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Long Run asymmetric relationships between Islamic and conventional equity indices

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Abstract

Despite the substantial growth in the Islamic finance sector in the recent years, there has been limited empirical research on Islamic equity indices. In our paper we explore the interconnectedness between Islamic and conventional equity indices during the period spanning from 2006 to 2010. The Dow Jones Islamic Market is representative of the Islamic equity market, while the Dow Jones Global and Dow Jones Industrial Average are well perceived equity benchmark indices. We adopt hidden co-integration and granger causality analysis, while we examine the impact of market conditions. We find that the negative index components are significant between the Islamic equity index and the conventional benchmarks, yet the two conventional indices do not support this contention. Moreover, there is evidence that an increasing in magnitude driving force emanates from the Islamic to the conventional index in the crisis and post-crisis periods. A portfolio optimisation case study reveals that there are diversification benefits to be reaped by the inclusion of an Islamic equity index. The finding is tied to the Islamic index's performance and diversification benefits, particularly during the financial crisis. It may be further linked to investors' embracing of Islamic finance principles on lower leverage and speculation practices.

JEL Classification: G14

Keywords: Islamic equity index, hidden co-integration, market crisis, portfolio optimisation

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1. Introduction

The Islamic finance sector has demonstrated resilience and growth as the landscape of financial services reshapes. With a compound annual growth rate, since 2006, around 16% *Shariah*-compliant assets are now estimated at $1.2 trillion offered by 349 institutions. The consistent growth of the sector reassures that there is appetite for alternative, ethical investments, while the 80% of the still untapped customer base ensures that there is scope and need for expansion.

The slowdown in growth (8.7% in 2013 compared to 20.7% in 2012) of Islamic assets, a sign of maturity, offers the opportunity for challenges to be addressed. Henceforth, Islamic finance needs to tap the potential of retail banking as well as microfinance. Paramount to this success would be innovation; in products, services, internal processes and education. Products would have to go beyond *Murabahah*, *Ijarah* and Profit-and-Loss (PLS) contracts to cater for the emerging needs of the, particularly Muslim and of a lower place in the value ladder, customers. Investment in human resources has been on the rise but needs to maintain the momentum so that issues of service lag and time-consuming procedures are minimised (Pellegrina, 2008; DiVanna and Hancock, 2013). Education of any interested party needs to ensure that the unique brand identity is further fostered. From an academic viewpoint, research has sought to investigate similarities and differences between Islamic and conventional finance.

Islamic banks, for instance, have been much researched in terms of business models, efficiency, financial characteristics and stability; see among others Boumedeine and Caby (2009), Cihak and Hesse (2010), Beck *et al.,* (2013), Johnes *et al.*, (2013) and Abedifar *et al.*, (2013). Islamic equity indices have also attracted empirical research, albeit to a lower extent. See, for example, studies of Hakim and Rashidian (2004) and Chen *et al.*, (2004). However, the focus of empirical research on this particular field has been on comparative performance and long-run relationships of Islamic vis-à-vis conventional equity indices.

The present paper aims to contribute to the growing empirical literature on Islamic equity indices by abridging two, arguably, distinct literatures, Islamic banking and Islamic indices. We take a foothold on documented evidence regarding superior performance and resilience of Islamic banks, particularly amidst crises. Subsequently, we investigate the impact on the interrelation between Islamic and conventional equity indices. We aim to uncover evidence in support of the notion that Islamic equity indices are either more appealing in terms of risk/return trade-off, and/or less interconnected to the market; hence offering important diversification benefits. We do so by employing hidden co-integration and granger causality analysis for the periods before, during and after the global financial crisis.

We contribute to the extant literature in two ways. First, we provide the first application of hidden co-integration to compare Islamic and conventional indices. Therefore we are able to compare and contrast asymmetric effects in the dynamics of Islamic and conventional equity indices. Second, we provide novel empirical results by documenting the consolidation of Islamic equity indices as risk mitigation tools in the investment universe in separate phases of the global financial crisis.

Our key findings may be summarised as follows. We find that positive index components are interconnected among all three index pairs. By contrast, the negative index components are only significant between the Islamic equity index (Dow Jones Islamic Market-DJIM) and the world conventional benchmark. Furthermore, the prevalence of an Islamic index in co-integration links becomes more significant during distressed times and across time. This is verified by the rising significance of the causality relationship between DJIM and Dow Jones Industrial Average (DJIA) hinting that investors are looking for investments less correlated to the market. Islamic equity indices are of comparable performance and can help in the construction of a well-diversified portfolio especially in distressed times.

The remainder of the paper is structured as follows. The relevant literature review is presented in Section 2. Sections 3 and 4 present and describe the methodology and data used. Results and discussion are presented in Section 5 with a final section to conclude.

2. Literature Review

Research on Islamic finance is growing at a steady pace with studies covering bank aspects such as, efficiency (Johnes *et al.*, 2013), performance (Hasan and Dridi, 2010), stability (Cihak and Hesse, 2010; Beck *et al.*, 2013) and risk types (Abedifar *et al.*, 2013; Baele *et al.*, 2012). Yet, the main focal point remains the comparison of Islamic to conventional practices. A recent line of research investigates the performance differentials between Socially Responsible Investments (SRI) and Islamic investments (Abdelsalam *et al.*, 2013). Several studies have focused on the accounting and regulation aspects of Islamic finance, see for example El-Nahass *et al.*, (2013) and Alexakis and Tsikouras (2009) among others. The remainder of this section will focus on the literature closely related to the Islamic equity indices and the methodologies applied therein.

Co-integration analysis has been used extensively in many areas of economics and finance featuring applications in the consumption and income relationship; see among others Lettau and Ludvigson (2003) and Campbell (1987), as well as the predictability of asset prices (Campbell and Shiller, 1988; Lettau and Ludvigson, 2001), co-existence of bubbles in different asset classes (Campbell and Shiller, 1987) and the term structure of interest rates (Hall *et al.,* 1992). Several papers complement co-integration analysis with causality analysis to test for the efficient market hypothesis. For some applications see among others McDonald and Taylor (1988; 1989) and Jones and Uri (1989).

The separation of bull and bear periods is an interesting topic in financial literature, while a growing number of econometric techniques cater for the varying dynamics between the two periods. For example, the notion that bad news has more severe effect on financial time series than good news dates back to the introduction of EGARCH/TGARCH models by Nelson (1991) and Zakoian (1994) that were designed to capture this asymmetric effect on volatility modelling and forecasting. For example, Awartani and Corradi (2005) investigate the gains in forecasting performance that the allowance for the asymmetric component might bring in the case of the S&P 500 index. Their findings show that all asymmetric GARCH models forecasts outperform those of the benchmark GARCH(1,1) providing evidence that leverage effects bear additional information.

The number of articles that examine the returns and characteristics of Islamic indices are limited. Hakim and Rashidian (2004) compared the Dow Jones Islamic Market Index - US (DJIMI) with the Wilshire 5000 Index (W5000) over the 1999 to 2002 period. The DJIMI, covering about 75% of the W5000 represents a restricted investment universe which adheres to the Islamic finance guidelines. A strong relationship was verified by means of co-integration and causality analyses between the W5000 and the risk-free interest rate. However, such relationship could not be verified for the DJIMI and the risk-free rate or the W5000, possibly indicating that factors affecting the DJIMI are different to interest rates or broad markets. Therefore, the less diversified DJIMI exhibits unique risk-return characteristics that render it unrelated to the broad market without any sacrifice in return-risk trade-off from an investor's viewpoint.

The DJIMI is the oldest, launched in 1999, and most researched Islamic index. For example, a study by Hassan (2000) investigates the efficiency market hypothesis and calendar anomalies on the DJIMI over the period 1996 to 2000. The author finds that, contrary to conventional indices, no turn-of-calendar year, turn-of-financial year or month effects are verified for the DJIMI which may be attributed to the screening criteria and the shun of practices (*i.e.,* short sale) typically associated with speculation.

Another difference between Islamic and conventional indices is unveiled by the study of Sadeghi (2013) which investigates the impact of index revisions on the return and liquidity of stocks over the 2006 to 2008 period. Research related to conventional indices has found that inclusion of a stock in an index can increase the stock's asset value by increasing the firm's recognition (Merton, 1987). Chen *et al.,* (2004) and Elliot *et al.,* (2006) offer some case studies on the S&P 500 index. By contrast, Sadeghi (2013) finds that the addition of an Islamic stock to the DJIMI would have a negative impact on the stock's value. Perhaps this is related to prohibition of engagement in speculative, as opposed to real economy, activities under Islamic finance. In a sense, inclusion of the stock in the index may be considered as diversion from the Islamic guidelines, while echoing the agency view of Friedman (1996).

Hussein (2004) compared the performance of the FTSE Global Islamic Index and the FTSE All-World Index during the 1996 to 2003 period. The authors divide the period to allow for the varying market conditions related to the dot.com crisis. The author's findings suggest that the Islamic Index outperforms the conventional counterpart during the bull market, while the opposite is true during the bear market. Overall, there are no significant gains/losses from the use of a *Shariah* compliant index. Therefore the author concludes that the use of ethical filters does not have a negative impact on the performance of the FTSE Global Islamic Index (Hussein, 2004).

The rising popularity of Islamic equity indices is evidenced in the recent study of El-Khamlichi (2013). The author compares and contrasts four Islamic indices published by Dow Jones (Dow Jones Islamic Market Index - DJIMI), Financial Times (FTSE *Shariah* World), Standard & Poor's (S&P 500 *Shariah*) and Morgan Stanley (MSCI World Islamic) to their respective conventional counterparts. Empirical findings are suggestive of diversification opportunities related to the Islamic indices of Dow Jones and S&P and their conventional counterparts, as evidenced by co-integration analysis. By contrast, the Islamic indices of the FTSE and MSCI do not verify this contention. The divergent finding may be related to varying *Shariah* screening filters adopted by the equity companies.

Investments adhering to Islamic finance guidelines often are grouped under the encompassing title of Socially Responsible Investments (SRI). This categorisation opens a new line of research which compares the performance of Islamic finance investments to SRI. The study of Miglietta and Forte (2007) compares Islamic investments to SRI, the focus being on mutual funds and equity indices of both categories via the use of co-integration analysis. The main difference is that mutual funds based on Islamic finance are more regulated in the sense that they need to abide by stricter rules on what constitutes a permissible investment. On the other hand, SRI places more emphasis on issues like environmental protection and social profile.

The comparative performance of Islamic and conventional equity funds over the 2005 – 2011 period in Saudi Arabia is investigated in El-Mosallamy and El-Masry (2013). Using asset pricing factor models they find that Islamic equity funds outperform conventional ones. However, a crucial limitation of the study is that market conditions are not taken into account.

Related to SRI, but contributing to the banking literature, the study of Shaban *et al.,* (2013) assess the determinants of social responsibility in Islamic banking vis-à-vis conventional (both private and public) banks. The authors find that Islamic, similarly to state-owned, banks engage strategically in social responsibility actions but for different reasons. For the former the reasons lie within the modus operandi and the principles of Islamic finance, while in the latter it may be an artefact of politics.

These studies are of interest and show the way forward in the sense that they seek to uncover the underlying differences between Islamic and conventional investments. The impact of crisis has brought to surface drawbacks and limitations of conventional practices. Instead the resilience of Islamic finance has turned attention to the underlying mechanisms and brought to surface risk diversification benefits.

3. Methodology

In this section we present the methodology we adopt in the paper. First, we utilise the co-integration framework of Engle and Granger (1987) to test for a long-run equilibrium in the three indices, namely the Dow Jones Global (DJGI), the Dow Jones Islamic Market (DJIM) and the Dow Jones Industrial Average (DJIA). Second we use the Granger causality test to investigate causality presence and direction in the three indices. This would allow us to draw conclusions on which index influences another. Third we decompose the indices into a positive and a negative component adopting a hidden co-integration framework, in line with Alexakis *et al.,* (2013).

Up to this point the analysis considers the full sample. To allow for varying market conditions to have an effect on the interrelationship of the indices we split the sample into sub-periods. Instead of relying on ad hoc assumptions about the cut-off date, we implement a structural breakpoint test of Bai and Perron (1998) and categorise the sub-periods accordingly. We prefer the Bai and Perron (1998) breakpoint test as it does not assume prior knowledge of the breakpoint date, as the Chow (1960) breakpoint test, or a single breakpoint as the Quandt-Andrews (Quandt, 1960; Andrews 1993) and Zivot-Andrews (1992) tests that also exist in the literature. The structural breakpoint test is performed on the volatility of the DJIA, which is estimated using a GARCH(1,1) model. For the breakpoint identification we rely on the

Schwarz information criterion[2]. The break test approach is to compare the information criteria for a model with varying number of breaks in the volatility series.

3.1 Co-integration models

Two series X_t, Y_t are co-integrated when they are both integrated of the same order and there exists a linear combination between them that is stationary. The basic idea of co-integration is that series X_t, Y_t move closely together without deviating one from another in the long run, even though the individual series are non-stationary (Niarchos and Alexakis, 1998)

$$X_t, Y_t \sim I(1)$$
$$z_t = X_t - aY_t$$
$$z_t \sim I(0)$$

Where α is the co-integrating parameter and its magnitude shows the co-integrating speed.

If two variables are co-integrated then according to the Granger Representation Theorem (Engle and Granger, 1987), there exists an Error Correction Model (ECM) which is defined as:

$$\Delta Y_t = a_0 + \sum_{i=1}^{n} \beta_{1t} \Delta Y_{t-i} + \sum_{i=1}^{n} \beta_{2t} \Delta X_{t-i} + \psi_1 z_{t-1} + \varepsilon_{1t}$$
$$\Delta X_t = \gamma_0 + \sum_{i=1}^{n} \delta_{1t} \Delta Y_{t-i} + \sum_{i=1}^{n} \delta_{2t} \Delta X_{t-i} + \psi_2 z_{t-1} + \varepsilon_{2t}$$

Co-integrated variables in the bivariate case must possess temporal 'causality' in the Granger sense in at least one direction. For a pair of series to have an attainable equilibrium, some causation between them to provide the necessary dynamics must exist. Consequently, one important implication to emerge from the co-integration literature is that prices in an efficient speculative market cannot be co-integrated (Engle and Granger, 1987). Otherwise, as Niarchos and Alexakis (1998) point out, variation in one of the series X_t, Y_t would improve the forecasting ability of the other.

3.2 Granger Causality

[2] The break test approach is to compare the information criteria for a model of no breaks up to a maximum of 5 breaks in the volatility series. The Schwarz information criterion is minimized (-10.881) when 3 breaks.

In the Granger (1969) causality framework, series Y is said to be “Granger caused” by X if the latter helps in the prediction of the former. This has important implications for portfolio rebalancing and trading as an equity index would have precedence over another. Naturally, this would imply inefficiency under the Efficient Market Hypothesis (Niarchos and Alexakis, 1998).

Two series X_t, Y_t are said to be Granger caused if one can be expressed in terms of lags of the other, while these lags are jointly statistically significant.

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \ldots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \ldots + \beta_l y_{t-l} + \varepsilon_t$$
$$y_t = \gamma_0 + \gamma_1 y_{t-1} + \ldots + \gamma_l y_{t-l} + \delta_1 x_{t-1} + \ldots + \delta_l x_{t-l} + u_t$$

Where *l* represents the number of lags. The null hypothesis for the Granger causality test assumes that $\beta_1 = \ldots = \beta_l = 0$ and $\delta_1 = \ldots = \delta_l = 0$ against a two-sided alternative. Rejection of the null hypothesis implies that lags of Y_t, X_t carry predicting power over X_t, Y_t respectively.

3.3 Hidden Co-integration

Hidden co-integration models decompose each of the original series into two components, a positive and a negative, and subsequently test for co-integration in these components (Granger and Yoon, 2002). Positive and negative shocks are defined as:

$$\varepsilon^+ = \max(\varepsilon_t, d);\ \varepsilon^- = \min(\varepsilon_t, d);\ \eta^+ = \max(\eta_t, d);\ \eta^- = \min(\eta_t, d)$$

Where *d* represents a threshold value, usually set to zero, and $\varepsilon_t, \eta_t \sim \mathrm{N}(0, \sigma)$

The two series X_t, Y_t can then be written as cumulative sums of the positive and negative components of the two series (Granger and Yoon, 2002).

$$X_t = X_{t-1} + \varepsilon_t = X_0 + \sum_{t=1}^{t} \varepsilon_t^+ + \sum_{t=1}^{t} \varepsilon_t^- = X_0 + X^+ + X^-$$
$$Y_t = Y_{t-1} + \eta_t = Y_0 + \sum_{t=1}^{t} \eta_t^+ + \sum_{t=1}^{t} \eta_t^- = Y_0 + Y^+ + Y^-$$

where

$$X_t^+ = \sum_{t=1}^{t} \varepsilon_t^+ ;\ X_t^- = \sum_{t=1}^{t} \varepsilon_t^-$$
$$Y_t^+ = \sum_{t=1}^{t} \eta_t^+ ;\ Y_t^- = \sum_{t=1}^{t} \eta_t^-$$

It then follows that

$$\Delta X_t^+ = \varepsilon_t^+ ;\ \Delta X_t^- = \varepsilon_t^-$$
$$\Delta Y_t^+ = \eta_t^+ ;\ \Delta Y_t^- = \eta_t^-$$

The two series X_t, Y_t are hidden co-integrated if their components are co-integrated with each other. Four cases are identified.

- Neither $\{X_t^+, Y_t^+\}$ nor $\{X_t^-, Y_t^-\}$ are co-integrated. Series X_t, Y_t are not hidden co-integrated.
- Either $\{X_t^+, Y_t^+\}$ or $\{X_t^-, Y_t^-\}$ are co-integrated. Series X_t, Y_t are hidden co-integrated and they share common positive or negative shocks.
- Both $\{X_t^+, Y_t^+\}$ and $\{X_t^-, Y_t^-\}$ are co-integrated but with different co-integrating vectors. Series X_t, Y_t are hidden co-integrated. This implies that the co-integration intensity varies between positive and negative shocks.
- Both $\{X_t^+, Y_t^+\}$ and $\{X_t^-, Y_t^-\}$ are co-integrated with the same co-integrating vectors. Series X_t, Y_t are co-integrated. This implies that the co-integration intensity is the same between positive and negative shocks.

Once hidden co-integration has been established, a Crouching Error Correction Model (CECM) may be formulated. For the case where the positive (or negative) components are hidden co-integrated, the CECM may be defined as:

$$\Delta X_t^+ = \beta_0 + \beta_1 \Delta X_{t-1}^+ + \beta_2 \Delta Y_{t-1}^+ + \psi_1 (Y_{t-1}^+ - X_{t-1}^+) + \eta_{1t}$$
$$\Delta Y_t^+ = \delta_0 + \delta_1 \Delta X_{t-1}^+ + \delta_2 \Delta Y_{t-1}^+ + \rho_1 (Y_{t-1}^+ - X_{t-1}^+) + \xi_{1t}$$

If both the positive and the negative components exhibit hidden co-integration, then the CECM is defined as:

$$\begin{aligned}\Delta X_t &= \beta_0 + \beta_1 \Delta X^+_{t-1} + \beta_2 \Delta Y^+_{t-1} + \beta_3 \Delta X^-_{t-1} + \beta_4 \Delta Y^-_{t-1} + \psi_1 (X^+_{t-1} Y^+_{t-1}) + \psi_2 (X^-_{t-1} - kY^-_{t-1}) + \eta_t \\ \Delta Y_t &= \delta_0 + \delta_1 \Delta X^+_{t-1} + \delta_2 \Delta Y^+_{t-1} + \delta_3 \Delta X^-_{t-1} + \delta_4 \Delta Y^-_{t-1} + \rho_1 (X^+_{t-1} Y^+_{t-1}) + \rho_2 (X^-_{t-1} - kY^-_{t-1}) + \xi_t\end{aligned}$$

where $k \neq 1$. In the special case that $k=1$ the CECM collapses to the standard Error Correction Model (ECM).

$$\begin{aligned}\Delta X_t &= \beta_0 + \beta_1 \Delta X^+_{t-1} + \beta_2 \Delta Y^+_{t-1} + \beta_3 \Delta X^-_{t-1} + \beta_4 \Delta Y^-_{t-1} + \psi (X_{t-1} - Y_{t-1}) + \eta_t \\ \Delta Y_t &= \delta_0 + \delta_1 \Delta X^+_{t-1} + \delta_2 \Delta Y^+_{t-1} + \delta_3 \Delta X^-_{t-1} + \delta_4 \Delta Y^-_{t-1} + \rho (X_{t-1} - Y_{t-1}) + \xi_t\end{aligned}$$

Therefore, $\psi_1 = \psi_2 = \psi$ and $\rho_1 = \rho_2 = \rho$ while the coefficients for the positive and negative components of the two series should be the same; hence $\beta_1 = \beta_3; \beta_2 = \beta_4; \delta_1 = \delta_3; \delta_2 = \delta_4$.

4. Data

We consider two benchmark equity indices, the Dow Jones Global (DJGI) and the Dow Jones Islamic Market (DJIM) for the period 03/1/2006 – 31/12/2010. This gives us a sample of 1257 observations. Stylised facts for this time span feature a period of high volatility related to the global financial crisis (mid-2008 to mid-2009) and two low volatility periods; namely a pre-crisis and a post-crisis. Data are taken from Datastream.

The weighting for the two indices is based on float-adjusted market capitalisation, while both of them cover approximately 95% of the underlying market. Eligible for selection in the DJGI are all equities that trade in the underlying markets' major exchanges. Equities are screened for share class and liquidity, while the index is reviewed on a quarterly basis to account for de-listings, bankruptcies and M&A activity. The DJIM applies business type and financial screening to ensure that featured equities comply with Islamic finance. Businesses in alcohol, tobacco and pork-related products, conventional financial services, entertainment and weapons are precluded. The main rationale behind financial screening is to ensure that companies with large elements of debt and intangible assets are excluded. Although not universally standard, financial screenings of Dow Jones ensure that equities are excluded if any of the following criteria are in excess of 33%. These are: i) Total debt divided by trailing 24-month average market capitalisation; ii) Cash plus interest-bearing securities divided by trailing 24-month average market capitalisation; iii) Cash and interest-bearing securities divided by average market capitalisation; iv) Accounts receivables divided by trailing 24-month average market capitalisation.

Table 1 provides key descriptive statistics for the two indices considered alongside the Dow Jones Industrial Average (DJIA) for comparison purposes. Mean return is positive over the examined period for all three indices; however the DJIM has outperformed the two conventional indices while bearing lower risk. Specifically, the DJIM has a mean return of 0.013% compared to the 0.005% of DJGI and DJIA, while annualised volatility is 20.45% for the DJIM as opposed to the 20.84% and 22.79% of the DJGI and the DJIA respectively. All series show the commonly reported stylised facts of being leptokurtic, autocorrelated and stationary.

[Insert Table 1 around here]

5. Results

Table 2 reports the co-integration analysis results for the log prices of the three indices we consider. The Engle-Granger and Johansen approaches verify that all series are co-integrated. However, the co-integration is stronger for the pairs containing the DJIM, as evidenced by the higher statistical significance. Specifically, the co-integrating pairs of DJIM/DJIA and DJIM/DJGI are significant at the 1% significance level, under both Engle-Granger and Johansen approaches.

[Insert Table 2 around here]

Granger causality results (see Table 3) indicate that there are significant one directional causality effects related to the DJIM. Specifically, we verify that past performance of DJIM may be successfully used in to forecast both DJGI and DJIA. In addition, we document Granger causality from the DJIA to the DJGI.

A possible explanation for the result may lie within the nature of the companies featured in the three indices. Companies included in the DJIM and DJIA would be considered as investments of a higher quality, albeit for different reasons. On the one hand, companies in the DJIM would have passed all the *Shariah* related screening process; thus they would be expected to be less leveraged and less volatile compared to the DJGI and DJIA. This is plausible because financial screening would have eliminated companies bearing a high debt component in their balance sheets, while the typically more volatile conventional finance firms would not have gone past the business type screening. On the other hand, the thirty companies in the DJIA, although many of them are not engaged in the traditional "heavy industry", are considered as international firms of a very high quality and reputation. As a result, the DJIA is among the most widely used benchmarks.

[Insert table 3 around here]

Table 4 presents the output of the hidden co-integration analysis. Estimated coefficients for the OLS regressions of positive and negative components of the three indices are reported. Overall we find that all three combinations of positive index components (i.e., DJGI/DJIA, DJIM/DJIA and DJGI/DJIM) show evidence of a co-integrating relationship. By contrast, there is a single pair of negative index components (DJGI/DJIM) showing co-integrating evidence. More specifically, the ADF tests on the residuals of each regression (Engle-Granger approach) as well as the Johansen co-integration tests suggest that a long-run relation is particularly strong between the negative components of the DJGI and DJIM. The little evidence of co-integration shown in the positive components of the DJGI/DJIA, DJIM/DJIA and DJGI/DJIM pairs of indices is verified only by the Johansen test.

An economic interpretation of the hidden co-integration analysis may be related to the flight to quality effect. During periods of prolonged uncertainty and turbulence, market participants rebalance their portfolios and shift to investments less likely to experience a loss of capital. In the present context of equity indices, such investments would consist of companies of a preferential financial background or operating in a less affected sector. Therefore, companies with low proportions of debt, high proportion of tangible assets as well as companies operating in the relatively secure heavy industrial or consumer sectors would be preferred. However, as the constituents companies of a *Shariah* compliant index need to abide by *Shariah* restrictions, they would have the desired characteristics. Consequently, an index like the DJIM may behave as a safe haven for investors during distressed times.

It is interesting to note that the DJIA, although a high quality benchmark index, does not show similar behaviour to the DJGI during crisis. That is an interesting finding in its own right as it shows that investors during times of distress shun conventional practices altogether and opt for alternative investments. In other words, during distress investors are not looking for better quality in the same universe (*i.e.*, conventional) of investments, which the DJIA may arguably offer over the DJGI, they rather seek for an alternative and less interlinked “universe” of investments.

[Insert Table 4 around here]

5.1 Market conditions

In this section we repeat the hidden co-integration analysis for the bear/bull periods in the sample.

Table 5 reports estimated coefficients and standard errors for the regression with structural breaks on the volatility series of DJIA. There are four periods identified as calm (4/1/2006 – 26/7/2007), pre-crisis (27/7/2007 – 4/9/2008), crisis (5/9/2008 – 4/6/2009) and post-crisis (5/6/2009 – 31/12/2010). Before the global financial crisis, annualised volatility is at a low level of 1.14%, while in the next period climbs to 19.86%. Volatility surges to 42.65% as the crisis extends further with the nationalisation of Freddie Mac and Fannie Mae, two of the largest mortgage providers in the USA, the bankruptcy of Merill Lynch and Lehman Brothers and the downgrade on AIG's credit rating. In the post-crisis period, there are signs of recovery in the US stock markets, while annualised volatility drops at around 16.60%. The financial crisis which brought to surface issues like over-leveraging, deregulation and financial complexity has slowly been put behind. However, the world would enter a recession phase and a Euro crisis, highlighting issues of monetary and political nature, would unravel.

[Insert Table 5 around here]

Table 6 reports co-integration results in each of the four periods. Our results show that the co-integration link between DJGI and DJIM, although highly significant in the calm and pre-crisis periods, strengthens in the post-crisis period. By contrast, for the DJIM and DJIA pair of indices there is little evidence of co-integration in the years up to the crisis period. However, in the post-crisis period there is strong evidence of co-integration. This link receives renewed interest given the lack of co-integration between DJIA and DJGI.

[Insert Table 6 around here]

Granger causality results by market conditions are reported in table 7. We document a statistically significant causality relationship from the DJIM to DJGI in the pre-crisis period which strengthens further in the crisis and post-crisis periods. Similarly, there is a statistically significant causality relationship from the DJIM to the DJIA starting in the pre-crisis period, becoming more pronounced in the crisis period, while retaining its significance in the post-crisis period. By contrast, the causality evidence between the two conventional indices, DJGI and DJIA, are mixed. Up to the pre-crisis period, there is a strong causality relationship from DJIA to the DJGI which, however, becomes statistically insignificant in subsequent periods. Conversely statistically significant causality links from the DJGI to the DJIA are only verified for the pre-crisis period.

[Insert Table 7 around here]

This may imply that there are sound benefits to the investors, in terms of diversifiable risk or better risk/return trade-off, which may be accessible through Islamic equity indices. The popularity of Islamic equity indices may be evidenced by the rising Market Capitalisation figures across the distinct phases of the recent financial crisis (see Table XX8). Specifically, there is a 24% increase in market capitalisation pertaining to the DJIM in the years leading to the financial crisis, compared to a 2% of the DJGI and DJIA. During the crisis, market capitalisation of DJIM dropped by 52% - compared to 38% for DJGI and DJIA – but picker up soon thereafter. Financial performance of the DJIM, in terms of risk/return trade-off, has been superior to the two conventional indices. Specifically the DJIM recorded about 40% and 25% less losses during the pre-crisis and crisis periods, while at any point it was neither the worst performer (in terms of return) nor the most volatile.

[Insert Table 8 around here]

5.2 Case Study: Portfolio Optimisation

In this section we examine the benefits to portfolio diversification emanating from the use of an Islamic index. Although this is not supposed to be an exhaustive experimentation of techniques and possibilities it demonstrates the diversification benefits in a clear and concise manner. We adopt the mean-variance modern portfolio theory of Markowitz (1952), albeit with a few alterations. Specifically, we allow for time-varying covariance structure among the three indices considered, similar to the Yilmaz (2010) paper, and also assess the portfolio holdings separately in each of the four periods identified in our sample.

Portfolio optimisation details, in the more convenient for large portfolios matrix notation, are available in any advanced finance textbook; hence it will be mentioned here only briefly.

Assume $\mathbf{R}_t = \begin{pmatrix} r_a \\ r_b \\ r_c \end{pmatrix}$, $\mathbf{w}_p = \begin{pmatrix} w_{a,p} \\ w_{b,p} \\ w_{c,p} \end{pmatrix}$, $\mathbf{\Sigma}_t = \begin{pmatrix} \sigma_{a,t}^2 & \sigma_{\alpha b,t} & \sigma_{\alpha c,t} \\ \sigma_{\alpha b,t} & \sigma_{b,t}^2 & \sigma_{bc,t} \\ \sigma_{\alpha c,t} & \sigma_{bc,t} & \sigma_{c,t}^2 \end{pmatrix}$

Where **R** is a matrix with logarithmic daily returns; **w** is a matrix containing the weights assigned to each asset in every period *p*; **Σ** is a time varying variance-covariance matrix[3].

Alteration of the weights would give a different return-risk composition, while the Minimum Variance Portfolio (MVP) is the only portfolio for which no higher return may be achieved without incurring more risk. The portfolio return and risk are respectively:

[3] For the estimation of the time-varying variance covariance matrix we employ a DCC-GARCH(1,1) model of Engle (2002) which combines the flexibility of the GARCH family of models at the univariate level to the lack of the dimensionality curse found in earlier multivariate frameworks, such as BEKK and VEC models.

$$R_p^* = \mathbf{w}_p^{'}\mathbf{R}_t \;, \sigma_p^* = \mathbf{w}_p^{'}\mathbf{\Sigma}_t\mathbf{w}_p$$

Therefore the MVP may be calculated by writing a constrained[4] minimization problem and solving as:

$$\min_m \sigma_p^* = \mathbf{w}_p^{'}\mathbf{\Sigma}\mathbf{w}_p \quad s.t. \mathbf{w'1} = 1$$

Three investment strategies are tested; the first (S1) allows investments in Islamic equity indices only (DJIM); the second (S2) allows only for conventional equity indices (DJGI, DJIA), while the third (S3) allows for a combination of both Islamic and conventional equity indices. Of course such strategy may not be accepted by a Muslim investor as it invests in conventional assets but it could serve the diversification purposes of a conventional investor who is not interested in the religious aspect *per se*.

Table 9 presents the minimum variance portfolios for the three strategies in the full sample and each of the four sub-periods[5]. It is evident that the combined strategy (S3) is the less risky strategy irrespective of period, as verified by both risk measures. A pure Islamic strategy records higher portfolio returns compared to the other two, with the S3 strategy being second. A pure conventional strategy records the lowest return – which is negative in the full period. Across the four time periods, a finding of particular interest is that S3 comes closer in performance to the S1 strategy. For example, a shift from S3 to S1 in the calm period would increase portfolio returns by about 40.5%, while a similar shift in the pre-crisis period would increase returns by approximately 21.1%. However, during the crisis and in the post-crisis periods the gains from a similar shift are at about 1.6% and 2.7% respectively. A reason for this finding may be traced to the weighting that the Islamic equity index has been assigned across the periods, which is presented in Figure 1.

[Insert Table 9 around here]

[Insert Figure YY1 around here]

6. Conclusion

[4] The most important constraint is that the weights sum up to 1. Other constraints may prevent negative weights (short sale) or restrict the investment in a particular asset but are not explored here.

[5] We do not explore portfolio re-balancing in the identified periods; therefore average returns and average conditional variances-covariances are utilized in the portfolio maximization algorithm in every period. We leave portfolio rebalancing strategies as an extension for future research.

Islamic finance has been attracting rising interest during the past decade from the academic and professional world. Research areas pertaining particularly to Islamic banks have received a large slice of the Islamic finance research pie, while important findings with regards to efficiency, profitability and stability have been widely disseminated. Yet others areas, such as Islamic equity indices, still remain relatively in the shadows.

In this paper we empirically investigate the relationship between Islamic and conventional equity indices. Our aim is to examine if the elsewhere documented evidence about Islamic banks are also applicable in Islamic equity indices. Therefore we focus on the financial performance of Islamic indices and the diversification benefits they offer to investors.

We employ the novel in the area hidden co-integration technique with Granger causality testing for three well known global benchmark indices. Our sample consists of the Dow Jones Islamic Market, the Dow Jones Global Index (conventional) and the Dow Jones Industrial Average (conventional) studied over the 2006 – 2010 period. We segment the sample, using appropriate break detection tests, into four sub-samples – calm, pre-crisis, crisis and post-crisis. Subsequently we investigate the impact of the global financial crisis on performance, interconnectedness and diversification benefits of the indices and complement with a case study on portfolio diversification.

We find that the Islamic equity indices are establishing themselves as an important diversification tool to investors. Many findings allude to this contention. First, the co-integration and granger causality analyses between negative index components reveal that the Islamic equity index is a driving force behind the conventional ones, particularly after the crisis; thus uncovering a rise in the importance of Islamic finance for investors

Specifically, the crisis has highlighted the importance of *Shariah* compliant stocks due to their lower leverage and shunning of conventional financial practices, such as complex debt-based financial products. The higher resilience of such stocks to the financial crisis is verified by the highly significant causal relationship from DJIM to DJGI and to DJIA in the crisis period. The fact that this causal relationship maintains its statistical significance even in the post-crisis period may reflect investors' scepticism and concern about conventional financial practices. It may also be inferred from the lack of co-integration and causality relationships of DJGI and DJIA that investors' response to the crisis was not to diversify their portfolios geographically (given that DJGI has a wider geographical coverage than DJIA, which is essentially restricted to US firms), but to look for alternative investments.

Second, there is a trend in the Islamic equity index's financial performance which becomes more competitive across time with return and risk characteristics bridging the gap to the conventional indices. Moreover, the Islamic index surpasses the two conventional indices' financial performance during the crisis and in the period that follows. Evidence from our portfolio optimisation case study suggests that a well-diversified portfolio has an increasing composition of an Islamic equity index in the period during and following the financial crisis.

Our findings may have important practical implications for portfolio management. Directions for future research include the investigation of a larger set of equity indices, possibly with specific sectorial or geographical focus, as well as portfolio re-balancing techniques. We investigate some of these avenues in future research.

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Appendix

Table 1: Descriptive Statistics.

	DJGI	DJIM	DJIA
Mean (%)	0.005	0.013	0.005
Volatility (Annualised %)	20.84	20.45	22.79
Max	8.664	9.775	10.508
Min	-7.160	-8.185	-8.201
Skewness	-0.428	-0.427	0.026
Kurtosis	9.863	11.751	11.863
JB	2503.109	4045.612	4110.823
p-value	*(0.000)*	*(0.000)*	*(0.000)*
LB (8)	32.883	35.171	48.638
p-value	*(0.000)*	*(0.000)*	*(0.000)*
ADF	-7.390	-19.920	-7.396
p-value	*(0.000)*	*(0.000)*	*(0.000)*

Notes: The table reports key descriptive statistics for Dow Jones Global (DJGI) and the Dow Jones Islamic Market (DJIM) over the period 03/1/2006 – 31/12/2010. JB denotes the Jarque-Bera test for normality, LB denotes the Ljung-Box autocorrelation test, ADF denotes the Augmented Dickey Fuller unit root test. *,**,*** denote statistical significance at the 10%, 5% and 1% levels respectively

Table 2: Co-integration results.

	DJGI	DJIM	DJIA
DJGI			0.809*** (0.004)
DJIM	1.175*** (0.011)		
DJIA		0.927*** (0.009)	
C	-3.435*** (0.080)	-1.042 (0.091)	4.872*** (0.019)
R-squared	90.72	87.77	97.64
Engle-Granger Approach			
ADF	-3.402**	-4.165***	-3.426**
Johansen Approach			
Eigenvalue	0.016	0.016	0.013
Trace Statistic	22.16***	22.23***	18.63**
5% Cr	15.49	15.49	15.49

Notes: The table reports estimated coefficients and standard errors in parentheses for the OLS regressions of the log prices of DJGI, DJIM, DJIA on the full sample. ADF refers to the Augmented-Dickey Fuller test for unit root on the residual series. *,**,*** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 3: Granger Causality.

	DJGI	DJIM	DJIA
DJGI		1.77 (0.171)	0.736 (0.479)
DJIM	186.04*** (0.000)		159.09*** (0.000)
DJIA	19.42*** (0.000)	1.994 (0.136)	

Notes: The table reports the results of the Granger Causality test on the full sample. Numbers reported are F-statistics while number in parentheses are p-values. The null hypothesis is that the index appearing in a given row granger causes the index appearing in a given column. For example, the null hypothesis that DJIM Granger causes DJGI is rejected at all significance levels. *,**,*** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 4: Hidden co-integration results.

	DJGI+	DJGI-	DJIM+	DJIM-	DJIA+	DJIA-
DJGI+					1.081*** (0.001)	
DJGI-						1.069*** (0.001)
DJIM+	1.028*** (0.001)					
DJIM-		1.058*** (0.001)				
DJIA+			0.898*** (0.001)			
DJIA-				0.883*** (0.001)		
C	-0.021*** (0.002)	0.064*** (0.001)	0.097*** (0.003)	-0.115*** (0.003)	-0.079*** (0.004)	0.059*** (0.003)
R-squared	99.95	99.97	99.83	99.89	99.80	99.92
ADF	-2.121	-6.052***	-1.423	-2.519	-0.380	-1.041
Eigenvalue	0.038	0.047	0.014	0.004	0.034	0.002
Trace Statistic	49.45***	60.67***	18.23**	5.98	45.73***	3.25
5% Cr	15.49	15.49	15.49	15.49	15.49	15.49

Notes: The table reports estimated coefficients and standard errors in parentheses for the OLS regressions of the DJGI+, DJGI-, DJIM+, DJIM- and DJIA+, DJIA- on the full sample. ADF refers to the Augmented-Dickey Fuller test for unit root on the residual series. *,**,*** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 5: Breaks Identification Regression

Dependent Variable	Volatility
Calm	0.0007***
	(0.0002)
Pre-Crisis	0.0122***
	(0.0002)
Crisis	0.0262***
	(0.0003)
Post-Crisis	0.0102***
	(0.0002)
R-squared	68.23
F-statistic	899.52
p-value	0.000

Notes: The table reports OLS estimates and standard errors in parentheses for the break identification regression in the full sample. The dependent variable is the GARCH(1,1) volatility series of DJIA. Break identification follows the Bai and Perron (2003) procedure, while the break estimation is carried out using the Schwarz information criterion. Breakpoint dates are 27/07/2007, 5/09/2008 and 5/06/2009.

Table 6: Co-integration results by market conditions.

Indices pairs	**DJGI-DJIM**	**DJIM-DJIA**	**DJIA-DJGI**
Calm Period (n=391 obs)			
Engle-Granger Approach			
ADF	-6.823***	-4.837***	-2.733
Johansen Approach			
Eigenvalue	0.084	0.037	0.018
Trace Statistic	33.83***	14.67*	7.283
5% Cr	15.49	15.49	15.49
Pre-Crisis (n=280 obs)			
Engle-Granger Approach			
ADF	-4.640***	-3.309**	-2.863*
Johansen Approach			
Eigenvalue	0.104	0.045	0.038
Trace Statistic	30.74***	13.29	14.22*
5% Cr	15.49	15.49	15.49
Crisis (n=188 obs)			
Engle-Granger Approach			
ADF	-3.381**	-2.131	-1.021
Johansen Approach			
Eigenvalue	0.349	0.145	0.036
Trace Statistic	85.99***	37.03***	15.49
5% Cr	15.49	15.49	15.49
Post-Crisis (n=398 obs)			
Engle-Granger Approach			
ADF	-8.248***	-5.557***	-1.882
Johansen Approach			
Eigenvalue	0.309	0.189	0.016
Trace Statistic	149.03***	85.18***	9.27
5% Cr	15.49	15.49	15.49

Notes: The table reports estimated coefficients and standard errors in parentheses for the OLS regressions of the log prices of DJGI, DJIM, DJIA on the four sub-samples. ADF refers to the Augmented-Dickey Fuller test for unit root on the residual series. *,**,*** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 7: Granger Causality.

	DJGI	DJIM	DJIA		DJGI	DJIM	DJIA
Calm				**Crisis**			
DJGI		2.582* (0.077)	1.581 (0.207)			1.354 (0.260)	0.088 (0.915)
DJIM	2.534* (0.081)		1.817 (0.163)		62.33*** (0.000)		55.613*** (0.000)
DJIA	13.94*** (0.000)	1.336 (0.264)			2.802* (0.063)	1.992 (0.139)	
Pre-Crisis				**Post-Crisis**			
DJGI		0.170 (0.843)	4.605** (0.011)			0.712 (0.491)	2.177 (0.114)
DJIM	8.999*** (0.000)		6.487*** (0.002)		24.92*** (0.000)		17.105*** (0.000)
DJIA	12.101*** (0.000)	0.153 (0.858)			1.924 (0.147)	3.875** (0.021)	

Notes: The table reports the results of the Granger Causality test on the four sub-samples. Numbers reported are F-statistics while number in parentheses are p-values. The null hypothesis is that the index appearing in a given row granger causes the index appearing in a given column. For example, the null hypothesis that DJIM Granger causes DJGI is rejected at all significance levels. *,**,*** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 8: Descriptive Statistics by Period.

	Mean Return (%)	Volatility (Annualised) %)	Max (%)	Min (%)	Skewness	Kurtosis	JB statistic	LB statistic (8)	Mean Market Capitalisation ($)
Calm									
DJGI	0.059	33.16	2.089	-2.510	-0.496	4.291	43.072***	33.19***	7,001,906
DJIM	0.049	36.88	2.323	-2.802	-0.430	4.272	38.319***	26.69***	5,951,927
DJIA	0.056	32.85	2.069	-3.349	-0.619	5.745	147.414***	15.52*	4,027,050
Pre-Crisis									
DJGI	-0.131	137.53	8.664	-7.160	-0.180	3.883	7.124**	8.30	4,852,015
DJIM	-0.102	155.17	9.775	-8.186	-0.180	4.673	22.927***	11.96	4,520,620
DJIA	-0.131	166.81	10.508	-8.201	0.196	4.435	17.332***	12.04	2,822,556
Crisis									
DJGI	-0.077	16.36	3.074	-3.619	-0.118	3.241	1.329	7.17	7,136,976
DJIM	-0.047	15.96	2.860	-3.672	-0.312	3.407	6.478**	13.03	7,603,594
DJIA	-0.066	19.77	3.488	-3.181	-0.028	3.134	0.246	20.11**	4,111,821
Post-Crisis									
DJGI	0.074	16.61	4.683	-3.163	-0.154	4.515	39.637***	15.55**	5,891,055
DJIM	0.074	15.94	4.162	-3.141	-0.170	4.461	37.317***	14.43*	5,691,257
DJIA	0.070	15.89	3.825	-3.670	-0.213	4.689	50.307***	10.90	3,388,824

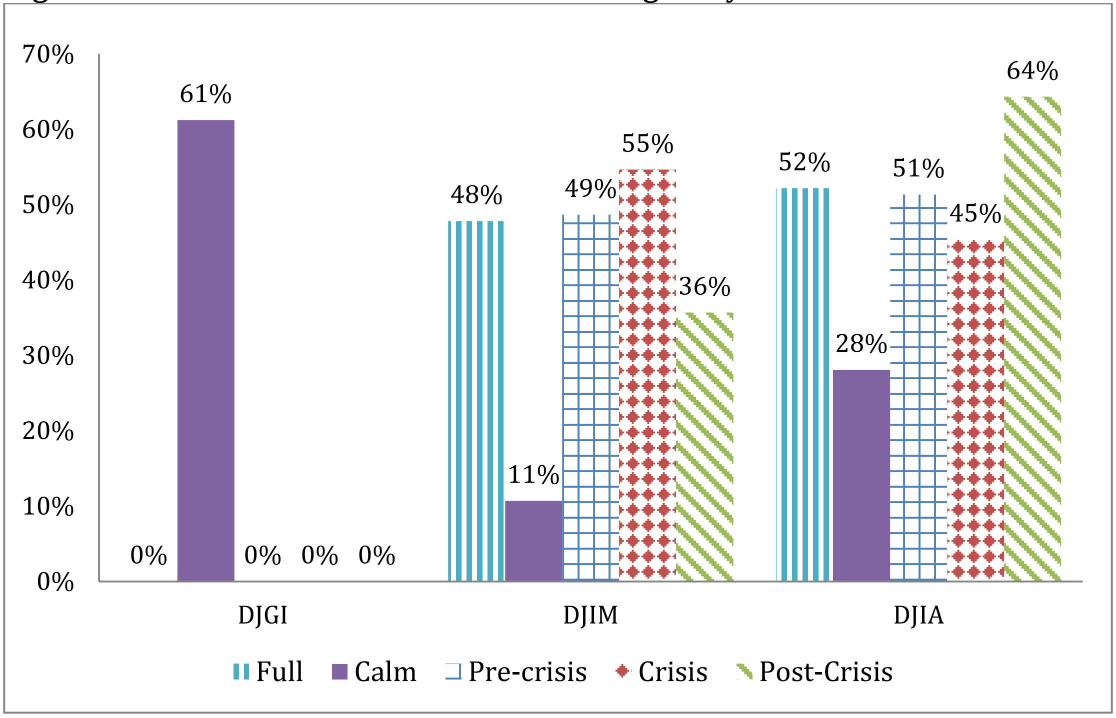
Notes: The table reports key descriptive statistics for Dow Jones Global (DJGI), the Dow Jones Islamic Market (DJIM) and the Dow Jones Industrial Average (DJIA) over the period 03/1/2006 – 31/12/2010. JB denotes the Jarque-Bera test for normality, LB denotes the Ljung-Box autocorrelation test. *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively

Table XX9: Minimum Variance Portfolio Performance.

Period	Strategy	W_{DJGI}	W_{DJIM}	W_{DJIA}	Return (MVP)	Annualized Volatility (MVP)	VaR95 (MVP)
Full	**S1**	0.00%	100.00%	0.00%	0.016%	22.416%	2.307%
	S2	86.63%	0.00%	13.37%	-0.007%	20.307%	2.111%
	S3	0.00%	47.83%	52.17%	0.010%	19.073%	1.966%
Calm	**S1**	0.00%	100.00%	0.00%	0.066%	14.238%	1.378%
	S2	81.82%	0.00%	18.18%	0.040%	10.348%	1.378%
	S3	61.23%	10.69%	28.07%	0.044%	10.310%	1.378%
Pre-Crisis	**S1**	0.00%	100.00%	0.00%	-0.034%	19.175%	2.021%
	S2	93.33%	0.00%	6.67%	-0.056%	16.817%	1.798%
	S3	0.00%	48.65%	51.35%	-0.042%	15.617%	1.660%
Crisis	**S1**	0.00%	100.00%	0.00%	-0.125%	39.411%	4.208%
	S2	97.64%	0.00%	2.36%	-0.151%	37.920%	4.080%
	S3	0.00%	54.63%	45.37%	-0.127%	34.842%	3.737%
Post-Crisis	**S1**	0.00%	100.00%	0.00%	0.073%	18.173%	1.810%
	S2	50.63%	0.00%	49.37%	0.060%	15.712%	1.568%
	S3	0.00%	35.67%	64.33%	0.071%	15.124%	1.496%

Notes: Table reports the minimum variance portfolio weights, return and risk in each of the three investment strategies for every period. S1 denotes a pure Islamic strategy; S2 denotes a pure conventional strategy and S3 allows the investment in both Islamic and conventional equity indices. VaR95 is the portfolio Value at Risk at the 95% significance level. Annualized Volatility is measured as the average conditional volatility in each period. Conditional variances/covariances are estimated via a DCC-GARCH(1,1) model.

Figure YY1. Minimum Variance Portfolio Weights by Period



Notes: Figure shows minimum variance portfolio weights in the full and the four sub-periods of the analysis per equity index. Full: 3/1/06-31/12/10; Calm: 3/1/06-26/7/07; Pre-Crisis: 27/7/07-4/9/08; Crisis: 5/9/08-4/6/09; Post-Crisis: 5/6/09-31/12/10.