section 2 reviews the literature and presents our hypotheses. Sections 3 and 4, respectively, detail our research methodology and data. Section 5 discusses our findings, whereas Section 6 concludes with our final remarks and related implications for portfolio and risk managers.

2. Literature review and hypothesis development

What is the link between bonds and *sukuk* instruments? Despite the importance of the bond market and the increased tendency for portfolio managers to receive global mandates, few studies investigate this question. Furthermore, questions regarding bond cross-market relationships still exist and there is no general consensus among researchers about their dynamic co-movements.

We identify three main research streams of empirical finance pertinent to our study, based on their methodology: studies based on unconditional correlations, those that investigate cointegration across markets and those focusing on time-varying properties of correlations.

Older research on international fixed-income markets relies on unconditional correlations and provides mixed results in terms of diversification benefits as the sample periods become more recent (Iben & Litterman, 1994; Levy & Lerman,1988; Solnik, Boucrelle, & Le Fur, 1996). In particular, as Hansonn, Liljeblom, and Loflund (2009) claim for 1997–2006, only diversification into emerging debt markets expands the unconditional mean-variance frontier of both government and corporate bond portfolios.

However, unconditional correlation coefficients do not distinguish between short- and long-run relationships. Further studies, refining the methodology, analyze the cointegrating relationships of bond markets. Even with this improvement, results are mixed.

For example, preliminary research by DeGennaro, Kunkel, and Lee (1994) and Clare and Lekkos (2000) do not find any long-run cointegration relationship among government bonds of five major industrialized countries. The researchers attribute this finding to the presence of market-access barriers. Yang (2005) confirms this in a different time span, though Barassi, Caporale, and Hall (2001) and Smith (2002) find the opposite. Ciner (2007), examining daily instead of monthly data for the same sample, detects evidence of cointegration only when subperiods are considered.

More recently, the empirical literature on international bond market co-movements focuses on time-varying properties of correlations and has important implications for monetary policies and portfolio managers. The majority of papers investigate yield co-movements and the influence of fundamental variables on volatility spillovers.

Investigating portfolio diversification benefits, Hunter and Simon (2005) find an increase in correlations during 1992–2002, suggesting that periods of high conditional volatility or negative returns lead to lower correlations. Cappiello et al. (2006) develop a model to explore cross-market dynamics by allowing conditional asymmetries in volatilities and correlations; they find that the latter increase in U.S., European EMU and non-EMU bond markets. In contrast with Hunter and Simon (2005), the authors provide evidence that, in the bond market, correlations and volatilities tend to move together.

A fourth research stream, specific to Islamic financial instruments, offers a small number of recent contributions. Although Kuran (2004) argues that a substantial indifference exists between Islamic and non-Islamic finance in terms of efficiency and stability, for instance, others stress the differences in Islamic banking products and governance structures due to religious principles (Elnahass, Izzeldin, & Abdelsalam, 2014) and point to a higher stability of Islamic banks (Cihak & Hesse, 2010). Beck, Demirguc-Kunt, and Merrouche (2013) highlight higher asset quality, greater capitalization, and better stock performance for listed Islamic banks, especially during the subprime financial crisis.

Despite the exponential growth of *sukuk*, just a few studies focus on these instruments. Godlewski, Turk-Ariss, and Weill (2013), for example, compare stock market reactions to announcements of *sukuk* and conventional bond issues in Malaysia, finding a negative market reaction to the former. Godlewski, Turk-Ariss, and Weill (2016) show that *sukuk* type and *Shari'a* scholar reputation affect how stock markets react to the issuance. Alam, Hassan, and Haque (2013) shows that the market reaction is negative for the announcements of Sukuk before and during 2007 global financial crisis, and is positive for announcement of conventional bond before the crisis period and negative during and after crisis periods. Hassan and Oseni (2014) analyzes the existing regulation and supervision of sukuk markets in the world. Oseni and Hassan (2015) examines the importance of governing laws in sukuk transaction both conceptually and through a survey of 10 sukuk issues, and concludes that it may be more appropriate to resolve any dispute arising from a Sukuk transaction under Sharī'ah-compliant rules and supervised by experts in Islamic law.

Maghyereh and Awartani (2016) consider spillover of returns and volatility between *sukuk* and *Shari'a*-compliant stocks with their conventional counterparts, using a spillover index approach. They find a different transmission mechanism for *sukuk* that is attributable to their greater proximity to equity markets than conventional bonds.

Two conflicting hypotheses may predict co-movements of *sukuk* and bonds. The first hypothesis is closely related to the theoretical arguments regarding the relationship among *sukuk*, stocks, and bonds. According to some scholars (Aloui et al., 2015a,b; Kim and Kang, 2012; Wilson, 2008), we cannot expect substantial differences, as *sukuk* and traditional securitizations have generally similar structures (Onder, 2016) and thus *sukuk* are not a financial innovation. Within this stream, Aloui et al. (2015a) assess co-movements between *Shari'a* compliant stocks and *sukuk* in the Gulf Cooperation Council (GCC) countries, finding that Islamic assets experience co-movements similar to conventional stocks and bonds, with the overall portfolio diversification varying across frequencies and time. In a subsequent paper (Aloui et al., 2015b), researchers investigate international factors driving these co-movements, showing that oil prices and credit-event information had a positive impact in 2008–2013. Kim and Kang (2012), using a multivariate GARCH model, document the existence of unidirectional volatility spillovers from *Shari'a*-compliant stocks to *sukuk* during the subprime financial crisis.

On the other hand, Iqbal and Mirakhor (2007) and Cakir and Raei (2007) claim that Islamic assets are distinct from traditional assets based on their underlying religious codes. More precisely, five principles distinguish Islamic financial products: the prohibition of explicit interest rates (*riba*), excessive uncertainty (*gharar*), and specific markets or products (pork, alcohol, weapons), as well as requirements that the contractual parties share profits and losses, and that the operations maintain a direct link to the real economy. In this framework, *sukuk* are certificates reflecting participation rights in underlying assets that define the instruments' performance, potentially behaving as a hybrid of bonds and equity. Moreover, the prohibition of excessive uncertainty extends to short selling, arbitrage, and pure speculation—the main drivers of volatility linkages between asset classes (Fleming, Kirby, & Ostdiek, 1998).

Akhtar et al. (2012) argue that Islamic assets provide substantial diversification benefits during financial crises and show lower volatility linkages than conventional stocks and bonds. Balcilar, Cerci, and Demirer (2015) offer a similar view, reporting even a negative correlation between *sukuk* and global stock markets during financial crisis. This behavior implies a significant role for *sukuk* in offering diversification benefits to global stock portfolios.

Given these views of *sukuk*, we are not able to exclude *a priori* that differences or similarities are contingent not only on the financial instrument used as a comparison, but also on their geographical scope. Therefore, our contrasting hypotheses are as follows:

- *H1a: Investors consider* sukuk *similar to conventional bonds, with no material differences between the two assets in terms of dynamic conditional correlations and their determinants.*
- *H1b: Investors consider* sukuk *different from conventional bonds, and this affects their dynamic conditional correlations and their determinants, suggesting that* sukuk *offers diversification benefits.*

3. Econometric methodology

To analyze the properties of *sukuk* and the implications for portfolio and risk managers, we adopt a two-step methodology. First, we investigate if *sukuk* and corporate bonds are cointegrated in the long-run. Then, we analyze cross-market dynamic conditional correlations.

Cointegration is important for portfolio managers, as it measures long-run relationships across markets. The Johansen (1988, 1991) maximum likelihood estimator provides a powerful test for cointegration restrictions in a VAR representation.

Dynamic conditional correlations are measured with a multivariate GARCH model, where volatilities and correlations are a function of past returns. To overcome their computational issues, we implement a dynamic conditional correlation (DCC) GARCH model (Engle, 2002), which is an extension of the constant correlation estimator (CCC) obtained by introducing a time-varying effect in the correlation matrix. Our choice follows Engle and Sheppard (2005): DCC offers the best performance among the families applicable to large panel models and is more powerful than the CCC-GARCH.

The multivariate DCC model is shown in the following equations:

$$\begin{cases} \varepsilon_t = \sigma_t \eta_t \\ \sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_{0i}\varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_{0j} h_{t-j} \end{cases} \tag{1}$$

where σ_t^2 is any univariate GARCH model, α_{0i} and β_{0j} are non-negative constants, and ω is a (strictly) positive constant.

$$\begin{cases} H_t = D_t R_t D_t \\ D_t = diag(\sigma_{11t}^{1/2} \ldots \ldots \sigma_{NNt}^{1/2}) \\ R_t = diag[Q_t]^{-1} Q_t \, diag[Q_t]^{-1} \end{cases} \tag{2}$$

where D_t is a $n \times n$ diagonal matrix of time-varying standard deviations from univariate GARCH models with $\sqrt{h_{it}}$ on the diagonal, and R_t is a correlation matrix, with the $n \ x \ n$ symmetric positive definite matrix $Q_t = \left(q_{ij,t}\right)$ given by:

$$Q_t = \left(1 - \alpha - \beta\right)\bar{Q} + \alpha u_{t-1} u'_{t-1} + \beta Q_{t-1} \tag{3}$$

where standardized residuals $u_t = \varepsilon_{it}/\sqrt{h_{iit}}$ and α and β are non-negative scalar parameters satisfying $\alpha + \beta < 1$.

Eq. (1) models the conditional variances of *sukuk* and bond indexes as a GARCH (1,1) process, where variances of each index return are a function of their past squared innovations and variances. We set a univariate standard GARCH (1,1) process for all time series rather than its asymmetric evolutions. This is consistent with the lower asymmetry in conditional volatilities of returns for bonds versus equities (Cappiello et al., 2006). Once the univariate volatility models are fitted, we use the standardized residuals to estimate the correlation parameters by using the DCC model described in Eq. (2).

4. Data and preliminary analysis

We collect daily data for six corporate bond indexes (combining investment-grade and high-yield for Europe, the United States, and emerging markets) from Bloomberg Professional Services for January, 1, 2010 to December, 31, 2014. As the transmission of information in bond markets increased in speed, we prefer daily data to weekly and monthly data.

We use Bloomberg indexes due to their price transparency, instead of relying on single dealer pricing or composite pricing across a small number of dealers, which could bias our analysis. The data draws on more than 4000 market participants. The beginning of our sample period corresponds to the inception date of the Bloomberg fixed-income indexes. As a measure of well-diversified investments in a particular geographical area, indexes are market-capitalization weighted, which could be useful for benchmarking purposes and portfolio indexing (details are provided in Table 1).

Unfortunately, Bloomberg does not provide an index on *sukuk* instruments. Therefore, we construct an index of such instruments with the same Bloomberg methodology and criteria to avoid selection bias in our analysis.[1] In particular, we collect daily data for 68 highly liquid *sukuk* issuances listed in the major Islamic and non-Islamic markets (Bursa Malaysia, Nasdaq Dubai, and the London Stock Exchange).[2] The selection of *sukuk* instruments is driven by the same criteria required by Bloomberg indexes: (1) maturity of at least one year, (2) outstanding amount in excess of $200 million, (3) at least one rating availability from Moody's, S&P, RAM, or MARC. Moreover, to limit currency effects, we focus only on USD-denominated *sukuk* (the majority within this market). The Bloomberg Professional Services indexes include issuances that are

[1] The technical document is available at: http://www.bloombergindices.com/content/uploads/sites/2/2016/01/633470877_INDX_GFI_WP_151022.pdf.

[2] For *sukuk* prices, we use the Bloomberg generic price (BGN), a market consensus price for corporate and government bonds calculated using prices from several sources in order to obtain highly accurate quotes.

Table 1
Description of Bloomberg corporate indexes.

Market	Name	Ticker
U.S. Investment-Grade	Bloomberg USD Investment Grade Corporate Bond Index	BUSC
U.S. High-Yield	Bloomberg USD High Yield Corporate Bond Index	BUHY
Emerging M. Investment-Grade	Bloomberg USD Investment Grade Emerging Market Corporate Index	BIEM
Emerging M. High-Yield	Bloomberg USD High Yield Emerging Market Corporate Bond Index	BEAC
EU Investment-Grade	Bloomberg Investment Grade European Corporate Bond Index	BECO
EU High-Yield	Bloomberg EUR High Yield Corporate Bond Index	BEUH

Source: Bloomberg Professional Services.
This table presents the cross-country indexes used in our analysis, as well as their tickers and data sources.

Table 2
Sample description.

Features	2010	2011	2012	2013	2014
Issue type:					
- *Al-mudarabah*	3	4	4	4	4
- *Al-ijiara*	7	8	16	20	19
- *Al-musharakah*	3	2	1	1	1
- *Al-wakala*	1	3	5	6	4
Total	14	17	26	31	**28**
Mean values:					
Issue size ($000)	880	825	750	750	750
Market value ($000)	101,617	138,855	185,562	252,943	201,587
Rating (S&P)	A+	A+	A	A+	A+
Coupon (%)	5.13	5.02	4.78	4.15	3.88
Time-to-maturity (years)	3.74	3.63	4.05	3.91	3.76
Effective duration (years)	3.1	3.09	3.28	3.5	3.62
Yield-to-maturity (%)	7.17	4.59	2.97	2.54	2.34
Option-adjusted spread (bps)	253.21	236.51	252.95	184.38	134.81

Source: Bloomberg Professional Services.
This table presents descriptive statistics for the *sukuk* sample used in our analysis, distinguishing the composition in terms of the underlying business model from mean values of volume and performance indicators.

Table 3
Descriptive statistics of returns.

Index	Mean	St. dev.	Skewness	Kurtosis	Normality test	LM test	LM ARCH test
SUKUK	0.035%	0.163%	1.401	18.004	17849***	241.280***	116.62***
BUSC	0.024%	0.282%	−0.408	1.689	188.41***	37.229***	175.00***
BUHY	0.031%	0.183%	−1.872	13.321	10296***	875.990***	239.87***
BIEM	0.025%	0.209%	−1.742	14.216	11519***	274.23***	203.74***
BEAC	0.027%	0.265%	−1.572	14.252	11453***	639.865***	396.58***
BECO	0.013%	0.528%	0.107	1.253	85.956***	24.182**	65.92***
BEUH	0.036%	0.244%	−1.188	10.468	6193.1***	364.995***	247.98***

Significance codes: *** at the 99.99% level; ** at the 99% level.
This table presents the descriptive statistics of returns of all indexes used in our analysis, along with the Ljung-Box autocorrelation test on the first 25 lags (LM-Test) and the LM ARCH test.

Table 4
Correlation matrix between *sukuk* and corporate bond returns.

	SUKUK	BUSC	BUHY	BIEM	BEAC	BECO	BEUH
SUKUK	1	0.167	0.375	0.416	0.409	0.151	0.423
BUSC		1	0.116	0.521	0.108	0.061	0.068
BUHY			1	0.628	0.811	0.214	0.701
BIEM				1	0.716	0.296	0.507
BEAC					1	0.231	0.657
BECO						1	0.318
BEUH							1

This table presents the unconditional correlation matrix of returns between all indexes in our comparison during our sample period (2010–2014).

priced daily. To avoid illiquidity bias due to limited trading, we require the same for *sukuk* issuances. Rebalancing the index takes place on the last trading day of the month. The final number of *sukuk* in our index, therefore, can be interpreted as the universe of *sukuk* that comply with our selection criteria in the aforementioned markets.

Our *sukuk* index has four main *sukuk* types: *Al-Ijara*, involving the lease of a specific asset; *Al-Mudarabah*, where the capital provider and the manager share profits and the former bears all losses except those attributable to misconduct, negligence, or breach of contract of the latter; *Al-Musharakah*, where the capital provider and manager share profits as established in the contract and losses in proportion to the quota held; and *Al-Wakala*, a model similar to an agency agreement, where the manager acts on behalf of the capital provider.

These structures are widely accepted due to their standardization and similarities in terms of risk and returns with conventional bonds. The composition of our index reflects the *sukuk* market in terms of structures. Table 2 summarizes our sample.

Table 3 shows descriptive statistics for the period under investigation (2010–2014). We report summary statistics for returns that are calculated as first differences of the log prices of the indexes. All exhibit daily returns close to zero. *Sukuk* and EU Investment-Grade Corporate Bond (BECO) indexes are positively skewed, but all other indexes are not. In terms of kurtosis, all indexes have fat tails, except the U.S. and European investment-grade indexes.

Table 5
Duration-adjusted and YTM.

Index	Duration-adjusted					YTM				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
SUKUK	3.099	3.092	3.284	3.503	3.619	7.172	4.587	2.971	2.537	2.337
	(−0.147)	(−0.136)	(−0.476)	(−0.104)	(−0.122)	(−0.963)	(−0.826)	(−0.356)	(−0.197)	(−0.113)
BUSC	6.189	6.446	6.962	6.873	7.021	3.873	3.710	3.075	3.030	3.016
	(−0.100)	(−0.179)	(−0.148)	(−0.128)	(−0.108)	(−0.322)	(−0.159)	(−0.286)	(−0.281)	(−0.090)
BUHY	4.255	4.293	4.166	4.282	4.273	8.519	7.552	7.080	6.478	6.354
	(−0.094)	(−0.147)	(−0.075)	(−0.184)	(−0.104)	(−0.673)	(−0.735)	(−0.398)	(−0.369)	(−0.387)
BIEM	5.806	5.896	6.169	6.133	6.174	4.873	4.627	3.953	4.015	4.150
	(−0.097)	(−0.075)	(−0.196)	(−0.164)	(−0.118)	(−0.391)	(−0.193)	(−0.373)	(−0.477)	(−0.214)
BEAC	4.531	4.418	4.086	4.158	3.975	8.028	8.645	8.537	7.450	7.930
	(−0.046)	(−0.095)	(−0.079)	(−0.115)	(−0.059)	(−0.687)	(−1.150)	(−0.704)	(−0.656)	(−0.770)
BECO	4.589	4.665	4.856	4.950	5.139	3.253	3.846	2.838	2.142	1.646
	(−0.079)	(−0.051)	(−0.095)	(−0.060)	(−0.124)	(−0.172)	(−0.147)	(−0.463)	(−0.137)	(−0.253)
BEUH	3.746	3.705	3.411	3.208	3.326	7.905	8.560	7.428	5.130	4.142
	(−0.068)	(−0.061)	(−0.142)	(−0.104)	(−0.114)	(−0.689)	(−1.606)	(−1.110)	(−0.290)	(−0.181)

This table presents the dynamic between duration-adjusted spreads and yield-to-maturity, together with standard deviations (in brackets), across all indexes in our comparison during our sample period (2010–2014) and broken down by year.

Table 6
Ratings and OAS.

Index	Rating					OAS				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
SUKUK	A+	A+	A	A+	A+	253.207	236.505	252.949	184.381	134.809
						(−25.376)	(−47.910)	(−37.951)	(−11.667)	(−14.606)
BUSC	A	A	A−	A−	A−	161.824	179.192	182.850	142.934	115.458
						(−13.626)	(−42.313)	(−23.668)	(−7.703)	(−10.236)
BUHY	B+	B+	B+	B+	B+	590.299	554.031	555.949	462.416	429.502
						(−48.396)	(−122.012)	(−47.946)	(−30.813)	(−50.339)
BIEM	BBB+	BBB+	BBB+	BBB+	BBB+	258.480	271.201	277.389	246.309	231.826
						(−24.035)	(−55.862)	(−35.290)	(−22.623)	(−24.566)
BEAC	BB−	BB−	BB−	BB−	BB−	586.557	683.743	751.011	602.950	635.849
						(−51.732)	(−169.457)	(−73.145)	(−49.716)	(−90.978)
BECO	A+	A	A	A−	A−	137.829	182.375	183.595	110.390	85.434
						(−18.227)	(−49.473)	(−31.690)	(−11.276)	(−5.051)
BEUH	BB−	BB−	BB−	BB−	BB−	537.241	603.668	601.088	402.550	315.716
						(−58.383)	(−195.357)	(−83.226)	(−36.191)	(−39.508)

This table presents the dynamic of ratings and option-adjusted spreads, together with standard deviations (in brackets), across all indexes in our comparison during our sample period (2010–2014) and broken down by year.

In terms of returns, the *sukuk* index performs on average like the U.S. corporate high-yield index but with a lower standard deviation, probably due to lower trading in secondary markets. According to Jones, Gautham, and Lipson (1994), in conventional markets the number of transactions – not size – is positively related to volatility. According to Bloomberg Professional Services, trading volumes for the 10 most liquid *sukuk* are significantly lower than other fixed-income markets.

In relation to the third moment, the *sukuk* index is positively skewed. *Sukuk* issuances are frequently oversubscribed, with returns higher than other bonds even during recessions or the Eurozone sovereign debt crisis. Two primary drivers may explain these higher returns: the positive relationship between expected returns from corporate bonds and liquidity risk (Lin, Wang, & Wu, 2011) as well as the recent drop in European interest rates that stimulated the search for higher returns from emerging market bonds.

The Jarque–Bera normality test strongly rejects the null hypothesis of normality of daily return distributions for all indexes, which is consistent with general findings in financial markets data. The Ljung–Box autocorrelation test on the first 25 lags (LM-Test) suggests significant autocorrelation at the 1% level for all daily price changes. In addition, we perform the LM ARCH test and obtain evidence of heteroskedasticity for all indexes.

Table 4 summarizes our preliminary analysis of unconditional correlations among bond returns. Overall, the *sukuk* index shows a low correlation with other corporate bond indexes, ranging from 0.11 to 0.42 (all significant at the 99.99% confidence level). Correlations increase at the regional level (Emerging Market Investment Grade, BIEM; Emerging Market High-Yield index, BEAC). Moreover, correlations vary across time; in particular, they increase in bear markets (i.e., 2011 and 2013).[3]

Table 5 compares our *sukuk* index on the basis of specific interest-risk indicators, such as duration-adjusted spread and yield-to-maturity (YTM). *Sukuk* show a lower duration than high-yield indexes due to higher coupons and a shorter average life. Two main effects explain the decrease in YTM: the generalized trend of yields due to worldwide monetary policies and, as a consequence, the strong demand for emerging markets bonds and *sukuk* instruments providing higher yields.

In terms of credit risk (Table 6), *sukuk* exhibit an upper-medium-grade rating that remains relatively stable during the sample period. In fact, the average credit rating of *sukuk* is better than that observed in the emerging markets investment-grade index. Despite this, we find a similar option-adjusted spread (both in terms of mean and standard deviation), attributable to an illiquidity premium required by investors in a thin secondary market.

[3] We omit this preliminary result, available upon request, due to the subsequent methodological refinement on the same issue.

Table 7
Coupon and time to maturity.

Index	Coupon					Time to maturity				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
SUKUK	5.13	5.02	4.78	4.15	3.89	3.74	3.63	4.05	3.91	3.89
BUSC	5.72	5.52	5.25	4.78	4.54	6.19	6.45	6.96	6.87	6.90
BUHY	8.03	8.08	7.95	7.52	7.11	5.73	5.39	5.14	4.98	4.89
BIEM	6.60	6.19	5.84	5.31	5.09	8.57	8.46	8.84	8.71	8.88
BEAC	8.80	8.73	8.64	7.98	7.60	5.74	5.57	5.15	5.09	4.87
BECO	4.82	4.79	4.76	4.37	3.90	6.06	6.06	6.21	6.15	6.17
BEUH	7.15	7.14	6.94	6.70	6.07	4.49	4.52	4.07	3.62	3.76

This table presents the dynamic of coupons and time to maturity across all indexes in our comparison during our sample period (2010–2014) and broken down by year.

Table 8
Unit root analysis.

Index	Lags	ADF
SUKUK	4	−0.0545*
BUSC	10	−0.0581*
BUHY	8	−0.0796**
BIEM	9	−0.0551*
BEAC	3	−0.0753**
BECO	1	−0.9733***
BEUH	9	−0.1307***

Significance codes: *** at the 99.99% level, ** at the 99%, and * at the 95% level.
This table presents the results of testing for nonstationarity for all investigated bond indexes. The Augmented Dickey Fuller (ADF) test is performed and the lag lengths are determined by the Akaike's Information Criteria (AIC). The null hypothesis is nonstationarity, and the 5% critical value is −1.95.

Table 9
Johansen test.

H = 0	Test	Critical values		
		90%	95%	99%
$r \le 6$	10.75	7.52	9.24	12.97
$r \le 5$	25.71	13.75	15.67	20.20
$r \le 4$	33.64	19.77	22.00	26.81
$r \le 3$	43.44	25.56	28.14	33.24
$r \le 2$	59.71	31.66	34.40	39.79
$r \le 1$	67.34	37.45	40.30	46.82
$r = 0$	83.83	43.25	46.45	51.91

This table provides Johansen's (1991) trace test for cointegration between *sukuk* and other bond indexes. Lag lengths, determined by the AIC and BIC criterion, are three. The null hypothesis is no presence of cointegrating vectors.

Table 10
GARCH model.

	ω		α		β	
	Value	Sign.	Value	Sign.	Value	Sign.
SUKUK	7.448×10^{-9}	*	0.0759	***	0.9257	***
BUSC	1.065×10^{-7}	*	0.0555	***	0.9301	***
BUHY	9.579×10^{-8}	***	0.3410	***	0.6579	***
BIEM	7.268×10^{-8}	**	0.1308	***	0.8562	***
BEAC	2.109×10^{-7}	***	0.2841	***	0.6926	***
BECO	1.017×10^{-7}	*	0.0263	***	0.9701	***
BEUH	2.985×10^{-8}	**	0.1484	***	0.8605	***

Significance codes: *** at the 99.99% level,** at the 99% level, and * at the 95% level.
This table presents the parameter estimated for univariate GARCH models used to standardize time series of returns of each index.

Table 11
DCC-GARCH model.

	ω		α		β	
	Value	Sign.	Value	Sign.	Value	Sign.
SUKUK	1.1036×10^{-8}	*	0.0651	*	0.9194	***
BUSC	8.2816×10^{-8}		0.0511		0.9373	***
BUHY	9.1824×10^{-8}	**	0.3351	**	0.6564	***
BIEM	4.8108×10^{-8}	**	0.1225	*	0.8715	***
BEAC	1.8296×10^{-7}	**	0.2885	***	0.6985	***
BECO	7.8605×10^{-8}	*	0.0258	***	0.9714	***
BEUH	7.3429×10^{-8}	*	0.1318	**	0.8640	***
		Log-likelihood = 52949.65				

Significance codes: *** at the 99.99% level, ** at the 99% level, and * at the 95% level.
This table provides the results and the log-likelihood values for the DCC-GARCH (1,1) model.

We also compare coupon rates and time to maturity (Table 7). We find that they are similar to investment-grade indexes, even though the time to maturity is the shortest in our sample.

5. Empirical analysis

5.1. Cointegration tests

In order to test the long-run relationship between bonds and *sukuk*, we perform the Johansen (1991) cointegration test, starting from the Augmented Dickey Fuller test (ADF) and with lag lengths determined by the AIC criteria. Tables 8 and 9 report the results. The null hypothesis of no cointegration ($r = 0$) is rejected.

The result reveals that all series are bounded by some relationship during the time span. We therefore find the first evidence that *sukuk* yielding innovations in the long-run have a similar pattern to those observed in fixed-income markets. In terms of long-run relationships in fixed-income yield innovations, our results support the findings of Barassi et al. (2001), Smith (2002), and Ciner (2007). Thus, our findings suggest there is a long run-equilibrium relationship among interest rates of both *sukuk* and fixed income markets.

5.1.1. DCC results

The first stage of the DCC model consists of fitting univariate GARCH for each index's time series of returns. We estimate GARCH models with maximum likelihood methods and, consistently with Cappiello et al. (2006), we do not find evidence of asymmetries in fixed income markets. Moreover, the standardized GARCH (1,1) appears optimal for all time series. Table 10 shows the estimated parameters of the GARCH processes. We observe the typical finding that $\emptyset_1 = \alpha_1 + \beta_1$ is close to unity (significant for each model). The Ljung–Box test statistics provide no evidence of linear or nonlinear dependence in the standardized residuals in all univariate models; therefore the model is not misspecified.

As a second step, we standardize returns of the univariate GARCH models, and we estimate the correlation matrix and the parameters α and β of the DCC-GARCH symmetric model. Table 11 shows the results.

We find that the *sukuk* index demonstrates a relatively low conditional volatility in reaction to market shocks and demonstrates a higher persistence in conditional volatility (β above 0.9), similar to investment-grade indexes. Therefore, we argue that *sukuk* volatility takes longer to cease following a shock. We observe a similar low reaction and high persistence in U.S. and European investment-grade indexes (BUSC and BECO). Conversely, high-yield indexes display higher conditional volatility in reaction to market shocks ($\alpha > 0.1$) and a low persistence in conditional volatility. In comparison, both the emerging market investment-grade and high-yield indexes show stronger reactions to market shocks.

Based on log-likelihood values, we find that the asymmetric and the flexible DCC models outperform the symmetrical DCC counterpart. However, the sum of the α, β, γ parameters were above one for four of our time series.[4]

5.1.2. Volatility linkages

Fig. 1 presents plots of univariate volatilities. In absolute terms, *sukuk* returns are much less volatile than the U.S. and European investment-grade bond indexes. In relation to investment-grade and high-yield bonds from the same region, *sukuk* exhibit similar volatility in absolute terms, even though peaks are more pronounced in emerging market bond indexes during stress periods. The lower volatility could be related to the fact that fixed-income markets in emerging countries are not as developed as in industrialized countries.

By analyzing Fig. 1, consistently with Jones et al. (1994), we observe that when markets anticipate a large shock, return volatility decreases. Before both the European sovereign debt crisis and the Federal Reserve's tapering announcement, return volatilities tend to decrease in all bond indexes. In periods of stress, consistently with Wang and Wu (2015), price volatility tends to increase dramatically due to the flight to liquidity. In addition, the evidence confirms the much stronger relation between price volatility and trading variables for less liquid speculative-grade bonds.

Although univariate models estimate the volatilities, we examine links across indexes by a pairwise correlation between the estimated variances of two times series. Conditional variances of *sukuk* and other indexes, despite an increase during the time span, are moderately correlated at the global level (0.397).

We find a more pronounced volatility linkage between *sukuk* and investment-grade indexes during the European sovereign debt crisis and in 2013 (even stronger at the regional level). Correlation among volatilities between *sukuk* and emerging market investment-grade bonds peaks at 0.8. The link is similar to the high-yield index in the same region.

Regarding the volatility linkage between *sukuk* and the U.S. and European high-yields, we find a relation similar to other indexes during the time span and more similar during bear markets. However, *sukuk* volatility in absolute terms increases less in comparison with other fixed income indexes.

5.1.3. Correlation dynamics

Correlations across indexes show considerable variation. Figs. 2 and 3 plot the estimated dynamic correlation between *sukuk* and investment-grade or high-yield indexes for our sample period. Table 12 provides the summary statistics for DCC models.

The dynamic conditional correlations between *sukuk* and all fixed-income indexes seem to follow a similar path during the time span. This result is consistent with Cappiello et al. (2006), providing evidence that international diversification benefits across fixed income markets decrease during recessions; moreover, bond markets and *sukuk* tend to move together.

Furthermore, we provide evidence of the potential diversification benefits of *sukuk*. Despite the material rise in correlations during crisis periods, *sukuk* tend to maintain lower dynamic correlations. Thus, introducing *sukuk* in a well-diversified international bond portfolio should provide diversification benefits.

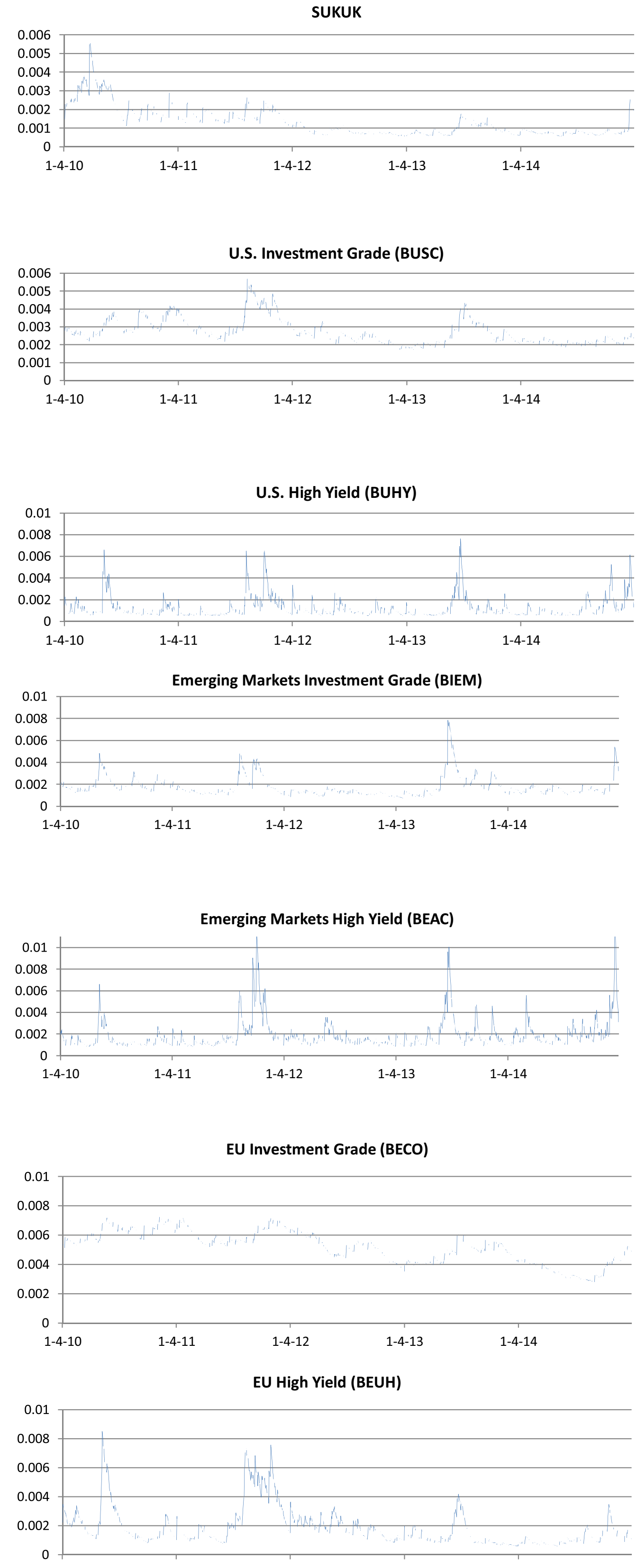

Fig. 1. Univariate conditional volatilities.
This figure plots the univariate conditional volatilities for the *sukuk* index, as well as the investment-grade and high-yield corporate bond indexes of the United States, emerging markets, and the EU.

[4] These omitted results are available upon request.

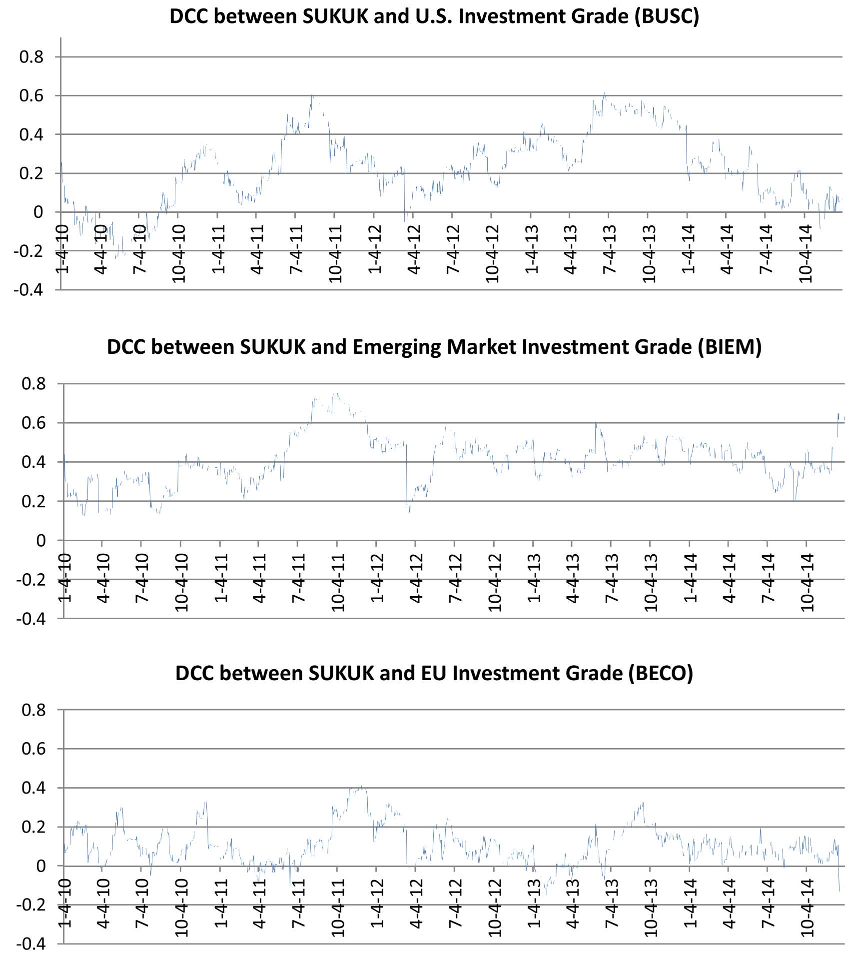

Fig. 2. Dynamic conditional correlations between *sukuk* and bond investment-grade indexes.
This figure plots the dynamic conditional correlations between the *sukuk* index returns and the U.S., emerging market, and European investment-grade bond index returns.

Table 12
Summary statistics for DCC.

	SUK-BUSC	SUK-BUHY	SUK-BIEM	SUK-BEAC	SUK-BECO	SUK-BEUH
Mean	0.2219	0.2407	0.4122	0.2681	0.104	0.3117
St. dev.	0.1874	0.1129	0.1258	0.1273	0.0991	0.1141
J–B	16.75***	19.33***	9.81***	2.83*	114***	8.53***
LM ARCH	1261.3***	1228***	1253.5***	1246.1***	1227.1***	1238.9***

Significance codes: *** at the 99.99% level; * at the 95% level.
This table presents descriptive statistics of the DCC's mean, standard deviation, Jarque–Bera test of normality, and the LM ARCH test.

From the DCC plots, we see significant increases after the European sovereign debt crisis and in 2013, when investment-grade bonds suffered their worst performance since 1994 as a consequence of concerns on the Federal Reserve tapering. In spite of the poorer performance of investment-grade segments, high-yield bonds are in a better position at year end.

Focusing on investment-grade indexes, the increase in dynamic correlations between *sukuk* and European bonds during the sovereign debt crisis is pronounced and rises from an average of 0.1 to 0.4. A similar yet smaller increase occurs in 2013. By comparing *sukuk* and the U.S. investment-grade index we find a similar behavior, especially during 2011 and 2013. On average, we find more pronounced correlations than those observed in Europe. Our results are consistent with Nowak, Andritzky, Jobst, and Tamirisa (2011), which finds that Fed announcements have a larger impact on emerging bond markets. We find that this applies to *sukuk* as well, as revealed in Figs. 1 and 2 after June 2013.

More interesting for investors in emerging markets is the DCC between *sukuk* and the emerging market investment-grade index, which shows a more linear trend over time. On average, correlations range from 0.4 during bull periods to 0.6 during the European sovereign debt crisis. Dynamic correlations in the high-yield segment (shown in Fig. 3) are on average similar to those observed previously for investment-grade indexes.

Even here we observe a sharp increase in correlations during the European debt crisis and a smaller one in 2013. In 2014, a bull market for high yields, we note a decrease in correlations. Finally, the average correlation between *sukuk* and high yields in emerging markets seems to reflect the same pattern detected earlier for dynamic correlations with investment-grade bonds of emerging markets.

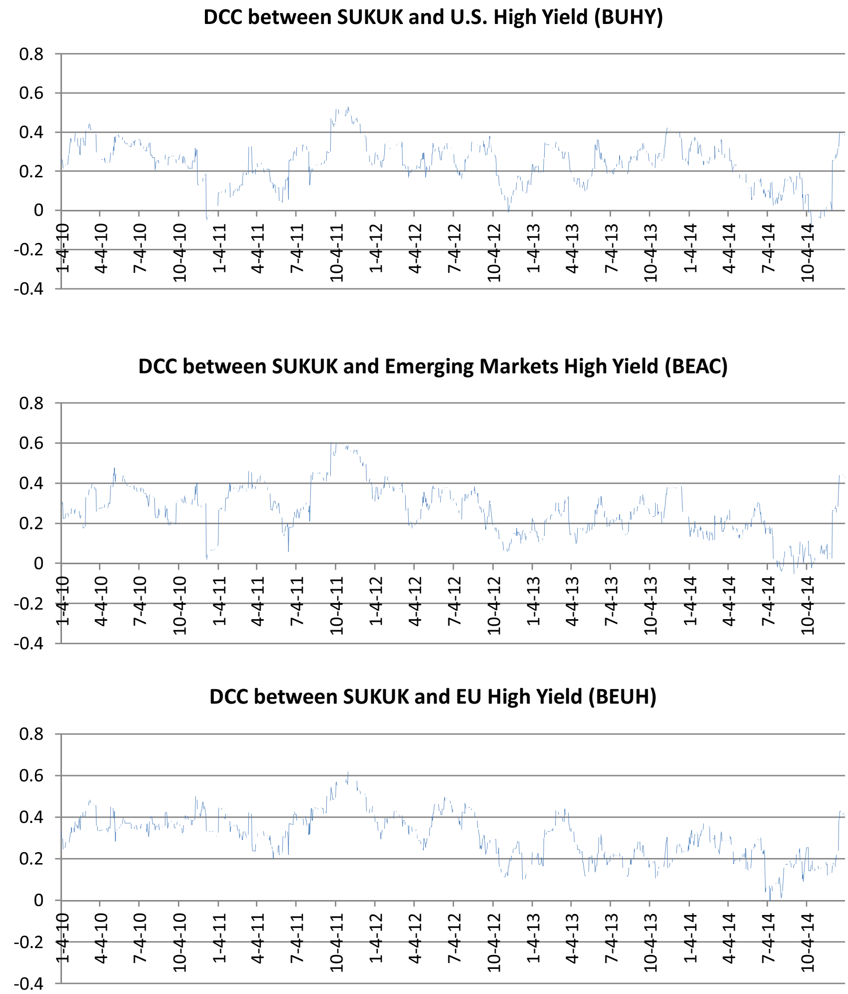

Fig. 3. Dynamic conditional correlations between *sukuk* and high-yield indexes.
This figure plots the dynamic conditional correlations between *sukuk* index returns and the U.S., emerging market, and European high-yield bond index returns.

5.1.4. Structural breaks in the DCC paths

In this section, we employ the Bai and Perron (2003) test in order to check for multiple structural breaks in the DCC paths over time. Breakpoints allow us to understand reactions to specific events, such as central bank announcements.

The ARCH test statistics displayed in Table 12 provide significant evidence of heteroskedasticity. Thus, we assume that a GARCH (1,1) model can capture the conditional variance behavior of the DCC series. In order to find the structural breakpoints of the estimated persistence in the conditional variance ($\beta_{i,t}$) for each DCC's volatility, we employ the following standard linear regression model:

$$\beta_{i,t} = \delta\beta_{i,t-1} + e_{i,t} \tag{4}$$

According to Bai and Perron (2003) the problem of dating structural changes is finding the breakpoints that minimize the objective function:

$$(i_1, \ldots . i_m) = argmin_{(i_1,\ldots,i_m)} RSS\,(i_1, \ldots, i_m) \tag{5}$$

where:

$(i_1, \ldots . i_m)$ are the multiple structural changes, and

$RSS\,(i_1, \ldots, i_m)$ is the resulting minimal residual sum of squares of β_j.

As in Bai and Perron (2003), we estimate the optimal number of breaks through the Bayesian Information Criteria (BIC) because the Akaike Information Criteria (AIC) may overestimate the number of breaks (see Table 13).

We identify some common structural breakpoints. The European sovereign debt crisis in September 2011 and the Federal Reserve tapering (Summer 2013 and January 2014) significantly increased DCCs. The spike in Eurozone credit spreads had a significant impact on dynamic correlations between *sukuk* and bond markets. This result is in line with Fender, Hayo, and Neuenkirch (2012), who find that credit risk in emerging markets is related more to global and regional risk premiums than country-specific risk factors. Thus, diversification benefits for holding fixed-income investments from emerging countries might be limited during crisis periods.

Regarding the tapering effect, our results suggest that investors attach greater importance to exchange-rate risk after May 2013, when the Fed was expected to reduce its asset purchase program. The effect was significant for U.S. dollar-denominated emerging market bonds (Gadanecz, Miyajima, & Shu, 2014) and for *sukuk*. As Kusuma and Silva (2014) note, *sukuk* issuance dropped after the fixed-income downturns of Summer 2013. Furthermore, the "whatever it takes" Draghi speech on July 26, 2012, had a significant impact on the DCCs of *sukuk* and investment-grade indexes (BUSC and BECO), diminishing the dynamic correlations across these assets.

5.1.5. Global factors driving DCCs paths

In this subsection, we regress the obtained conditional correlations on determinants we presume affect the behavior of DCCs

Table 13
Structural breakpoints and interval dates by index.

	Number of structural breakpoints	Estimated breakpoint dates	95% confidence intervals for break dates
United States			
SUK-BUSC	5	27/09/2010	[27/09/2010–27/10/2010]
		25/10/2011	[25/10/2011–25/11/2011]
		26/07/2012	[26/07/2012–26/08/2012]
		26/04/2013	[26/04/2013–26/05/2013]
		10/01/2014	[10/01/2014–10/02/2014]
SUK-BUHY	5	24/09/2010	[24/09/2010–24/10/2010]
		24/06/2011	[24/06/2011–24/07/2011]
		20/09/2012	[20/09/2012–20/10/2012]
		25/06/2013	[25/06/2013–25/07/2013]
		01/04/2014	[01/04/2014–01/05/2014]
Emerging markets			
SUK-BIEM	4	25/05/2011	[25/05/2011–25/06/2011]
		20/02/2012	[20/02/2012–20/03/2012]
		21/06/2013	[21/06/2013–21/07/2013]
		26/03/2014	[26/03/2014–26/04/2014]
SUK-BEAC	4	13/07/2011	[13/07/2011–13/08/2011]
		29/08/2012	[29/08/2012–29/09/2012]
		03/05/2013	[03/05/2013–03/06/2013]
		07/03/2014	[07/03/2014–07/04/2014]
Europe			
SUK-BECO	5	06/12/2010	[06/12/2010–06/01/2011]
		01/09/2011	[01/09/2011–01/10/2011]
		25/07/2012	[25/07/2012–25/08/2012]
		13/06/2013	[13/06/2013–13/07/2013]
		12/03/2014	[12/03/2014–12/04/2014]
SUK-BEUH	3	15/07/2011	[15/07/2011–15/08/2011]
		28/08/2012	[28/08/2012–28/09/2012]
		21/02/2014	[21/02/2014–21/03/2014]

This table presents the results of the Bai and Perron (2003) test for multiple structural breaks in a linear regression framework, as well as the estimated 95% confidence interval for their dates. The optimal number of breakpoints corresponds to the lowest Bayesian Information Criterion (BIC).

over time. Identifying global factors that could explain the co-movements between the *sukuk* market and the bond market can provide useful policy implications, not only for portfolio managers but also for policymakers who wish to identify the global economic factors affecting the sign and size of dynamic correlations. This methodology is consistent with several recent studies (e.g., Andersson, Krylova, & Vähämaa, 2008; Kim, Moshirian, & Wu, 2006).

Table 14
Summary statistics of selected global determinants.

Index	Mean	St. dev.	LM ARCH test
CO	4.513	0.122	55.82***
US CDS	3.430	0.415	198.50***
LIQ	0.010	0.005	198.60***
US yield curve	2.539	0.625	245.76***
VIX	18.590	6.723	312.94***

This table presents descriptive statistics of the global determinants: mean, standard deviation, and the LM ARCH test.

Specifically, we estimate the following regression model:

$$\rho_{ij} = \alpha + \beta_1 CO_{t-1} + \beta_2 UScds_{t-1} + \beta_3 Liq_{t-1} + \beta_4 USyield\ curve_{t-1} + \beta_5 VIx_{t-1} + \varepsilon_{ij} \quad (6)$$

where ρ_{ij} is the dynamic conditional correlation between *sukuk* and bonds, such that:
i = *sukuk* and j = BUSC, BUHY, BIEM, BEAC, BECO, BEUH,
CO_{t-1} is the lagged crude oil prices,
$UScds_{t-1}$ is the lagged U.S. corporate CDS spreads,
Liq_{t-1} is the *sukuk* index bid-ask spread,
$USyield\ curve_{t-1}$ is the lagged U.S. yield-curve spread, and
VIx_{t-1} is the S&P 500 VIX index.

Summary statistics of the variables selected are provided in Table 14.

We estimate the regression model using the Newey–West transformation in order to control for cross-section heteroskedasticity and autocorrelation of residuals. Because Aloui et al. (2015b) show that higher crude oil prices cause higher stock returns, *sukuk* returns, and increasing correlations among GCC countries' indexes, we add this control variable.

Moreover, we add the U.S. credit default swaps spread to capture credit-event information. According to Jorion and Zhang (2007) and Norden and Weber (2009), U.S. CDS spreads have important implications both for emerging market CDS spread behavior (Fender et al., 2012) and for other country spreads in general (Longstaff, Pan, Pedersen, & Singleton, 2011). In addition, they also affect portfolio construction with credit-sensitive instruments.

We also believe that the bid-ask spread, as a liquidity risk indicator in the *sukuk* market, has a large impact on time-varying correlations. The impact increases with rising price volatility and lower trading volume. This is also a proxy of investor uncertainty that leads to higher correlations due to frequent portfolio reallo-

Table 15
Impact of global factors on *sukuk*-bond return correlations.

	Constant	CO_{t-1}	$UScds_{t-1}$	Liq_{t-1}	$USyield\ curve_{t-1}$	Vix_{t-1}	Adj. R^2
Sukuk-BUSC	−2.147*	0.417*	0.135***	17.036***	−0.065*	−0.0092	0.502
	(−1.972)	(1.778)	(3.303)	(7.806)	(−1.861)	(−0.193)	
Sukuk-BUHY	0.0883	−0.0769**	0.903***	6.828***	0.005	0.0053***	0.287
	(0.707)	(−2.798)	(10.935)	(12.085)	(1.118)	(9.374)	
Sukuk-BIEM	−0.4025**	0.1652***	0.0175	6.336*	−0.0864***	0.008*	0.423
	(−3.172)	(5.923)	(1.093)	(0.013)	(−4.441)	(2.077)	
Sukuk-BEAC	−0.9713	0.133	0.107**	3.163	0.0134	0.0106***	0.495
	(−0.621)	(0.405)	(2.621)	(1.379)	(0.589)	(3.7155)	
Sukuk-BECO	−0.510***	0.085***	0.001	5.981***	−0.0023	0.008**	0.305
	(−4.719)	(3.605)	(0.023)	(12.237)	(0.556)	(3.233)	
Sukuk-BEUH	−0.346*	0.046*	0.114***	−3.628***	−0.006	0.006***	0.544
	(2.407)	(2.066)	(17.201)	(−7.95)	(−1.593)	(13.267)	

Significance codes: *** at the 99.99% level; ** at the 99% level; * at the 95% level.
This table presents the OLS regression estimates for factors explaining cross-index return correlations (t-values are in brackets). We estimate the regression model by using the Newey–West transformation. The dependent variables are the dynamic conditional correlations between *sukuk* and bond indexes. CO_{t-1} are the lagged crude oil prices, $UScds_{t-1}$ is the lagged U.S. corporate CDS spread, Liq_{t-1} is the *sukuk* index bid-ask spread, $USyield\ curve_{t-1}$ is the lagged U.S. yield curve spread, and VIx_{t-1} is the S&P 500 VIX index.

cations. Regarding interest risk, we use the U.S. yield curve spread, which affects the Euro yield spread (Van Landschoot, 2008) and the emerging markets yield spreads.

Finally, as several authors document (Baur & Lucey, 2009; Connoly, Stivers, & Sun, 2005; Kim et al., 2006), stock market uncertainty measured by the VIX index increases bond returns, suggesting that bonds may be a better hedge against stock market downturns. Thus, we expect a positive relation between stock market uncertainty and dynamic correlations.

The results displayed in Table 15 reveal several important findings. First, higher crude oil prices cause a rise in all DCCs pairs except the negative impact on correlations with the high yield from U.S. (BUHY).

Second, credit risk is positively related to all pairs of conditional correlations except the European high-yield segment. This result is in line with our preliminary analysis, because we detect an increase in correlations during market downturns such as the European sovereign debt crisis, which caused a sensible increase in credit spreads around the world.

In contrast with Aloui et al. (2015b), finding no significant effect of liquidity on correlations between *sukuk* and stock markets, we provide evidence to the contrary: *sukuk* liquidity affects co-movements with fixed-income markets. Moreover, higher bid-ask spreads might have liquidity constraints that are common in times of crisis, which confirms that in crisis periods co-movements between *sukuk* and bonds tend to increase.

Interest risk plays a significant role in explaining only the correlations between *sukuk* and both the investment grade-indexes from U.S. and emerging markets. This result is in line with the sensible increase in dynamic correlations observed during the tapering effect, which has a bigger impact on U.S. and emerging markets bonds.

Finally, the VIX index has a positive effect on the correlation behavior between bond markets and *sukuk*. This result is in line with Connoly et al. (2005), Kim et al. (2006), and Baur and Lucey (2009), suggesting that during stock market turmoil, bond returns increase.

5.1.6. Dynamic correlations and volatilities

The relationship between volatilities and correlation dynamics is an important feature for financial decision-makers: if they move together, risk increases and diversification benefits decrease.

We investigate whether volatilities and correlations are negatively or positively related by measuring the average pairwise correlation of *sukuk* variance with the fixed-income indexes. We find that, on average, if the *sukuk* index volatility increases, all pairwise correlations increase as well. In addition, once we focus on more severe downturns (i.e., 2011 and 2013), volatilities and correlations between *sukuk* and fixed-income indexes are relatively correlated with both U.S. and EU (0.5) bonds, as well as emerging markets bonds (0.6). The joint effect is higher when we compare the joint increase in volatilities and correlations within traditional bond markets. In previous studies, Solnik et al. (1996) and Cappiello et al. (2006) notices that volatilities and correlations tend to move together in fixed-income markets. This co-movement reduces diversification benefits. Thus, introducing *sukuk* in a well-diversified bond portfolio could provide diversification benefits due to the lower joint increase in correlations and volatilities.

6. Conclusions

Since the global financial turmoil, central banks eased monetary policy aggressively. In a low-yield environment, investors were attracted by emerging markets and, in particular, Islamic finance. Therefore, for bond investors a key challenge and opportunity exists in assessing risk-return characteristics and diversification benefits arising from these alternatives.

We address this issue by investigating the long-run relationship and dynamic correlations between major fixed-income markets (U.S., Europe, and emerging markets; investment-grade and high-yield) and the *sukuk* market (by building a cross-country index of highly liquid listed issues). We employ the Johansen cointegration test and the DCC-GARCH model under Student's t-distribution for the sample period 2010–2014.

We find that international bonds and *sukuk* are cointegrated, suggesting an increased cross-market co-movement. The DCC-GARCH model analysis provides several interesting results. In terms of volatilities, we find that *sukuk* and conventional investment-grade bonds exhibit a lower reaction of conditional volatility to market shocks and a higher persistence. Moreover, in comparison to U.S. and EU investment-grade bonds, *sukuk* returns are much less volatile during the investigated time span. Further, we find that dynamic conditional correlations and volatility linkages increase during shocks (i.e., the European debt crisis and the Federal Reserve tapering announcements). More specifically, the structural breakpoint test suggests common changes in DCC paths corresponding to these events. Finally, using ordinary least squares (OLS) we uncover the strong effect of global oil prices, U.S. credit-event information, stock market uncertainty, and liquidity shocks on DCCs over time.

Overall, our results show that *sukuk* have valuable similarities compared to conventional bonds. In particular, their reaction during market shocks is similar to that observed for investment grade bonds. However, we notice that *sukuk* also provide diversification benefits due to their lower volatility and dynamic correlation paths.

Our findings are relevant for portfolio and risk managers, as portfolio optimization necessarily considers cointegration, the dynamics of volatility and conditional correlations, and the determinants of DCCs paths. Our paper is relevant also for *sukuk* issuers, because we compare Islamic and conventional bond volatility during financial crises.

Finally, we stress that despite the diversification benefits and impressive growth of *sukuk*, investing in this asset class remains challenging due to its lower liquidity. However, wider and deeper secondary markets can render this asset class more attractive to long-term institutional investors (i.e., life insurers, pension and hedge funds). At the same time, the portfolio benefits from *sukuk* are not just about liquidity; regulation also affects their risk-return profile. Bigger secondary markets and lower demand could increase cross-market integration and decrease performance and diversification benefits.

References

Akhtar, S. M., Jahromi, M., John, K., & Moise, C. E. (2012). Intensity of volatility linkages in Islamic and conventional markets. Working paper, AFA 2012 Chicago Meetings Paper.

Alam, N., Hassan, M. K., & Haque, M. A. (2013). Are Islamic bonds different from conventional bonds? International evidence from capital market tests. *Borsa Istanbul Review*, *13*(September (3)), 22–29.

Aloui, C., Hammoudeh, S., & Hamida, H. B. (2015a). Co-movement between sharia stocks and *sukuk* in the GCC markets: A time-frequency analysis. *Journal of International Financial Markets, Institutions & Money*, *34*, 69–79. http://dx.doi.org/10.1016/j.intfin.2014.11.003

Aloui, C., Hammoudeh, S., & Hamida, H. B. (2015b). Global factors driving structural changes in the co-movement between Sharia stocks and *sukuk* in the Gulf Cooperation Council countries. *North American Journal of Economics and Finance*, *31*, 311–329. http://dx.doi.org/10.1016/j.najef.2014.12.002

Andersson, M., Krylova, E., & Vähämaa, S. (2008). Why does the correlation between stock and bond returns vary over time? *Applied Financial Economics*, *18*, 139–151. http://dx.doi.org/10.1080/09603100601057854

Bai, J., & Perron, P. (2003). Computation and analysis of multiple structure models. *Journal of Applied Econometrics*, *18*, 1–22. http://dx.doi.org/10.1002/jae.659

Balcilar, M., Cerci, G., & Demirer, R. (2015). Is there a role for Islamic bonds in global diversification strategies? An empirical analysis of risk transmissions and dynamic correlations. Paper available on ssrn.com.

Barassi, M., Caporale, G., & Hall, S. (2001). Irreducibility and structural cointegrating relations: An application to the G-7 long-term interest rates. *International Journal of Finance and Economics*, *6*, 127–138. http://dx.doi.org/10.1002/ijfe.147
Baur, D. G., & Lucey, B. M. (2009). Flights and contagion-an empirical analysis of stock-bond correlations. *Journal of Financial Stability*, *5*(4), 339–352. http://dx.doi.org/10.1016/j.jfs.2008.08.001
Beck, T., Demirguc-Kunt, A., & Merrouche, O. (2013). Islamic vs. conventional banking: Business model, efficiency and stability. *Journal of Banking and Finance*, *37*(2), 433–447. http://dx.doi.org/10.1016/j.jbankfin.2012.09.016
Cakir, S., & Raei, F. (2007). *Sukuk* vs. eurobonds: Is there a difference in value-at-risk, IMF Working Paper, WP/07/237.
Cappiello, L., Engle, R., & Sheppard, K. (2006). Asymmetric dynamics in the correlations of global equity and bond returns. *Journal of Financial Econometrics*, *4*(4), 537–572. http://dx.doi.org/10.1093/jjfinec/nbl005
Cihak, M., & Hesse, H. (2010). Islamic banks and financial stability: An empirical analysis. *Journal of Financial Services Research*, *38*(2), 95–113. http://dx.doi.org/10.1007/s10693-010-0089-0
Ciner, C. (2007). Dynamic linkages between international bond markets. *Journal of Multinational Financial Management*, *17*, 290–303. http://dx.doi.org/10.1016/j.mulfin.2007.02.007
Clare, A., & Lekkos, I. (2000). An analysis of the relationship between international bond markets. Working Paper 123, Bank of England.
Connoly, R. A., Stivers, C., & Sun, L. (2005). Stock market uncertainty and the stock-bond return relation. *Journal of Financial Quantitative Analysis*, *40*, 161–194. http://dx.doi.org/10.1017/S0022109000001782
DeGennaro, R., Kunkel, R., & Lee, J. (1994). Modelling international long-term interest rates. *Financial Review*, *29*(4), 577–597.
Elnahass, M., Izzeldin, M., & Abdelsalam, O. (2014). Loan loss provisions, bank valuations and discretion: A comparative study between conventional and Islamic banks. *Journal of Economic Behavior and Organization*, *103*, 160–173. http://dx.doi.org/10.1016/j.jebo.2013.08.018
Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business & Economic Statistics*, *20*(3), 339–350. http://dx.doi.org/10.1198/073500102288618487
Engle, R., & Sheppard, K. (2005). *Evaluating the specification of covariance models for large portfolios*. WP: New York University.
Fender, I., Hayo, B., & Neuenkirch, M. (2012). Daily pricing of emerging market sovereign CDS before and during the global financial crisis. *Journal of Banking and Finance*, *36*(10), 2786–2794. http://dx.doi.org/10.1016/j.jbankfin.2012.06.017
Fitch. (2016). *Fitch: sukuk take record share of Q1 2016 issuance in key markets*. http://www.cpifinancial.net/news/post/35650/fitch-sukuk-take-record-share-of-q1-2016-issuance-in-key-markets
Fleming, J., Kirby, C., & Ostdiek, B. (1998). Information and volatility linkages in the stock, bond and money markets. *Journal of Financial Economics*, *49*(1), 111–137. http://dx.doi.org/10.1016/S0304-405X(98)00019-1
Gadanecz, B., Miyajima, K., & Shu, C. (2014). Exchange rate risk and local currency sovereign bond yields in emerging markets. BIS Working Paper 474.
GIFR. (2012). Global Islamic Finance Report. http://www.gifr.net/home_ifci.htm.
Godlewski, C., Turk-Ariss, R., & Weill, L. (2013). Sukuk vs. conventional bonds: A stock market perspective. *Journal of Comparative Economics*, *41*(3), 745–761. http://dx.doi.org/10.1016/j.jce.2013.02.006
Godlewski, C., Turk-Ariss, R., & Weill, L. (2016). Do the type of *sukuk* and choice of *shari'a* scholar matter? *Journal of Economic Behavior and Organization*, http://dx.doi.org/10.1016/j.jebo.2016.04.020
Hansonn, M., Liljeblom, E., & Loflund, A. (2009). International bond diversification strategies: The impact of currency, country, and credit risk. *The European Journal of Finance*, *15*(5–6), 555–583. http://dx.doi.org/10.1080/13518470902872376
Hassan, M. K., & Oseni, U. A. (2014). The regulation and supervision of sukuk in global capital markets. In *Handbook on Islam and economic life*. Edward Elgar Publishing Company.
Hunter, D., & Simon, D. (2005). A conditional assessment of the relationship between the major world bond markets. *European Financial Management*, *11*(4), 463–482. http://dx.doi.org/10.1111/j.1354-7798.2005.00293.x
Iben, T., & Litterman, R. (1994). Have the benefits of international diversification diminished? *Journal of Fixed Income*, *4*(2), 27–34. http://dx.doi.org/10.3905/jfi.1994.408110
Iqbal, M., & Mirakhor, A. (2007). *An introduction to Islamic finance: Theory and practice*. Chichester: John Wiley & Sons.
Islamic Financial Services Board. (2009). Capital adequacy requirements for *sukuk*, securitisations and real estate investment, January.
Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*, 231–254. http://dx.doi.org/10.1016/0165-1889(88)90041-3
Johansen, S. (1991). Estimation and hypothesis testing of cointegrating vectors in gaussian vector autoregressive models. *Econometrica*, *59*, 1551–1580. http://dx.doi.org/10.2307/2938278
Jones, C. M., Gautham, K., & Lipson, M. L. (1994). Transactions, volume and volatility. *Review of Financial Studies*, *7*(4), 631–651. http://dx.doi.org/10.1093/rfs/7.4.631
Jorion, P., & Zhang, G. (2007). Good and bad credit contagion: Evidence from credit default swap. *Journal of Financial Economics*, *84*(3), 860–883. http://dx.doi.org/10.1016/j.jfineco.2006.06.001
Kim, H. B., & Kang, S. H. (2012). Volatility transmission between the *sharia* stock and *sukuk* GII markets in Malaysia. http://search.yahoo.com/search;_ylt=AuynaOiNRkSG9bf6F4qvcFebvZx4?p=volatility%2C+causality. (Accessed 12 November 2015).
Kim, S. J., Moshirian, F., & Wu, E. (2006). Evolution of international stock and bond market integration: Influence of the European Monetary Union. *Journal of Banking and Finance*, *30*(5), 1507–1534. http://dx.doi.org/10.1016/j.jbankfin.2005.05.007
Kuran, T. (2004). *Islam & mammon: The economic predicaments of Islamism*. Princeton: Princeton University Press.
Kusuma, K. A., & Silva, A. C. (2014). *Sukuk* markets: A proposed approach for development. Policy Research Working Paper 7133, World Bank.
Levy, H., & Lerman, Z. (1988). The benefits of international diversification in bonds. *Financial Analysts Journal*, *44*(5), 56–64. http://dx.doi.org/10.2469/faj.v44.n5.56
Lin, H., Wang, J., & Wu, C. (2011). Liquidity risk and expected corporate bond returns. *Journal of Financial Economics*, *99*(3), 628–650. http://dx.doi.org/10.1016/j.jfineco.2010.10.004
Longstaff, F. A., Pan, J., Pedersen, L. H., & Singleton, K. J. (2011). How sovereign is sovereign credit risk? *American Economic Journal: Macroeconomics*, *3*(2), 75–103.
Maghyereh, A. I., & Awartani, B. (2016). Dynamic transmissions between *sukuk* and bond markets. *Research in International Business and Finance*, *38*, 246–261.
Moody's. (2014). *Global credit research. Sovereign sukuk issuance to rise as new governments enter Islamic capital markets*. https://www.moodys.com/research/Moodys-Sovereign-sukuk-issuance-to-rise-as-new-governments-enter-PR_307600
Norden, L., & Weber, M. (2009). The co-movement of credit default swap, bond and stock markets: An empirical analysis. *European Financial Management*, *15*(3), 529–562. http://dx.doi.org/10.1111/j.1468-036X.2007.00427.x
Nowak, S., Andritzky, J., Jobst, A., & Tamirisa, N. (2011). Macroeconomic fundamental, price discovery, and volatility dynamics in emerging bond markets. *Journal of Banking and Finance*, *35*(10), 2584–2597. http://dx.doi.org/10.1016/j.jbankfin.2011.02.012
Onder, Y. K. (2016). Asset-backed contracts and sovereign risk. *Journal of Economic Behavior and Organization*, *132*, 63–76. http://dx.doi.org/10.1016/j.jebo.2016.10.006
Oseni, U., & Hassan, M. K. (2015). Revisiting the governing law clause in sukuk transactions. *Journal of Banking Regulation*, *16*(July), 220–249.
Smith, K. (2002). Government bond market seasonality, diversification and cointegration: International evidence. *Journal of Financial Research*, *25*, 203–221. http://dx.doi.org/10.1111/1475-6803.t01-1-00004
Solnik, B., Boucrelle, C., & Le Fur, Y. (1996). International market correlation and volatility. *Financial Analyst Journal*, *52*(5), 17–34. http://dx.doi.org/10.2469/faj.v52.n5.2021
Van Landschoot, A. (2008). Determinants of yield spread dynamics: Euro versus U.S. dollar corporate bonds. *Journal of Banking & Finance*, *32*(12), 2597–2605. http://dx.doi.org/10.1016/j.jbankfin.2008.05.011
Wang, J., & Wu, C. (2015). Liquidity, credit quality, and the relation between volatility and trading activity: Evidence from the corporate bond market. *Journal of Banking and Finance*, *50*(1), 183–203. http://dx.doi.org/10.1016/j.jbankfin.2014.10.003
Wilson, R. (2008). Islamic economics and finance. *World Economics*, *9*(1), 177–195.
Yang, J. (2005). International bond market linkages: A structural VAR analysis. *Journal of International Financial Markets, Institutions and Money*, *15*(1), 39–54. http://dx.doi.org/10.1016/j.intfin.2004.02.001