Do 'Sin Stocks' Deprive Islamic Stock Portfolios of Diversification? Some Insights from the Use of MGARCH-DCC

Nazrol Kamil Mustaffa Kamil *, Obiyathulla Ismath Bacha ** &
Abul Mansur Mohammed Masih ***
International Centre for Education in Islamic Finance

Abstract: There is this argument that *Shari'ah* compliant portfolios are at a disadvantage in terms of portfolio diversification given that the exclusion of 'sin stocks' shrinks the Islamic investor's investment universe. This paper investigates first, whether there is empirical evidence to substantiate such a claim, and second, can something be done to alleviate this disadvantage. Our results show that there is statistical evidence that Islamic portfolios are deprived of some benefits of diversification, at the sector level. However, the empirical evidence does not permit us to generalise such a finding at the specific stock level. By analysing the temporal characteristics of correlations using MGARCH-DCC, we argue that Islamic portfolios can minimise loss of diversification benefit by adopting appropriate portfolio allocation strategies. In particular, market sentiment and commodity prices are two key variables that can drive portfolio allocation switching decisions. In short, while there is some evidence that investors of *Shari'ah* compliant portfolios are denied additional benefits of diversification, there are arguably avenues to mitigate such a disadvantage.

Keywords: Portfolio diversification, *Shari'ah* compliant portfolios, Islamic stocks, Islamic capital market, MGARCH, dynamic conditional correlation (DCC)
JEL classification: C1, G11, Z12

1. Introduction

Islamic finance, even in its relatively nascent stages of evolution, has witnessed impressive rates of growth. Notwithstanding this, some critics of contemporary Islamic finance often highlight the absence of meaningful presence of equity-based financing instruments. It is a common argument amongst scholars and academics of Islamic finance that profit sharing instruments such as *mudarabah* and *musharakah* be the primary substitute for interest-bearing financial arrangements (Ayub 2007; Iqbal and Mirakhor 2007; Usmani 2002). However, after at least three decades of existence, Islamic banking and finance has yet to put into practice such equity-based structures in a meaningful way. In particular, *mudarabah* and *musharakah* financing presently account for only token fractions of total financing given out by Islamic financial institutions globally. In some cases, such financing makes up only a negligible percentage of total financing. The same can be said of Islamic capital markets – there are only a handful of *sukuk* structured employing genuine profit sharing mechanisms.

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*   PhD student, International Centre for Education in Islamic Finance (INCEIF); Lecturer, International Islamic University Malaysia. Email: *n_kamil@hotmail.com* (corresponding author)
**   Professor of Finance, International Centre for Education in Islamic Finance (INCEIF). Email: *obiya@inceif.org*
***   Professor of Finance and Econometrics, International Centre for Education in Islamic Finance (INCEIF). Email: *mansurmasih@inceif.org*

At the same time, equity markets globally are thriving, well organised and regulated. The majority of scholars have allowed investment in modern day equities on the basis of *maslahah*. Many of these jurists interpret joint-stock corporations in vogue today as forms of *mudarabah* and/or *musharakah*.[1] Thus the embracing and development of Islamic equity markets can be viewed as a means of addressing the aforementioned criticism that Islamic finance has thus far failed to incorporate, in substantial quantum, the spirit of profit sharing propagated by Islamic scholars.

However, the percentage of today's listed firms that are fully in compliance with the *Shari'ah* is very small.[2] Hence, some degree of compromise or tolerance is required. Towards this end, *Shari'ah* stock screening represents the process of identifying *Shari'ah* compliant equity investments that embody such a compromise. Firms involved primarily in such sectors as interest-based finance, gambling, tobacco and alcohol – the so-called 'sin stocks' – are typically excluded from *Shari'ah* compliant portfolios. In addition, in some *Shari'ah* jurisdictions, financial ratios are applied to filter out unacceptable levels of interest income as well as interest-based debt and receivables.

Given that Islamic equity is rapidly making inroads onto the global equity markets scene, many have made empirical enquiries into the performance of Islamic portfolios and funds *vis-à-vis* their conventional counterparts. A cursory review of current literature shows that in some instances, *Shari'ah* compliant portfolios have underperformed. A number of reasons can be attributed to such an observation. First, one could argue along the lines of the relative competence of asset managers of Islamic portfolios. Islamic funds tend to be smaller, newer and have access to fewer resources. This is particularly the case in less developed Islamic financial markets (Hoepner *et al.* 2010). Second, stocks which *Shari'ah* compliant portfolios do not have access to, by virtue of *Shari'ah* stock screening norms, may have consistently higher alpha, or excess market returns. The assumption here is that equity markets do not price risk and return efficiently. Third, *Shari'ah* compliant investors have a smaller investment universe to choose from. By excluding 'sin stocks' from the pool of *Shari'ah* compliant investable equity investments, such investors obtain less benefit from portfolio diversification. This paper seeks to delve into this third possible explanation.

In our humble opinion, such an endeavour would of interest to investors of *Shari'ah* compliant portfolios in at least two ways. First, is there empirical evidence that exclusion of 'sin stocks' puts such investors at a disadvantage, or is it mere unsubstantiated rhetoric? Second, if it is true that investors of *Shari'ah* compliant portfolios are at a disadvantage, what, if anything, can be done to minimise such a diversification handicap?

2. Research Objectives

Relating to the three purported reasons as to why Islamic funds have, in some cases, historically underperformed with respect to conventional funds, we argue that not much can be done, on the part of *Shari'ah* compliant investors, to address the first two reasons. Relative competence of Islamic asset managers and pricing efficiency of equity markets are

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[1] See Usmani (2002).

[2] For example, strictly speaking, for a firm to be completely in compliance with *Shari'ah* rules, it must neither receive nor pay any quantum of interest. This implies that the firm has no dealings whatsoever with conventional interest-based banking.

taken as externalities beyond the control of any given investor. Whether or not these factors are in fact affecting observed relative performance can probably be subjected to academic inquiry but is not the concern of this paper. Rather, we focus on the third ostensible reason.

Investors subscribing to the Islamic faith may want to channel part of their investment monies to equity investments. However, at the same time, their commitment to tenets of the *Shari'ah* binds them to limit their investment to *Shari'ah* compliant stocks. These investors may be interested to know whether the exclusion of 'sin stocks' would deprive them of additional benefits of diversification. This is our first research question.

One could contend – what would be the benefit of ascertaining an answer to the abovementioned research question? After all, pious investors would remain with their convictions regardless of whether there is empirical evidence to show that 'sin stocks' provide extra diversification benefit. In other words, investors of *Shari'ah* compliant portfolios, steadfast in their beliefs, would continue to avoid such stocks even if it is empirically proven that these stocks offer additional diversification benefits. This would render such a research question purely academic and of no practical consequence.

This leads us to our second research question. Given that such a disadvantage exists, is there anything that can be done to minimise it? This second research question not only introduces some practical context, but also makes the first research question indispensable. It only makes sense to ask the second research question after having first asked the first and found evidence that such a disadvantage is present.

More formally, we reiterate our two research questions:

i. Is there empirical evidence that exclusion of 'sin stocks' deprives *Shari'ah* compliant portfolios of additional benefits of diversification?
ii. Given that the answer to the above is in the affirmative, is there anything that can be done to minimise such a disadvantage?

3. Literature Review

Modern portfolio theory championed by Markowitz states that, amongst other things, "when we hold diversified portfolios, the contribution to portfolio risk of a particular security will depend on the covariance of that security's return with those of other securities, and not the security's variance" (Bodie *et al.* 2009). In other words, correlation of returns among assets matters. If assertions of the Capital Asset Pricing Model (CAPM) hold true in equity markets, equity returns only reflect systematic risk. The underlying assumption is that investors are fully diversified in their respective portfolios. When this is not the case, as with *Shari'ah* compliant portfolios, returns may be sub-optimal.

There has been a number of empirical works that compare the performance of Islamic funds *vis-à-vis* conventional ones. Many of these conclude that results are mixed, in that in some cases Islamic funds outperform conventional funds while in other cases the reverse is true (Elfakhani and Hassan 2005; Leong and Aw 1997; Shamsher and Annuar 1995). There are some ,however, for example, Hoepner *et al.* (2010), who found that in some cases, the performance of *Shari'ah* compliant funds was inferior to conventional funds, attributing it to investment style. Notwithstanding this, we did not encounter literature that specifically delved into the empirical investigation of the diversification dimension in attributing

performance differences between Islamic and conventional portfolios. We perceive this to be a gap in existing literature and hence our present endeavour.

To address our research objectives as identified above, we employed the use of dynamic conditional correlations. While this econometric technique has been put to use in various areas of application – in political science (Lebo and Box-Steffensmeier 2008), in modelling correlations in oil forwards and futures returns (Lanza *et al.* 2006), in multiple futures markets (Pesaran and Pesaran 2007) and in European equity markets (Kearney and Poti 2006) – we are not aware of any application of this method in the specific area of enquiry that this paper has identified. Thus we submit that this paper is novel in two ways – first, empirically investigating the diversification dimension in explicating relative performance of Islamic portfolios *vis-à-vis* conventional funds, and second, employing the dynamic conditional correlation model in such an empirical endeavour.

4. Methodology

In this empirical investigation, we modelled the volatility of three samples of daily returns of stock indices and individual stock prices, namely selected sector-based Malaysian equity market indices, selected Malaysian stocks and selected sector-based US equity market indices.[3] Further details, including sample periods, are shown in Table 1.

Table 1. Sample description, period and duration

Malaysia – sector indices		Malaysia – selected stocks		United States – sector indices	
Shari'ah compliant	Non-*Shari'ah* compliant	*Shari'ah* compliant	Non-*Shari'ah* compliant	*Shari'ah* compliant	Non- *Shari'ah* compliant
Construction Consumer prod. Industrial prod. Plantation Property Trading & Services	Finance	Sime IOI KLK Gamuda MISC PDB YTL Nestle Parkson Proton TNB Telekom	Maybank CIMB Public Bank BAT Carlsberg Genting Berjaya Toto	Basic Materials Consumer goods Consumer services Healthcare Industrials Oil & Gas Technology Telecommunication Utilities	Banking Insurance Fin. services Gambling Breweries Tobacco Media Hotels
		Sample period and duration :			
3 Jan 1994 – 30 Dec 2009 (16 years)		2 Jan 1995 – 30 Dec 2009 (15 years)		2 Jan 1993 – 30 Dec 2009 (17 years)	

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[3] Index providers and associated *Shari'ah* screening authorities are *Financial Times Bursa Malaysia* (FBM) and Dow Jones for Malaysia and the US, respectively.

We relied primarily on the Multivariate Generalised Autoregressive Conditional Heteroscedastic (MGARCH) model in Pesaran and Pesaran (2009). We initially tested for both normal and t distributions, to determine which would model our case more aptly. Results of unconditional correlation coefficients could suffice to provide empirical evidence to answer our first research question. However, to address our second research objective, we require the computation of conditional cross-asset correlations, computed by Microfit as

$$\tilde{\rho}_{ij,t-1}(\phi) = \frac{q_{ij,t-1}}{\sqrt{q_{ii,t-1}q_{jj,t-1}}}$$

where $q_{ij,t-1}$ are given by

$$q_{ij,t-1} = \bar{\rho}_{ij}(1 - \phi_1 - \phi_2) + \phi_1 q_{ij,t-2} + \phi_2 \tilde{r}_{i,t-1}\tilde{r}_{j,t-1}$$

In the above, $\bar{\rho}_{ij}$ is the (i,j)th unconditional correlation, ϕ_1 and ϕ_2 are parameters such that $\phi_1 + \phi_2 < 1$, and $\tilde{r}_{i,t-1}$ are the standardised asset returns.

We also tested whether the computed volatility was mean-reverting by estimating $(1 - \lambda_{i1} - \lambda_{i2})$. Some diagnostic tests were conducted to substantiate the validity of our models. For brevity, we omit further details of this model, which can be found in Pesaran and Pesaran (2009).

5. Empirical Findings and Interpretations

5.1 Kuala Lumpur Stock Exchange – Sector Indices

Table 2 summarises the maximum likelihood estimates of λ_{i1} and λ_{i2} for the seven sector indices returns, and δ_1 and δ_2, comparing multivariate normal distribution with multivariate student t-distribution. Note that the asset-specific estimates of the volatility decay parameters are all highly significant.

The maximised log-likelihood value for the case of t-distribution [96062.4] was larger than that obtained under the normality assumption [94684.3]. In addition, the estimated degree of freedom for the t-distribution [6.12] was well below 30; and any other value one would expect for a multivariate normal distribution. This suggests that the t-distribution is more appropriate in capturing the fat-tailed nature of the distribution of index returns.[4] Henceforth our analysis will work with the t-distribution estimates.

Table 3 shows the estimated unconditional volatilities (diagonal elements) and the unconditional correlations (off-diagonal elements) of the seven indices.

In Table 3, the numbers in parenthesis in the diagonal elements represent ranking of unconditional volatility (from lowest to highest). The ranking is characteristic of the Malaysian equity market. The construction, property and finance sectors tend to receive a larger share of speculative trades in stocks. This is particularly the case during bull runs and when the market is flush with liquidity. Not surprisingly, consumer products show the lowest volatility, reflecting the intuition that everyday consumer goods are relatively more recession proof and do not experience excessive growth during economic booms.

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[4] Pesaran and Pesaran (2009).

Table 2. Estimates of λ_{i1} and λ_{i2}, δ_1 and δ_2, for the seven sector indices.

		Multivariate normal distribution		Multivariate t distribution	
		Estimate	T-Ratio	Estimate	T-Ratio
Lambda 1 (λ_1)	Finance	.9265	165.098	.9227	136.871
	Construction	.9247	155.265	.9104	108.089
	Consumer products	.9310	177.665	.9196	120.568
	Industrial products	.9183	162.418	.9152	124.940
	Plantation	.9032	128.349	.9070	111.511
	Property	.9103	139.604	.9075	117.625
	Trading & services	.9260	151.604	.9221	138.341
Lambda 2 (λ_2)	Finance	.0649	13.916	.0679	12.038
	Construction	.0644	13.572	.0771	11.291
	Consumer products	.0622	13.874	.0712	11.000
	Industrial products	.0725	15.448	.0752	12.211
	Plantation	.0846	14.384	.0829	11.920
	Property	.0808	14.464	.0835	12.518
	Trading & services	.0674	12.775	.0703	12.204
Delta 1 (δ_1)		.9588	300.505	.9734	416.868
Delta 2 (δ_2)		.0189	19.017	.0152	15.356
Maximised log-likelihood		94684.3		96062.4	
Degrees of freedom (df)		-		6.1158	29.024

Note: λ_1 and λ_2 are decay factors for variance and covariance, respectively.

Table 3. Estimated unconditional volatility matrix for the 7 sectors

	Finance	Construct.	Cons.prod	Ind. prod	Plantation	Property	Trad & svs
Finance	.01721(5)	.82607	.79743	.81897	.69311 [a]	.81512	.86134
Construct.	.82607	.02058(7)	.77298	.80894	.67091	.80345	.80741
Cons.prod	.79743	.77298	.01180(1)	.83245	.72874	.77429	.80662
Ind. prod	.81897	.80894	.83245	.01466(2)	.74212	.83927	.82323
Plantation	.69311	.67091	.72874	.74212	.01479(3)	.70414	.70754
Property	.81512	.80345	.77429	.83927	.70414	.01803(6)	.75553
Trad & svs	.86134	.80741	.80662	.82323	.70754	.75553	.01637(4)

More pertinent to the main objectives of this paper are the correlations among the indices. A cursory examination of the unconditional correlations reported in Table 3 highlight the fact that the plantation sector has the lowest correlations with other sectors. To have a clearer picture of the relative correlation among sectors, we ranked the unconditional correlations (from lowest to highest)[5], shown in Table 4.

The above rankings tell us two important facts. First, for all sectors, the lowest correlation is with the plantation sector (see notation 'a' in Table 4). This implies that in order to fully

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[5] Each column represents the ranking of unconditional correlation between the index specified in the table header and other sectors.

Table 4. Ranking of unconditional correlations among 7 sectors

Finance (FIN)	Construction (CONST)	Consumer products (CPROD)	Industrial products (IPROD)	Plantation (PLANT)	Property (PROP)	Trading & services (TRSVS)
PLANT [a]	PLANT [a]	PLANT [a]	PLANT [a]	CONST	PLANT [a]	PLANT [a]
CPROD	CPROD	CONST	CONST	FIN [c]	TRSVS	PROP
PROP	PROP	PROP	FIN [c]	PROP	CPROD	CPROD
IPROD	TRSVS	FIN [b]	TRSVS	TRSVS	CONST	CONST
CONST	IPROD	TRSVS	CPROD	CPROD	FIN [b]	IPROD
TRSVS	FIN [b]	IPROD	PROP	IPROD	IPROD	FIN [b]

benefit from portfolio diversification, portfolios should include plantation stocks. Second and more pertinent, correlation with the finance sector is relatively higher for the following sectors – construction, trading and services, property, and consumer products (see notation 'b' in Table 4). Relating it to the purpose of this paper, this suggests that investors of *Shari'ah* compliant equity portfolios would not be significantly disadvantaged if their portfolios are heavily weighted in these aforementioned sectors. However, such investors stand to lose if their portfolios comprise stocks in plantations and industrial products (see notation 'c' in Table 4). In particular, the correlation between the finance and plantation sectors is the second lowest among all (see notation 'a' in Table 3). Taken together with the first observation (that the plantation sector has the lowest correlations), this has an important implication. Our correlation results show that a diversified portfolio ought to contain plantation stocks. Given that financial stocks are mostly not *Shari'ah* compliant, and given relatively lower correlation between the plantation and finance sectors, we argue that there is empirical evidence that investors in *Shari'ah* compliant portfolios are at a disadvantage, in terms of portfolio diversification. This answers our first research question.

Thus far, our analyses and conclusions on volatilities and correlations have been made on an unconditional basis. In other words, we take the average volatility and correlation in the sample period. However, the assumption that volatility and correlation remain constant throughout a period spanning over 10 years does not appeal to intuition. It is more likely that volatility and correlation are dynamic in nature and it is this aspect which the Dynamic Correlation Coefficient (DCC) model employed in this paper addresses.

We began with observing the temporal dimension of volatility. We charted the conditional volatilities for the seven sector indices but for the sake of brevity, only two are shown here. When we compared the conditional volatilities of the plantation and finance sectors (top panel in Figure 1), we found pronounced divergences during stock market crises. During the period of the Southeast Asian Financial Crisis of 1997/98, volatilities of the finance sector were substantially higher than the plantation sector. The opposite was found during the more recent 2008 Global Financial Crisis.

In contrast, when we compared the conditional volatilities of the finance and the trading and services sectors (bottom panel in Figure 1), we found that they more closely tracked one another. Taken together, these observations corroborate our earlier findings that the trading and services sector is relatively more correlated with the finance sector than the plantation sector is correlated with the finance sector.
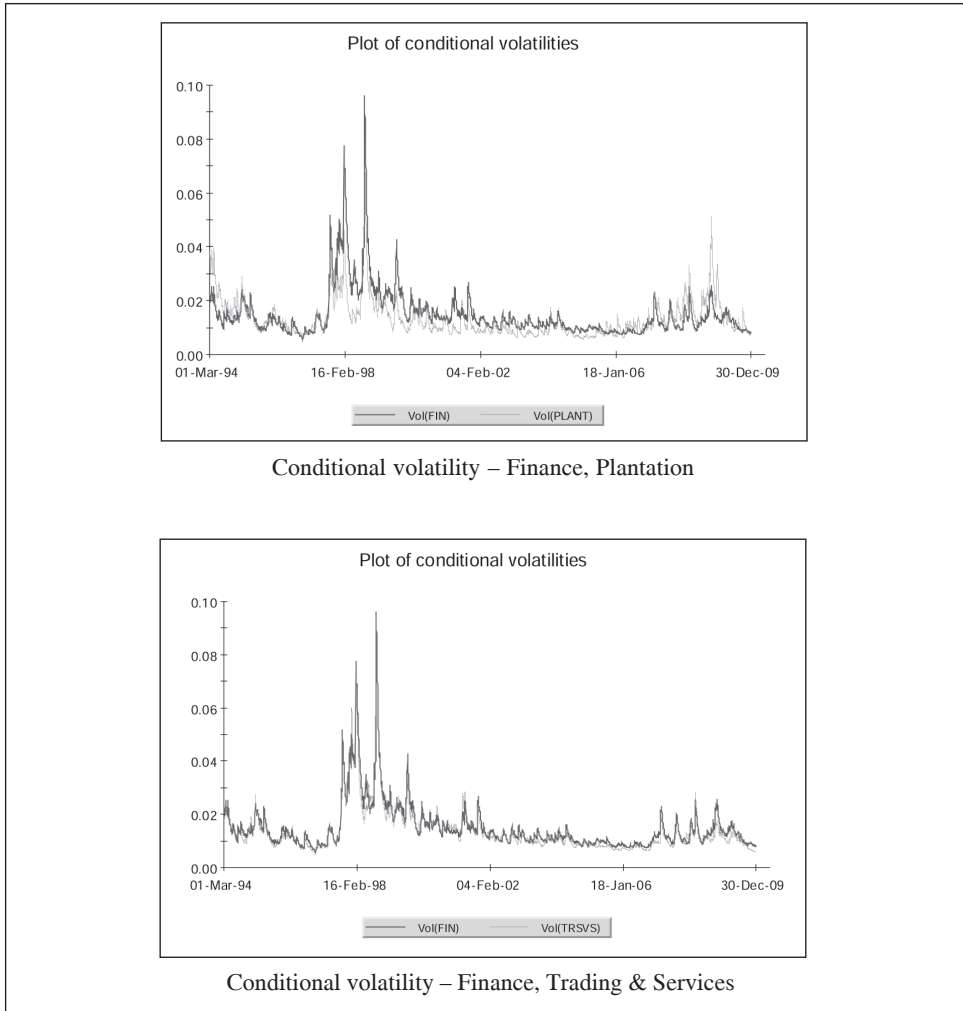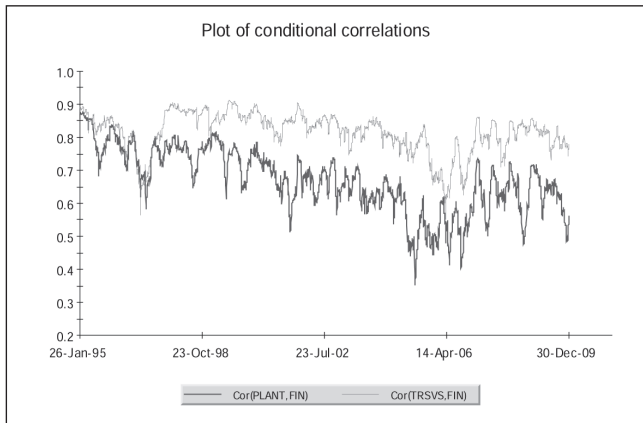
Conditional volatility – Finance, Plantation

Conditional volatility – Finance, Trading & Services

Figure 1. Conditional volatility – Finance, Plantation, Trading & Services

Then we turned our attention to conditional correlations. We compared the correlation between finance and plantation sectors with the correlation between finance and trading and services sectors, based on the top panel of Figure 2. A few observations are worth noting. First, from around 1997 onwards, correlations of the former are noticeably lower than those of the latter. This makes sense of our earlier observation on unconditional (average) correlations.[6] Second, while the trend of correlation for the latter is relatively

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[6] The overall correlation of the plantation sector with the finance sector was lower than that of the trading and services sector with the finance sector.
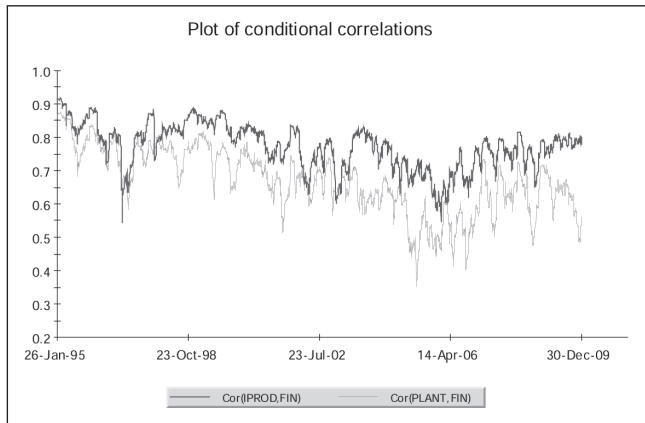
Plot of conditional correlations

Conditional correlation – Finance and Plantation Finance and Trading & Services


Malaysia Palm Oil Futures (in USD per metric tonne)
Source: International Monetary Fund

Figure 2. Conditional correlations – Finance, Plantation, Trading & Services;
Palm Oil Futures Prices

stable, in the case of the former (plantation), there is a distinguishable downward trend in correlation. Within the context of our paper, this implies that as time passes, the 'disadvantage' attributable to investors of *Shari'ah* compliant portfolios (in terms of inaccessible additional diversification benefit) grows. Third, the fluctuations in correlation for the plantation sector are larger (compared to trading and services). We offer the following plausible explanation. We argue that plantation stock returns are primarily driven by commodity prices. Thus juxtaposing commodity (chiefly palm oil and rubber) prices with our computed correlations would be quite revealing (see bottom panel of Figure 2). In

Conditional correlation – Finance and Industrial Products, Finance and Plantation
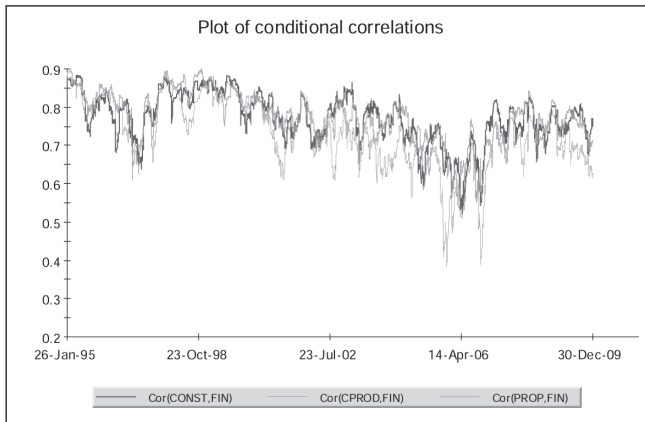
Conditional correlation – Finance and Construction Finance and Consumer Products, Finance and Property

Figure 3. Conditional correlations – Finance, Industrial Products, Plantation, Construction, Consumer Products, Property

recent times, commodity prices have been rather erratic, hence explaining the observed greater vacillation in correlation.

Next, we compared correlation with respect to finance, for plantation and industrial products sectors (see top panel of Figure 3). Here the difference in dynamic conditional correlations was less pronounced (compared to the trading and services sector). Nonetheless, spikes in correlation for the plantation sector (resulting from fluctuating commodity prices) were found.

Finally, we charted the conditional correlations (with respect to finance) for the following sectors – consumer products, property and construction (bottom panel of Figure 3). Here

we note the following observations. When the market is bullish, correlations of sectors with respect to the finance sector tend to decrease. This is because market exuberance typically impacts finance stocks to a greater degree. This is especially the case with respect to consumer products. The downward trend in correlation during bull runs is observed to a lesser extent in the property and construction sectors as these sectors typically also chalk up impressive price gains when the market is bullish.

At this juncture, we encapsulate the following key takeaways emanating from the preceding discussion. A case can be made that investors of *Shari'ah* compliant portfolios are at a relative disadvantage given that they are not allowed to include finance stocks in their portfolios. More specifically, these finance stocks provide additional benefits of diversification which such investors do not get access to. Empirical findings presented so far provide evidence that the extent of this forgone 'benefit' depends upon the following factors:

i.   *The Shari'ah compliant sectors invested in*. If a significant portion of the stocks are in plantation and consumer products, investors are likely to 'lose' more.
ii. *Market sentiment*. When the market is bullish, correlations *vis-à-vis* the finance sector decreases significantly, thereby amplifying the 'loss' assumed by investors.
iii. *Commodity prices*. Given that *Shari'ah* compliant portfolios contain plantation stocks, rising commodity prices reduce the correlation between finance and plantation sectors and in turn, magnify the 'disadvantage' of omitting finance stocks in investors' portfolios.

In short, whether or not investors of *Shari'ah* compliant portfolios lose out by not being able to include finance stocks depends on first, the sectors they invest in and second, the market conditions (which is time variant). Relating these findings to our second research question, we posit that investors of *Shari'ah* compliant portfolios can minimise the loss of diversification benefit (by not being able to invest in finance stocks) by doing the following:

a.   When the market is bullish, and presumptively finance stock returns would escalate, investors of *Shari'ah* compliant portfolios should divert their investments from sectors that have lower correlations with the finance sector (plantation and consumer products) to sectors with higher correlations with the finance sector (trading and services, and construction).
b.   When commodity prices rise and assuming plantation stock returns would escalate, investors of *Shari'ah* compliant portfolios should overweight stock allocations to sectors with correlations that are lower than the correlation between finance and plantation sectors. In our case, this would be the construction sector.

We stress that our prescription above only applies given the following caveat – that stock returns strictly reflect systematic risk. This is to say that the extent to which diversification benefit is maximised determines the overall portfolio return. Stated differently, the following logic is adopted. We assume that the market is efficient in that portfolio returns are determined by systematic risk only. This causality relationship holds true when a portfolio is fully diversified. When it is not, and this is the case for *Shari'ah* compliant portfolios which cannot invest in finance stocks, portfolio return is optimised when the loss of diversification benefit is minimised. The loss of diversification is greater when the

correlation between an invested sector and the finance sector is lower. Thus portfolio return is optimised by changing to or overweighting on sectors with higher correlations with the finance sector when the finance sector experiences a bull run, or by overweighting on a sector (construction) which has a lower correlation with a *Shari'ah* compliant sector that experiences a bull run (plantation).

In addition to the above, we tested the hypothesis that the index returns have non-mean reverting volatility. We found that in all seven sector indices, volatility was mean-reverting.[7] This implies that despite the fluctuations in volatility and correlation as discussed above, in the long run, volatility assumes an average value. However, note that the mean reverting process is generally a very slow one. Estimates of $(1 - \lambda_{i1} - \lambda_{i2})$ range from 0.0076 to 0.0125. Thus, while in the shorter term, the dynamics of conditional volatility and correlation can have a significant impact, in the longer term, the effects tend to even out and are captured by unconditional volatilities and correlations. This statistic has an important implication on our second research question. Given that it takes a very long time (a few years at least) for volatility to revert to a long-term average, there is value in portfolio sector switching that can optimise portfolio return by minimising loss in diversification benefit. In other words, unless an investor is only concerned with very long term returns, it pays to monitor the dynamism (or temporal dimension) of correlations between sectors and manage their portfolios accordingly.

To introduce robustness in our empirical results, we performed some diagnostic tests. Generally, the tests indicate validity of our *t*-DCC model.[8] The plot of the Value at Risk (VaR) of the portfolio for the forecasting period shows an increasing pattern, indicating that portfolio risk is likely to increase over time. Finally, we estimated a *t*-DCC model on residuals obtained from a regression of returns on the sector indices on their past values.[9] The results are very close to our earlier *t*-DCC model.[10]

5.2 Kuala Lumpur Stock Exchange – Selected Stocks

While the above approach of analysing via sector indices provides some useful insights, it embodies two important limitations. First, there are other non-*Shari'ah* compliant stocks that are not finance stocks. In Malaysian equities, there are no sector indices to directly capture these (non-financial) stocks. Thus we were not able to observe correlations with respect to these stocks (such as firms involved in the alcohol, tobacco and gambling businesses) via sector analysis. Second, by relying on sector analysis, we implicitly assumed that investors would invest in all the stocks that make up a given sector index (according to the proportion or weighting adopted by the given index). In reality, most investors would

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[7] Null hypothesis of non-mean reverting was rejected in all seven cases. See tables and figures for details.

[8] Lagrange Multiplier (LM) statistic was less than the critical value, thus the null hypothesis of correct specification of the *t*-DCC model cannot be rejected. In testing for VaR violations, $\hat{\pi}_N$ was very close to its expected value and the test statistic z_δ was not significant, both supporting the validity of the *t*-DCC model. However, the Kolmogorov-Smirnov test statistic was larger than its 5% critical value, rejecting the null hypothesis that probability integral transforms were uniformly distributed.

[9] This is essentially a two-step estimation method. First, residuals are obtained by running separate OLS regressions for each variable. Second, the DCC model is applied to these residuals.

[10] Details, including regression results for each equation, can be furnished upon request.

only hold positions in a small number of stocks per sector. In other words, while the sector indices capture the returns movements of all stocks included in a given index, a typical investor would be exposed to movements in only a handful of stocks for a given sector.

For the above two reasons, we also explored the dynamics of correlation between selected stocks. The criteria for stock selection were primarily stocks with high market capitalisation (and thus would likely be part of many investors' portfolios) and availability of a relatively long time series of data (see Table 5). We arbitrarily formed 3 groupings of non-*Shari'ah* compliant stocks (finance, tobacco & alcohol, and gambling) and 4 groupings of *Shari'ah* compliant stocks (plantation, industrials, consumer and utility & telecommunication). We computed the correlation between each of the 3 former grouping of stocks with each of the 4 latter grouping of stocks.

Table 5. Individual stocks selected as sample for each sector

Sector	Firm	Market cap (RM billion) [a]	Main business
Finance	Maybank	64	Banking and financial services
	CIMB	53	Banking and financial services
	Public Bank	34	Banking and financial services
Tobacco & alcohol	BAT Malaysia	14	Manufacturing and distribution of tobacco products
	Carlsberg Malaysia	2.9	Brewery
Gambling	Genting	39	Gambling, leisure and hospitality
	Berjaya Sports Toto	5.9	Gaming
Plantation	Sime Darby	58	Plantation, property, industrials, healthcare
	IOI Corporation	34	Plantation, resource based manufacturing, property
	KL Kepong (KLK)	26	Plantation, oleochemicals
Industrials	Gamuda	8	Engineering & construction, infrastructure, property
	MISC	26	Integrated oil & gas logistics, marine & heavy engineering
	Petronas Dagangan (PDB)	18	Downstream oil & gas
	YTL Corporation	14	Power generation, cement, construction, property, hotels & resorts
Consumer products	Nestle Malaysia	13	Fast moving consumer goods
	Parkson	6.4	Department stores
	Proton	2.9	Automotive manufacturing
Utility & Telecoms	Tenaga Nasional (TNB)	34	Power generation, transmission & distribution
	Telekom Malaysia	17	Telecommunications

[a] Approximate as at January 2012

Understandably, the possible combinations of correlation could be overwhelmingly large and hence we did not endeavour to exhaustively account for all observations. Instead, we chose to highlight selected key or interesting observations.[11]

Tables 6, 7 and 8 rank (from lowest to highest) the unconditional correlation between each of the 7 selected non-*Shari'ah* compliant stocks with each of the 12 selected *Shari'ah* compliant stocks.

Table 6. Unconditional correlations between selected finance stocks and selected *Shari'ah* compliant stocks

Finance											
Maybank	Nestle	Cons	0.261	CIMB	Nestle	Cons	0.256	Public	Nestle	Cons	0.216
	Parkson	Cons	0.267		Parkson	Cons	0.268		KLK	Plant	0.287
	KLK	Plant	0.319		KLK	Plant	0.298		MISC	Indus	0.296
	PDB	Indus	0.327		MISC	Indus	0.323		Parkson	Cons	0.324
	MISC	Indus	0.328		PDB	Indus	0.365		PDB	Indus	0.352
	IOI	Plant	0.407		Proton	Cons	0.411		Proton	Cons	0.357
	Proton	Cons	0.408		Gamuda	Indus	0.448		IOI	Plant	0.384
	Gamuda	Indus	0.444		IOI	Plant	0.453		Telekom	Ut/T	0.403
	YTL	Indus	0.469		Sime	Plant	0.48		Sime	Plant	0.422
	Sime	Plant	0.494		Telekom	Ut/T	0.486		Gamuda	Indus	0.428
	Telekom	Ut/T	0.506		YTL	Indus	0.5		YTL	Indus	0.436
	TNB	Ut/T	0.573		TNB	Ut/T	0.554		TNB	Ut/T	0.467
		Avg	**0.400**			**Avg**	**0.404**			**Avg**	**0.364**

Table 7. Unconditional correlations between selected tobacco & alcohol stocks and selected *Shari'ah* compliant stocks

Tobacco & Alcohol								
BAT	Parkson	Cons	0.114	Carlsberg	Parkson	Cons	0.166
	PDB	Indus	0.195		Nestle	Cons	0.173
	Proton	Cons	0.197		KLK	Plant	0.216
	Nestle	Cons	0.201		Gamuda	Indus	0.242
	Sime	Plant	0.224		Sime	Plant	0.244
	Gamuda	Indus	0.232		IOI	Plant	0.244
	MISC	Indus	0.233		PDB	Indus	0.247
	KLK	Plant	0.245		Telekom	Ut/T	0.248
	IOI	Plant	0.254		MISC	Indus	0.249
	TNB	Ut/T	0.257		Proton	Cons	0.251
	YTL	Indus	0.262		TNB	Ut/T	0.281
	Telekom	Ut/T	0.262		YTL	Indus	0.295
		Avg	**0.223**			**Avg**	**0.238**

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[11] Note that in this section, we relied on applying the MGARCH to the set of OLS residuals instead of the standard MGARCH model. This is because the latter approach resulted in non-convergence in some cases.

Table 8. Unconditional correlations between selected gambling stocks and selected *Shari'ah* compliant stocks

Gambling							
Genting	Nestle	Cons	0.185	Berjaya Toto	Nestle	Cons	0.215
	Parkson	Cons	0.233		Parkson	Cons	0.248
	MISC	Indus	0.236		KLK	Plant	0.285
	PDB	Indus	0.271		Proton	Cons	0.326
	KLK	Plant	0.285		MISC	Indus	0.327
	Proton	Cons	0.317		PDB	Indus	0.36
	Gamuda	Indus	0.367		IOI	Plant	0.378
	IOI	Plant	0.375		Telekom	Ut/T	0.394
	Sime	Plant	0.376		Sime	Plant	0.428
	YTL	Indus	0.388		Gamuda	Indus	0.428
	TNB	Ut/T	0.394		TNB	Ut/T	0.445
	Telekom	Ut/T	0.413		YTL	Indus	0.447
		Avg	**0.320**			**Avg**	**0.357**

A few observations are worthy of note here. First, while in the sector indices analysis we made the case that investment in the plantation sector would result in the greatest 'loss' in terms of forgone diversification benefit, here we observed that certain non-plantation stocks actually show greater relinquishment of diversification benefit. Consumer stocks appear to have the lowest unconditional correlation with respect to the 7 non-*Shari'ah* compliant stocks. In particular, Nestle and Parkson ranked top two in all but two cases. Second, in all cases, the bottom two would feature one or both of the selected utility and telecommunication stocks, TNB and Telekom. Taken together, this implied that investors of *Shari'ah* compliant portfolios would lose more in terms of diversification benefit if they invested in consumer stocks like Nestle and Parkson, compared to having invested in utilities and telecommunications.

Third, between the 3 groupings of non-*Shari'ah* compliant stocks, it appeared that investors of *Shari'ah* compliant portfolios would 'lose' the most diversification benefit with respect to the tobacco and alcohol sectors, followed by gambling and gaming, and finally the finance sector.[12]

Next, we examined the temporal dimension of correlation. For finance stocks, the general observed trend of correlation was as follows. Correlation was relatively low in the period preceding the 1997/98 Southeast-Asian Financial Crisis. This can be explained by the fact that finance stocks appreciated significantly in the bull market which preceded the said crisis. During the crisis itself, correlations were relatively high, signifying that all stocks took hits on their market valuations. As the market gradually recovered from the crisis, correlations began to drop again. Similar patterns were observed in the more recent 2008 Global Financial Crisis, albeit by lesser relative magnitudes.[13]

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[12] We arrive at this conclusion by comparing the average of unconditional correlation for the 12 stocks.
[13] Charts of dynamic correlations are available upon request.

For the tobacco and alcohol stocks, a somewhat similar pattern was observed during the 1997/98 Crisis. However, the trend of correlation was noticeably less fluctuating in the recent 2008 Crisis. We could argue that this reflects the contention that the latter crisis affected the financial sector more than other sectors. The trends for the gambling and gaming sector were comparable to that of tobacco and alcohol.

Within the confinement of this paper, it would not be practical or productive to discuss correlation trends of specific stocks. However, we wish to point out the utility of such analysis, particularly to investors. The astute investor would be interested to know how correlations between stocks behave at different points in time. For example, there are times when negative correlations were observed. One such case was between Maybank and Nestle stocks during the period of August to October 2002. Investors could take the cue from such idiosyncrasies and manage their portfolios accordingly. Relating this more specifically to our research objectives, in particular to our second research question, with the use of dynamic correlation coefficients, there is adequate evidence that 'loss' of diversification benefit from being limited to *Shari'ah* compliant stocks is both time-variant and stock-specific.

Interpreting the results of the analysis done at the firm level in light of our two research questions produces interesting findings. We compared the correlations of two *Shari'ah* compliant stocks, Nestle and TNB, with all other stocks in the sample, and the rankings are shown in Table 9.

With regard to the first research question, there is limited evidence showing that investors of *Shari'ah* compliant portfolios would be disadvantaged by not being able to invest in 'sin stocks'. In particular, the primary sources of deprivation of additional diversification benefit were from alcohol, tobacco and gambling stocks. Interestingly, the average correlation of *Shari'ah* compliant stocks was actually lower than the average for non-*Shari'ah* compliant stocks, more notably in the case of TNB. This implies that while there was some empirical evidence of the hypothesised loss of diversification benefit, it

Table 9. Unconditional correlations between Nestle, and TNB, with all other stocks in sample

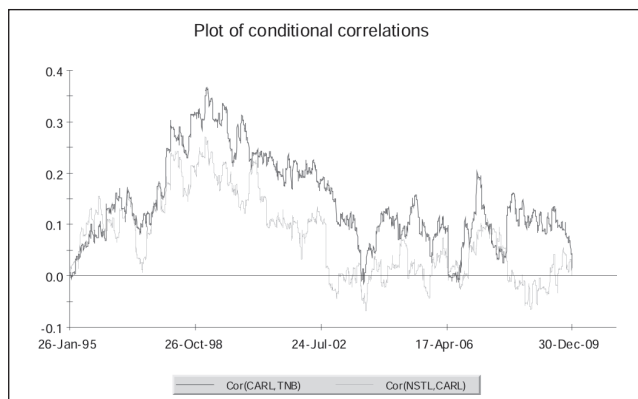| Correlation with Nestle				Correlation with TNB			
Non-*Shari'ah* compliant stocks		*Shari'ah* compliant stocks		Non-*Shari'ah* compliant stocks		*Shari'ah* compliant stocks	
Carlsberg	0.173	Parkson	0.125	BAT	0.257	Nestle	0.263
Genting	0.185	PDB	0.169	Carlsberg	0.281	Parkson	0.270
BAT	0.201	MISC	0.202	Genting	0.394	KLK	0.307
Berjaya Toto	0.215	KLK	0.203	Berjaya Toto	0.445	PDB	0.316
Public	0.216	Proton	0.208	Public	0.467	MISC	0.362
CIMB	0.256	Telekom	0.213	CIMB	0.554	IOI	0.407
Maybank	0.261	IOI	0.214	Maybank	0.573	Gamuda	0.422
		Gamuda	0.223			Proton	0.449
		Sime	0.254			YTL	0.470
		TNB	0.263			Sime	0.515
		YTL	0.276			Telekom	0.557
Average	**0.215**	**Average**	**0.214**	**Average**	**0.424**	**Average**	**0.394**

Figure 4. Conditional correlations – Carlsberg with TNB and Nestle

cannot be generalised to apply to all situations. The choice of stocks included in a given *Shari'ah* compliant portfolio would determine the extent, if any, of diversification benefit lost.

As for the second research question, in Figure 4, we compared the conditional correlations, with respect to Carlsberg, for Nestle and TNB. The plot shows that there were times when the aforesaid correlations closely tracked and there were other times when there were significant differences in correlation magnitude. In most cases, the correlation for Nestle was lower. The result implies that there is opportunity to reduce the impact of lost diversification benefit by switching stock allocation from Nestle to TNB particularly when the gap in correlation is relatively large (and Nestle has the lower correlation).

We also found that the volatility of all 19 stocks examined in this study was mean-reverting, albeit very slowly. Diagnostic tests conducted provide arguably sufficient evidence that our *t*-DCC models in this section (12 in total) are valid.[14]

5.3 New York Stock Exchange

Having deliberated on the nature of correlations in the Malaysian equity market, we extended the analysis to another equity market – the New York Stock Exchange. Here, as with the case of the Malaysian equity market, our primary concerns were twofold. First, we investigated if there was evidence that investors of *Shari'ah* compliant portfolios would be disadvantaged in terms of lost benefits of diversification, and second, whether this disadvantage, if it existed, was time-variant. Towards these questions, we estimated a number of *t*-DCC models to get insights on the unconditional as well as conditional correlations between 8 non-*Shari'ah* compliant sectors (banking, insurance, financial services, gambling, breweries, tobacco, media and hotels) and 9 *Shari'ah* compliant sectors (basic materials, consumer goods, consumer services, health care, industrials, oil & gas, technology, telecommunications and utilities). Table 10 ranks the unconditional correlations between each of the non-*Shari'ah* compliant sectors with the *Shari'ah* compliant sectors.

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[14] In all cases, the model 'passes' at least two of the three diagnostic tests employed – the LM test, the Kolmogorov-Smirnov Goodness-of-fit test and test for VaR violations.

Table 10. Unconditional correlations–non-*Shari'ah* compliant sectors with *Shari'ah* compliant sectors

Banking		Insurance		Fin. services		Gambling	
O&G	0.436	TECH	0.501	O&G	0.521	UTIL	0.357
UTIL	0.447	O&G	0.517	UTIL	0.536	O&G	0.387
TECH	0.478	UTIL	0.567	HCARE	0.604	HCARE	0.409
HCARE	0.502	TCOM	0.576	TECH	0.613	TCOM	0.411
TCOM	0.525	HCARE	0.609	TCOM	0.623	TECH	0.464
BMAT	0.571	BMAT	0.650	BMAT	0.666	CGOOD	0.520
CGOOD	0.615	CGOOD	0.713	CGOOD	0.699	BMAT	0.554
CSVS	0.658	CSVS	0.719	CSVS	0.782	CSVS	0.622
INDUS	0.696	INDUS	0.750	INDUS	0.810	INDUS	0.627
Average	**0.548**	**Average**	**0.622**	**Average**	**0.650**	**Average**	**0.483**
Breweries		Tobacco		Media		Hotels	
TECH	0.174	TECH	0.183	O&G	0.524	UTIL	0.405
O&G	0.274	O&G	0.257	UTIL	0.530	O&G	0.420
TCOM	0.276	TCOM	0.268	HCARE	0.598	HCARE	0.435
BMAT	0.308	BMAT	0.277	BMAT	0.657	TCOM	0.453
CSVS	0.323	CSVS	0.290	CGOOD	0.664	TECH	0.501
UTIL	0.323	INDUS	0.294	TCOM	0.665	CGOOD	0.570
INDUS	0.329	UTIL	0.310	TECH	0.686	BMAT	0.584
HCARE	0.388	HCARE	0.350	INDUS	0.823	INDUS	0.679
CGOOD	0.502	CGOOD	0.541	CSVS	0.871	CSVS	0.680
Average	**0.322**	**Average**	**0.308**	**Average**	**0.669**	**Average**	**0.525**

From Table 10, we can observe that tobacco and breweries have the lowest correlations. This implies that investors of *Shari'ah* compliant portfolios would potentially lose the most diversification benefit with respect to tobacco and alcohol stocks. A possible intuition behind these results is that people typically smoke and consume alcohol regardless of economic circumstances. In a sense, these 'sin products' are arguably recession-proof. Thus when times are bad, economically speaking, and other sectors suffer diminutions in or negative returns, tobacco and alcohol companies still register modest returns.

However, in order to make a more convincing case that *Shari'ah* compliant portfolios are in fact at a disadvantage, we need to consider another dimension to the analysis. After all, the above results show the relative correlations of non-*Shari'ah* compliant sectors with *Shari'ah* compliant sectors, and do not make comparisons between these aforementioned correlations and correlations that prevail among *Shari'ah* compliant sectors themselves. More specifically, if it was the case that the former correlations (non-*Shari'ah* with *Shari'ah*) were higher than the latter correlations (among *Shari'ah* compliant sectors), then we cannot academically argue that *Shari'ah* portfolios are at a loss. Nonetheless, our results show that this is not the case, as shown in Table 11.

On the average, correlations are lowest with respect to the oil and gas sector. We argue that this is the case because this sector's returns are significantly determined by prevailing oil prices. To the extent that in recent times (or at least in the sample period of our analysis)

Table 11. Unconditional correlations among *Shari'ah* compliant indices

Basic materials		Consumer goods		Consumer services		Healthcare	
TECH	0.503	TECH	0.516	O&G	0.484	O&G	0.465
HCARE	0.510	O&G	0.540	UTIL	0.511	TECH	0.494
TCOM	0.518	UTIL	0.593	TCOM	0.659	UTIL	0.506
UTIL	0.550	TCOM	0.599	BMAT	0.661	BMAT	0.510
CSVS	0.661	BMAT	0.673	HCARE	0.661	TCOM	0.526
O&G	0.667	HCARE	0.716	TECH	0.716	INDUS	0.649
CGOOD	0.673	CSVS	0.754	CGOOD	0.754	CSVS	0.661
INDUS	0.773	INDUS	0.760	INDUS	0.857	CGOOD	0.716
Average	**0.607**	**Average**	**0.644**	**Average**	**0.663**	**Average**	**0.566**

Industrials		Oil & Gas		Technology		Tele-communications		Utilities	
UTIL	0.561	TECH	0.371	UTIL	0.356	O&G	0.440	TECH	0.356
O&G	0.583	TCOM	0.440	O&G	0.371	UTIL	0.504	TCOM	0.504
HCARE	0.649	HCARE	0.464	HCARE	0.494	BMAT	0.518	HCARE	0.506
TCOM	0.664	CSVS	0.484	BMAT	0.503	HCARE	0.526	CSVS	0.511
TECH	0.758	CGOOD	0.540	CGOOD	0.516	TECH	0.575	BMAT	0.550
CGOOD	0.760	INDUS	0.583	TCOM	0.575	CGOOD	0.599	INDUS	0.561
BMAT	0.773	UTIL	0.594	CSVS	0.716	CSVS	0.659	CGOOD	0.593
CSVS	0.857	BMAT	0.667	INDUS	0.758	INDUS	0.664	O&G	0.594
Average	**0.701**	**Average**	**0.518**	**Average**	**0.536**	**Average**	**0.561**	**Average**	**0.522**

oil price movements did not always match general economic or business buoyancy, the aforementioned observation makes some sense.

Among all the *Shari'ah* compliant sectors, the lowest correlation was observed between the technology and utilities sectors (0.356). This unconditional correlation was higher than all unconditional correlations between the tobacco sector and all *Shari'ah* compliant sectors, except for consumer goods.[15] Thus we can assert the case that regardless of what *Shari'ah* compliant sectors are invested in, there would always be some additional benefit of diversification by including tobacco stocks. In other words, there is evidence that investors of *Shari'ah* compliant portfolios are at a disadvantage (first research question). Albeit to a lesser extent, the same can be said of alcohol-related stocks.[16] The potential loss in diversification benefit appears to be smaller in the case of the other non-*Shari'ah* compliant sectors.

Turning our attention to the second research question, we analysed the dynamics of correlations among the sectors. For the sake of brevity, we shall focus on the tobacco sector as our results show that it is the greatest source of loss in portfolio diversification.

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[15] The relatively higher correlation between tobacco and consumer goods is expected given that tobacco belongs to the broader category of consumer goods. In other words, returns of tobacco firms are included in the computation of the consumer goods sector index.

[16] Unconditional correlations between breweries and *Shari'ah* compliant stocks are lower than 0.356 except in the cases of health care and consumer goods.

The correlation between technology and tobacco sectors was particularly heightened during the dot-com 'bubble and bust' period. Similarly, correlations between the oil and gas sector, and the basic materials sector, with respect to the tobacco sector were significantly lower during periods of marked commodity prices fluctuations. At the same time, correlations between the tobacco and consumer goods sectors were found to be relatively stable, or comparably more consistent throughout the sample period. Taking these findings together, we advocate the following. In order for investors of *Shari'ah* compliant portfolios to reduce the diversification loss arising from not being able to invest in tobacco stocks, they should divert investments in sectors exposed to a higher degree of returns fluctuations to sectors that experience less volatility in returns, particularly during periods when the former sectors are subjected to greater volatility of returns. More specifically, when commodity prices are fluctuating, it may be in the interest of investors of *Shari'ah* compliant portfolios to switch portfolio allocation from oil and gas and basic materials sectors to stocks in consumer goods.

As is the case with the Malaysian equity market, we also found that the volatility of all 17 sector indices examined here was mean-reverting, albeit very slowly. Diagnostic tests conducted provide arguably sufficient evidence that our *t*-DCC models are valid.[17]

6. Conclusions

To summarise, recall our two research questions set forth at the onset of this discussion:

i. Is there empirical evidence that exclusion of 'sin stocks' deprive *Shari'ah* compliant portfolios of additional benefits of diversification?

ii. Given that the answer to the above is in the affirmative, is there anything that can be done to minimise such a disadvantage?

First, the results of our empirical investigations show that there is some evidence that the exclusion of 'sin stocks' would deny investors of *Shari'ah* compliant portfolios of additional benefits of diversification. The evidence is more convincing when analysis is conducted at sector level. When specific stock selections are considered, the evidence from the Malaysian equity market does not permit us to generalise. That is, in practice, we cannot conclude that investors of Islamic portfolios are always at a disadvantage in terms of portfolio diversification.

Second, assuming that Islamic portfolios are at the short-end of the portfolio diversification stick, we have demonstrated that *Shari'ah* compliant investors need not remain hapless. We illustrated through the use of dynamic correlation coefficients that loss of diversification benefit is both time-variant and stock-specific. Thus by judiciously articulating correlation trends and managing portfolio allocations accordingly, investors can minimise losses attributable to the forgone diversification benefit. It would not be practicable to exhaustively analyse all possible permutations of correlation trends and provide advocated portfolio allocation strategies here, but for illustrative purposes, we argue the following which is summarised in tabular form.

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[17] In all cases, the model 'passes' at least two of the three diagnostic tests employed – the LM test, the Kolmogorov-Smirnov Goodness-of-fit test and test for VaR violations.

Market/Level	Market conditions	Switch portfolio allocation	
		From	To
Malaysia/sectors	Overall bullish	Plantation, consumer products	Trading & service, construction
	Rising commodity prices	All other sectors	Construction
Malaysia/specific stocks	Subject to more detailed analysis	Consumer (Nestle)	Utilities (TNB)
United States/sectors	Fluctuating commodity prices	Oil & gas, basic materials	Consumer goods

7. Research Limitations

We reiterate our earlier stated caveat that the above prescriptions apply, provided stock returns are priced efficiently by systematic risk only. To the extent that prices are not efficient (and there is voluminous empirical literature attesting to violations of the Efficient Market Hypothesis), our observations may need revisiting and/or refinement. Similarly, in reality, one can reasonably make a case that portfolio returns are not exclusively determined by systematic risk. At least in the shorter term investment horizon, stocks with positive alpha do exist and serve as anomalies to our generalised model.

In the final analysis, it should be noted that our deliberations above are chiefly exploratory in nature. Our conjecture is that while there is empirical evidence that investors of *Shari'ah* compliant portfolios are deprived of additional benefits of diversification, something can be done to alleviate the resulting impact on portfolio risk and return. However, at this juncture, we are not able to provide a comprehensive, all-encompassing portfolio allocation model. Further research is needed before we can even approach such a robust portfolio management tool. At best, we have demonstrated that there is some utility in the use of dynamic conditional correlations in mitigating loss of portfolio diversification benefit, pertinent to investors of *Shari'ah* compliant portfolios.

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