Exploring portfolio diversification opportunities through venture capital financing

Jaffar, Yusuf and Masih, Mansur

INCEIF, Malaysia, INCEIF, Malaysia

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Mohammad Yusuf bin Mohammad Jaffar[1] and Mansur Masih[2]

Abstract

Increasingly Islamic financial institutions are being pressured by critics to offer profit and loss sharing (PLS) financing for the purpose of entrepreneurial development. We believe the growth of PLS can be incentivized by increasing the participation of Islamic asset managers and mutual funds in this sector. To achieve this we are conducting an exploratory study to link PLS investments with portfolio optimization opportunities for these asset managers. Through our studies we were able to determine that there was indeed a portfolio optimization opportunity for fund managers who invested in PLS investments over the long run. We conducted our analysis using recently established techniques of dynamic conditional correlation and modified discrete wavelet transformation. We hope this exploratory study will lay down the foundation for more studies to be conducted, to help industry practitioners and policy makers to adopt this product.

[1] Mohammad Yusuf bin Mohammad Jaffar, Graduate student at INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia.

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

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Introduction

Profits and loss sharing (PLS) financing in Islamic finance is seen as a catalyst for entrepreneurial development. This is because it provides financing to entrepreneurs to convert basic ideas into products and services. The method of financing is a private equity arrangement whereby a financier takes investment risk; whilst the entrepreneur invest his effort and skills into the business. Profits are to be shared in a pre-agreed upon profit sharing ratio. Losses would be borne by the financier.

Although Islamic banks have witnessed impressive rates of growth, critics of Islamic finance often highlight the absence of meaningful presence of PLS financing instruments. It is a common argument amongst scholars and academics of Islamic finance that PLS instruments need to be the primary substitute for interest bearing financial arrangements (Ayub 2007; Iqbal and Mirakhor 2007; Usmani 2002). However, after 30 years of existence, Islamic banking and finance has yet to put into practice PLS financing in a meaningful way. In particular, PLS financing presently accounts for only a token of the total financing given out by Islamic financial institutions globally. PLS financing has existed in the Western world for quite some time now, under the guise of private equity financing and venture capital. One may even argue that the strength of many Western developed nations is exactly because of their avid support for individuals' innovative entrepreneurial aspirations. Given the similarity between the two forms of financing, throughout the duration of this paper PLS financing would be referred to as venture capital (VC), venture capital style investments and equity financing.

One of the biggest challenge to growth of equity financing in the Muslim world is the lack VC investments by the private sector. VC activity seems to be prominent in only a few regions around the world, known as VC hotbeds where the private sector and government sector work hand in hand for entrepreneurial development (EY, 2013). In the developing world and the Middle East VC activity is limited. Although, governments in these regions are working actively

to promote the industry, little or no help is coming from the private sector hindering the industries development (GVCPE Index 2013). Taking Malaysia as a case study, the total funds invested in the Malaysian venture capital industry comprises of approximately RM5.698 billion between 1999 to 2012 (MVCA, 2012). Government investment constitutes approximately 54.07% of the total funds invested in the VC industry, remaining investment coming from corporates, banks, and foreign venture capital and pension funds. As an incentive to develop the VC industry in Malaysia the government has offered tax incentives for R&D development and built countless business parks around the country. Yet private investment activity in new entrepreneurial development is stagnating in the country. In fact according to the Special Innovation Unit Malaysia the VC industry in Malaysia is on a declining trend and without more government assistance in the next 5 years there will no privately backed VC organization left in the industry (ISpring Capital, 2011 ; Hussian, 2010).

We believe the growth of venture capital style investments can be incentivized by increasing the participation of Islamic asset managers and mutual funds in this sector. To achieve this we are conducting an exploratory study to link venture capital investments with portfolio optimization opportunities for these asset managers. Utilising Markowitz (1952) theory of portfolio diversification we explore the intrinsic benefits acquired by stock market investors who invest in venture capital style investments. By discovering possible correlation benefits we hope to incentivize further studies in the area and catalyse the development of PLS financing. Our study is targeted mainly to the developing Muslim world, utilising Malaysia as a case study. We believe that given Malaysia's leadership role in the Islamic banking sector, it would provide a good representation of the Islamic financial institutions in the developing Muslim world.

Literature review

We believe that the development of PLS financing and venture capital investments can have a positive impact to the Muslim developing world. According to Nadeem (2011) the benefits of the profit sharing agreements are job creation, distributive justice, wealth creation and poverty alleviation. On a macro level one of the main advantages of the profit sharing financing structure according to Mirakhor et al (2012) is that creates a closer coordination between the real and financial sectors of the economy. This help to stabilize a countries economy. Under debt

financing this is not the case as debt instruments (loans and financial derivative) are based on leverage, outpacing the growth of the real sector. This phenomenon is known as financial decoupling and Mirakhor et al (2012) together with Reinhart & Rogoff (2009) claim this as the main cause for economic destabilization and a financial crisis.

Venture capital (VC) industry has similar objective and is known to lubricate the wheels of innovation by considering and investing in the projects which are too risky for the traditional financiers. Some of the positive benefits that have been associated with the venture capital includes catalysing innovation, creation of successful technology companies, commercialising of scientific research and increasing overall competitiveness of an economy (Lerner and Kortum, 2001).

Venture capital achieves this by stimulating patent development and increasing firm performance of investee companies (Engel and Keilbach, 2007). Technological innovation has been recognized as the critical factor to increasing productivity and economic growth within the nation. Innovations allow organizations and companies to be more efficient, increase profits, cut their costs, and allow diversification of resources into profitable areas.

The VC industry plays an important role in helping entrepreneurs by taking investment risk to commercialise entrepreneur's inventions. Venture capital backed companies have been a key force for industry disruption and technological innovation over last 40 years. Without venture capital industry, there wouldn't be Google, Microsoft, Apple, Intel, Oracle or Genentech (DiGiorgio and Harris, 2013). Venture capital backed companies are also a key driver of job growth and create millions of highly skilled jobs. For example in the United States, impact of venture capital (VC) companies employed more than 12.5 million people (NCVA, 2012). It has been estimated that in the United States, a new job is created for every USD12,319 invested by a VC company. Average compensation paid by VC investee companies is also above industry average and amounts to USD70,000-USD80,000 per annum compared to the average of USD32,000 in the year 2002 (Brimacomb and Bowman, 2004).

Given the positive benefit derived from VC companies, one would expect Islamic financial institutions to actively participate in this mode of financing. Yet when it comes to private sector participation in this industry, both PLS and VC investments are limited in the developing Muslim world. To incentivize the spread of PLS financing in the Muslim world we have turned to portfolio theory to explore the possibility of organically attracting investments into this industry. Our pretext is that social motives and economic development are not goals of the private sector and thus investment in these industries will always be low. However if such type of investment can be profitable for Islamic asset managers and mutual funds, it would attract more participation in PLS financing. By utilizing modern portfolio theory we can determine if there exist portfolio optimization benefits for partaking in such forms of investments. 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. Therefore by exploring correlation benefits we hope to incentivize increase participation in the VC industry.

Research objective

Our objective in this study is to explore the existence of portfolio optimization benefits through VC style investments for Islamic asset managers and mutual funds investing in the stock market. We utilize VC style financing as a representation of profit sharing investment given their similarities. This is because the goal of venture capitals is entrepreneurial development and innovation, which are parallel to the goals purported by scholars and academicians to justify higher utilization of equity based instruments.

Our study explores portfolio benefits between venture capital style investments and the stock market. To do this our research has to addresses three main questions of interest. These are:

1. Whether there exists diversification benefits and portfolio optimization opportunities by the inclusion of VC style investments in a portfolio comprising of stocks.

2. To determine if the correlation between VC style investments and stock are consistent, and how does adverse market conditions impact the variances of these asset classes.

3. To identify regime changes that may occur over a passage of time, so that fund managers can design optimal portfolio management strategies based on a dynamic environment.

4. To identify the investment horizon that would benefit the most from portfolio diversification opportunities between VC style investments and the stock market.

To conduct this study we use daily data from the Malaysian stock market over from April 2014 till December 2013. The five main index to represent the Malaysia stock and venture capital investment that are used for the purpose of our study is specified in table 1 below:

Table 1: Indices used for the study

Index name	**Description**
FBM Ace	Due to the limitation in acquiring venture capital data, we utilized the FBM Ace (Ace) as a proxy of the performance of venture capital investment. Ace as a market for emerging growth companies. It is a sponsorship driven market with minimal criteria's for listing. Listing requirements of Ace are similar to selection criteria's of venture capital investments and is a good representation of the venture capital market.
FBM KLCI	The FBMKLCI (KLCI) is a key benchmark index representing the Bursa Malaysia stock exchange. It capitalization weighted index comprising of a portfolio of stock that comprises of the 30 largest companies in Bursa Malaysia which makes up 70% of the total market capitalization. This index is utilised to track the performance of the entire Malaysian stock market.

FTSE Bursa Malaysian EMAS (EMAS)	The EMAS index is a capitalization weighted index that comprises of the largest and mid-size company within the KLCI index and the FTSE Malaysia Small Cap Index (Small Cap).
FTSE Bursa Malaysia Top 100(Top 100)	The Top 100 index is a capitalisation weighted index that combines the KLCI index and FBM Mid 70 index. This index is good representation of both large multinational corporations and mid-size companies that comprises of the 100 of the largest companies in the entire stock market.
FTSE Bursa Malaysia Small Cap	The FTSE Bursa Malaysia Small Cap Index (Small Cap) comprises of 98% of the companies listed on the Main board of the Malaysia stock market excluding the companies in the Top 100 index. It mainly comprises of shares of small companies referred to as penny stocks.

Our selection of the indices was every facet of the Malaysian stock market was represented within our study. This is make sure that our study is as robust as possible given the within our limitations of information.

We utilize Malaysia as a case study because it is the global hub of Islamic banking and also because it has one of the largest established equities market in the Muslim world.

To address our research objectives as identified above, we employed the use of dynamic conditional correlations and wavelet transformation. While this econometric technique has been put to use in various areas of application including portfolio diversification Norsworthy et al. (2000), 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 Poti2005) – we are not aware of any application of this method in the area of enquiry that this paper has identified. Thus our paper is unique in two aspects – first, empirically investigating the diversification dimension between venture capital investment and stock investments in the developing Muslim world, and secondly employing advanced econometric techniques of Mutivariate DCC and Wavelet transform to identify these correlation benefits across different time scales.

Theoretical background

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

$$\sigma_p^2 = (\Sigma W_i^2 \sigma_i^2 + \Sigma\Sigma W_i W_j Cov_{ij})$$

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

Subsequent to these papers, countless authors have attempted to empirically test the covariance of asset returns amongst stock markets in order to identify portfolio diversification opportunities. A higher correlation between asset returns can therefore diminish the advantage of diversified investment portfolios (Ling and Dhesi, 2010). In this paper we draw upon such theoretical foundations and study the volatilities and cross-correlations amongst sample stock indices to answer the research questions.

One of the criticisms of the earlier models of modern portfolio theory was the assumption that the portfolio variances are constant and normally distributed. However, subsequent models have been developed that use asymmetric and fat tailed distributions that are closer to real world data.

The methodology we adopted in this paper was to utilise M-GARCH-DCC, which has the ability to adopt a student-*t* distribution of variances which is more appropriate in capturing the fat-tailed nature of the distribution of index returns (Pesaran and Pesaran, 2009). Furthermore, we used wavelet transform to decompose returns over different timescale to establish under which circumstance can investors capitalize on diversification benefits (In and Kim, 2013). We elaborate on the methodologies to be adopted in achieving the research objectives in the section below.

Analysis of methodology

Risk estimations

We begin our study by first trying to understand the relationship between stock market and venture capital investments in terms risk diversification. To achieve this, it is necessary to understand the multivariate relationship between different indices. Thus, we need a statistical model able to measure the temporal dependence between different index funds. The traditional approach to measure risk of financial assets is based in the historical covariance matrix. The use of this unconditional static measure has as drawback the fact that it is constant. However, an inappropriate model for dependence can lead to suboptimal portfolios and inaccurate assessments of risk exposures. Hence, it is necessary knowing the dynamic behavior of the covariance among financial assets.

To remedy this problem we relied on Multivariate Generalised Autoregressive Conditional Heteroscedastic (MGARCH) utilising dynamic conditional correlations as proposed Pesaran and Pesaran (2009) instead. In our study we tested for *t* distributions, as in the case of high risk assets such as stock and indices it is better able to capture the fat-tailed nature of the distribution of asset returns (Pesaran and Pesaran, 2007) especially for risk analysis where the tail properties of return distributions are of most concern. For the purpose of our test we utilized the following equation:

$$V(r_{it}|\Omega_{t-1}) = \sigma^2_{i,t-1} = \bar{\sigma}^2_i(1 - \lambda_{1i} - \lambda_{2i}) + \lambda_{1i}\sigma^2_{i,t-2} + \lambda_{2i}r^2_{i,t-1}$$

Where σ_i^2 is the unconditional variance of the ith asset return.

$\hat{\lambda}_{1i}+\hat{\lambda}_{2i}$are asset specific volatility parameters (individual asset return volatilities).We also tested whether the computed volatility was mean-reverting by estimating (1 – $\hat{\lambda}_{1i}-\hat{\lambda}_{2i}$). 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).

The main merit of Dynamic Conditional Correlations (DCC) in relation to other time-varying estimating methods (such as, rolling regressions and Kalman filters and their variants such as, Flexible Least squares) is that it accounts for changes in both the *mean* and *variances* of the time series (unlike the above methods which account for only the time-varying changes in the *mean*). In other words, DCC allows for changes both in the first moment (mean) and the second moment (variance). Understanding how correlations and volatility change over time and when they would be strong or weak is a motivation for the use of DCC models particularly in the financial markets. The DCC modeling allows us to pinpoint changes (both *when* they occur and *how)* in the interdependence between time series variables. Thus in this case allowing us to see identify possible diversification benefits provided by venture capital style investments in a dynamic environment that is constant flux.

MGRACH DCC models have proven to be reliable estimators of portfolio estimators and have been utilized in numerous studies including Fantazzini (2009) performed Value at Risk simulations. Aas &Berg (2009) investigated dependence structures between financial assets. Righi & Ceretta(2011a) identified structural changes in European markets volatility.

Confirming possible regime changes

In the next step of our analysis we wanted to test the existence of possible regime changes. Many economic time series exhibit regime changes marked by abrupt changes in the behavior of the series. Quite often, certain variables can behave quite differently during events such as market bubbles, economic downturns and so on and regime switching models provide an intuitive way to capture this non-linear behavior. The process which determines the probability of a regime switch is incorporated into the stochastic structure of the model, hence it is possible to draw

inference about which regime is in operation at what point of time. Markov models assume that regime shifts evolve according to a Markov chain.

A common restriction on these models is that transition probabilities evolve independently of the lagged values of the series itself. Regimes are said to evolve "exogenously" of the series. Hence these models are the best choice when the aim is to investigate regime shifts in the data without tying shifts to any observable variable. We aim to capture two distinct regimes which we believe to be present; regime one, a high correlation/ co-variance state and regime 2, a low correlation/ co-variance state.

One of the most widely used Markov models is a variation of the autoregressive (AR) model of order k. This is most useful in cases in which the exact data of the regime change is unknown. Through Markov switching we are able to pin point the exact time a regime change occurs and the duration of the regime shift.

Markov switching is calculated utilising a maximum likelihood estimate as proposed by Perlin (2010): Estimates of the response vectors can be derived by combining the parameter estimates of the Markov-switching unrestricted vector autoregression with the estimate of regime-dependent residuals, the formula is described below:

$$Pr(S_t = j|\psi_t) = \frac{f(y_t|S_t = j, \psi_{t-1})Pr(S_t = j|\psi_{t-1})}{\sum_{j=1}^{2} f(y_t|S_t = j, \psi_{t-1})Pr(S_t = j|\psi_{t-1})}$$

For the sake of brevity more details can be found in Perlin (2010).

Guidolin and Timmermann (2006a, GT) represents a good example of such efforts. They study a variety of MSMs for the joint distribution of U.S. stock and bond returns.

Decomposing returns into different time frames

As a last step in our analysis we wanted to determine what timescale of investment would the investor benefit for the risk diversification provided venture capture style investments. To that we shifted our attention to identifying multi-scale features.It has been well established that by

representing time series in other domains (i.e. frequency, wavelet, Z transform, laplacian, etc.), certain characteristics that are not visible in a single time domain are highlighted. Such characteristics may be used to better understand the underlying time series.

To achieve this we turn our attention to the Wavelet method, which has been applied to separate the dynamics in a time series over a variety of different time horizons. Hence, wavelet analysis provides an efficient way to localize changes across time scales while maintaining entropy conservation. This makes wavelets a suitable tool for analyzing economic and financial stochastic processes. Therefore, by decomposing a time series on different scales, one may expect to obtain a better understanding of the data generating process as well as dynamic market mechanisms behind the time series.

Wavelets or short waves are similar to sine and cosine functions in that they also oscillates about zero. The discrete wavelet transform is usually applied through filter banks. This approach was first proposed by Mallat (1989), employing the pyramid algorithm and *quadrature mirror filters*. In general, a signal is filtered by convolving it by the filter coefficients. In the context of the discrete wavelet transforms, a time series will pass through two filters, a low pass and a high pass filter. Afterwards, the output of each filter is down-sampled. Through this process, the original time series is decomposed into two components, each half the size of the original time series. The component obtained through the high pass filter, contains the details from the original time series. The component obtained through the low pass filter represents the smoothed version of the original time series. This filtering and down-sampling process can be reiterated, each time feeding the smoothed time series as the input to the next stage of low and high pass filters.

An alternative wavelet transform for the discrete wavelet transform (DWT)of a time series is the Maximal Overlap Discrete Wavelet Transform (MODWT). Unlike the classical DWT, the MODWT is a non-orthogonal transform. It has many advantages over the DWT such as non-dyadic length sample size, invariant translation (i.e. shifting the time series by an integer unit will shift the MODWT wavelet and scaling coefficients the same amount), provides increased resolution at coarser scales and produces more asymptotically efficient wavelet variance estimator than DWT.

For the purpose of this study we would be using the MODWT to identify changes in covariance and correlation of the index funds over different timescales to identify the diversification benefits of venture capital type investments over different timescales. To do this we utilize the formula proposed by Whitcher et al. (2000a) The wavelet covariance of (Xt ,Yt) is defined as:

$$\gamma_{XY}(\lambda_j) = \frac{1}{2\lambda_j} Cov(\tilde{\omega}_{X,jt}, \tilde{\omega}_{Y,jt})$$

Based on past research ,in the area of finance, wavelet analysis appears useful, as different traders view the market with different time resolutions, for example hourly, daily, weekly or monthly. Markets consist of agents working in different time horizons. Therefore, the dynamics of interrelation between markets consist of scales that possibly behave differently. Different types of traders analyze the multi-scale dynamics of time series. In fact, they analyzed the risk management at different time-horizon and tried to find the corresponding investment strategies.

Norsworthy et al. (2000) analyzed stocks from the US market and find that beta coefficients generally decrease as we move into higher scales.

Empirical results

Risk diversification

The purpose of this research is to conduct an exploratory study on whether there exist incentive for Islamic asset managers and mutual funds to invest a certain percentage of their portfolio in the PLS financing/ VC style investment. If this incentive exist, it would provide an impetus for asset managers to partake in VC investments. We have utilized the Ace as a proxy to venture capital investment. To begin our empirical analysis we first need to answer the question on whether there exist a relationship between the stock markets and venture capital style investments for the purpose of portfolio diversification. To do this we model the unconditional correlation between various asset classes. Table 2 summarizes the maximum likelihood estimate

of$\lambda_1$and$\lambda_2$for five of our index funds returns, as well as forδ_1 and δ_2. The t-statistic is refers to the volatility decay over the long. Please note that all test statistics are highly significant.

Table 2: estimates of $\lambda_1$and $\lambda_2$and $\delta_1$and $\delta_2$for five index funds				
			Multivariate t distribution	
			Estimate	T-ratio
Lamda 1 λ_1	Ace Index		.81115	[.000]
	TOP 100 Index		.79974	[.000]
	KLCI Index		.80496	[.000]
	EMAS Index		80092	[.000]
	Small Cap Index		.80509	[.000]
Lamda 2 λ_2	Ace Index		.12721	[.000]
	TOP 100 Index		.18175	[.000]
	KLCI Index		.17423	[.000]
	EMAS Index		.18046	[.000]
	Small Cap Index		.17317	[.000]
Delta 1 δ_1			.83774	[.000]
Delta 2δ_2			.14740	[.000]
Maximum log likelihood			53873.2	
Degrees of freedom			5.2993	
Note: $\lambda_1$and λ_2 are decay factors for variance and covariance respectively				

Table 3: Estimated unconditional volatility matrix for 5 index funds					
	Ace Index	Top Index	KLCI Index	Emas Index	SmallCap Index
Ace Index	.012537	.18232	.17345	.20089	.28191
Top Index	.18232	.0078995	.98811	.99104	.76015
KLCI Index	.17345	.98811	.0076788	.98545	.75340

Emas Index	.20089	.99104	.98545	.0079340	.81732
Small Cap Index	.28191	.76015	.75340	.81732	.010282

Table 3 shows the estimated unconditional volatilities (diagonal elements) and the unconditional correlations (off-diagonal elements) of our chosen five index funds. In Table 3, the numbers in parenthesis in the diagonal elements represent ranking of unconditional volatility (from lowest to highest). The ranking is characteristics of the nature of a stock market, with indexes comprising of small size high growth companies being riskier than those that track the entire market. The SME and technology shares tend to comprise to a larger extent shares of speculative trades stocks and are referred to as paper shares. This is particularly the case during bear runs and when the market participants sell down risky shares to invest in safer assets. Not surprisingly, indices that track the more mature companies show the lowest volatility, reflecting the intuition that everyday established company stocks are relatively more recession proof and do not experience excessive growth during economic booms. 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 venture capital style investments has the lowest correlations with other indices. To have a clearer picture of the relative correlation among sectors, we ranked the unconditional correlations (from lowest to highest), shown in Table 4.The above rankings tell us two important facts. First, for all sectors, the lowest correlation is with the venture capital style investment (see notation ‘a’ in Table 4). This implies that fund managers may need to allocate a certain percentage of their portfolio to venture capital style investments in order to fully benefit from portfolio diversification opportunities. Second and more pertinent, indices of the stock markets of developing countries, due to limited investment options, are closely related and thus alternative investment vehicles need to be identified to protect against downward trend in the stock market.

Table 4 : Ranking of unconditional correlations among five index funds				
Ace Index	Top Index	KLCI Index	Emas Index	SmallCap Index
KLCI Index	Ace Index	Ace Index	Ace Index	Ace Index

TOP Index	Small Cap Index	Small Cap Index	Small Cap Index	KLCI Index
Emas Index	KLCI Index	Emas Index	KLCI Index	Top Index
Small Cap Index	Emas Index	Top Index	Top Index	Emas Index

Relating it to the purpose of this paper, this suggests that Muslim developing country mutual fund investors and Islamic financial institutions could achieve portfolio optimization by allocating a certain percentage of portfolio composition towards venture capital funds. This may be because venture capital investment's performance profile are different from the companies that comprise of the main market. Like in the case of Bursa Malaysia, the largest companies comprise of oil and gas, construction, manufacturing, telecommunication, finance and agriculture sector, with little contribution coming from technological companies. VC business is about creating new business models, making businesses more efficient and about making the life's of consumers easier. Thus venture capital returns do not depend on the economic performance of the country, but rather it is a tools that helps create innovative ideas that helps boost economic growth of the country. Therefore it should come as no surprise that profit sharing financing returns are uncorrelated to the main market and thus offer diversification benefit to existing Islamic fund managers. In-fact in the U.S mutual fund portfolios that compromise of a mix of venture capital investment are able to earn superior returns as compared to the returns of growth oriented mutual funds (Brophy and Gutner, 1988). This is why in the developed world majority of venture capital funds originate from private institutions. In the developed world there is a trend for mutual funds to directly participate in venture capital investing themselves, in a bid to increase their portfolio optimization (Wall street journal, 2014).Some experts may argue that that venture capital style investments may be substituted by investing in small cap stocks in the stock market. However based on our results although Small Cap stocks do provide correlation benefits, the degree of correlation is not as low as venture capital style investments. We argue that there is evidence suggest that venture capital style investments and the stock market are loosely related and thus it offers diversification benefits for mutual fund companies and Islamic asset managers to benefit from.

Before we proceed into our next research questions we had to ensure that our findings were robust and that this test is accurate within a certain significance level. Table five summarizes the results of our robustness test.

Table 5: Robustness testing		
	Coefficient	**p-value**
LM test	24.686	0.016
	Test statistic	**Critical value**
Goodness of fit[3]	0.3461	0.84344
	Mean hit rate	**p-value**
Tolerance probability[4]	0.98077	0.135

In the above figure, we can see that the Kolmogorov-Smirnov test statistic is 0.3461, which is lower than 5% critical value. Therefore, we cannot reject our null hypothesis that the probability integral transforms are uniformly distributed.

From the above table, we can see that the mean hit rate (0.99808) is very close to the expected value (0.99000), and the test statistic is not significant. *Both supporting the validity of the t-DCC model*.

However our LM, due the existence of serial correlation was equal to 24.686 (P value = 0.016), which is statistically significant at a 5% critical level, going against our null that the model t-DCC is correctly specified. Nonetheless 2/3 diagnostic test confirms the validity of the model and the fact that MGRACH models contain asymptotic properties that are not effected by serial correlations, we believe that the presence of serial correlation would not have an adverse effect on model specification. Testing details have been provided in **Appendix I**

[3]Kolmogorov-Smirnov Goodness-of-Fit Test:
[4]Testing for VaR Exceptions

In figure 1 we can see the charts of conditional volatilities plotted during our entire period of study. As we can see from chart that conditional volatilities hit a peak in 2008 at the beginning of the financial crisis and reverted back to normal over the long run. We also observed that venture capital style investments exhibited the highest volatilities as compared to other indexes during period of economic stability. However during periods of crisis venture capital style investment demonstrated the least volatility relative to other indices. The difference in volatilities is because during period of crisis, firm look for new technologies for the purpose of increasing business efficiency and waste reduction, in order to cut down their cost. This leads to higher demand for innovative technology, possibly bolstering the performance of venture capital style investments (EY,2011). In a similar study (Frenz et al, 2012) although some firms reduced spending on R&D projects, large innovative firms in the U.K increased R&D investments and it was found that these firms coped better in the crisis. In the chart we can only see that volatility has remained relatively stable through our period of study implying that over the long run volatility is mean reverting and effects of a shock do not have permanent impact. We also observed that all stock market indices track one another, implying close correlation between the main market indices. Taken together, these observations corroborate our earlier findings that the venture capital style investments when paired with stock market investments does offer potential diversification opportunities to mutual funds and Islamic asset managers.

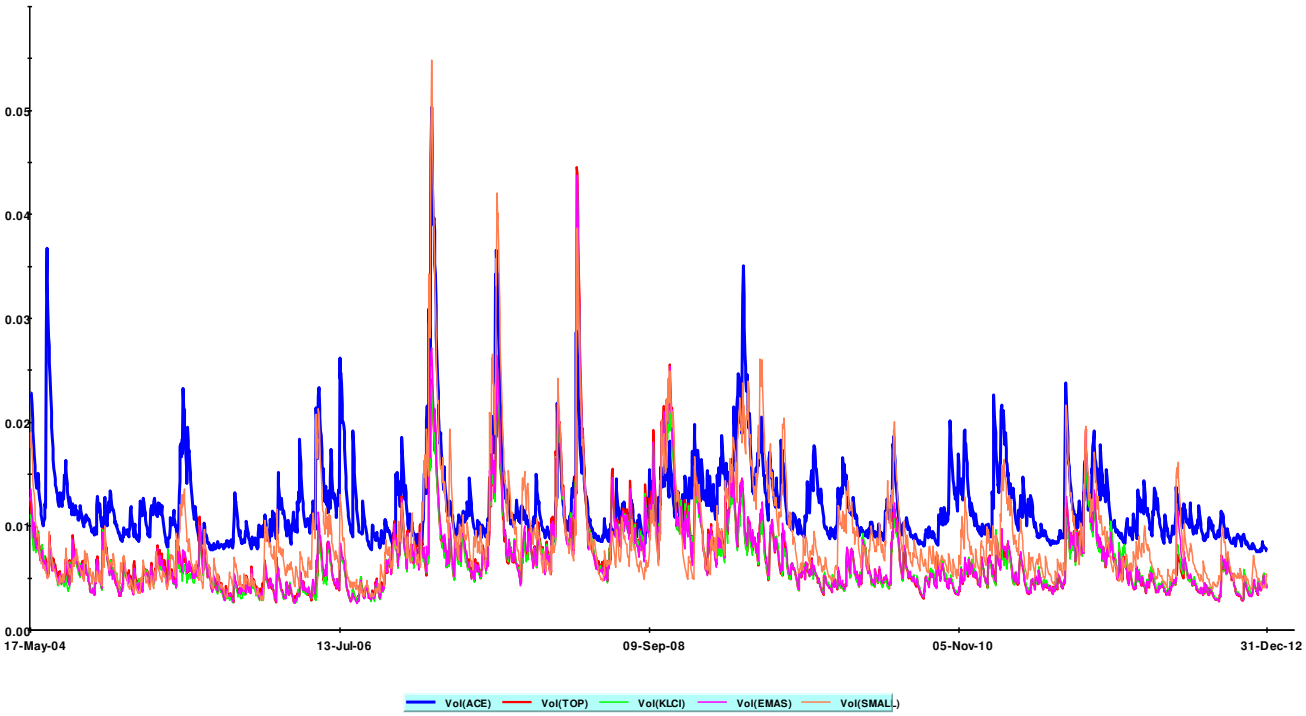

Figure 1: Conditional volatility of Ace, KLCI, EMAS, TOP 100 and Small Cap Indices from the period of May 2004- December 2012.

Reactions of index funds to shocks

Given that we have uncovered evidence to suggest that correlation benefits existing between venture capital style investments and the stock market. The next question that in the event of a shock to the system would these correlations and volatiles revert back to normal. The implication of this results would be of importance to fund managers. Slow mean reversion allows fund managers an avenue to engage in portfolio optimization strategies. To do this we test the hypothesis whether volatility in returns are mean reverting. To achieve this we test the null hypothesis that:

H_0: $\hat{\lambda}_1+\hat{\lambda}_2 = 1$

The summarize results are provided in table 6 below:

Table 6: estimates the null hypothesis that H_0: $\hat{\lambda}_1+\hat{\lambda}_2 = 1$			
	$1-\hat{\lambda}_1-\hat{\lambda}_2$	Standard Error	T-ratio
Ace Index	0.0625	0.0209	2.9868
TOP 100 Index	0.1243	0.0208	5.9691
KLCI Index	0.1210	0.0208	5.8058
Emas Index	0.1303	0.0208	6.2633
Small Cap Index	0.1359	0.0207	6.5371

In our test we found that in all five sector indexes, volatility was mean reverting. Details of the test statistics have been provided in **Appendix II**

This implies that despite the fluctuations in volatility and correlation, in the long run, volatility assumes an average value, this corroborates our findings in figure 1 above. However, note that the mean reverting process is generally a very slow one. Estimates of $(1 - \lambda i1 - \lambda i2)$ range from 0.0625 to 0.1359. 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 returns 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.

Then we turned our attention to conditional correlations. We charted the conditional correlations (with respect to finance) for all different indices in comparison to venture capital style investments (Figure 2). Here we note the following observations. When the market is bullish, correlations increases across all indices. What we found interesting though was that in times of crisis, correlation between venture capital style investments and other indices drop, even negative levels. This shows that there is strong possibilities of portfolio diversification opportunities in times of crisis through the utilization of alternative investment options. This also

implies a possible loss opportunity cost for fund managers that do not participate in venture capital style investments, as they may be losing out portfolio optimization opportunities by constructing sub-optimal portfolios. The downward shift in correlation alludes to a possible regime change in the stock market. To confirm this assumption we utilised Markov switching techniques to identify when this regime change occurred and its duration. Figure 3 illustrates the state of market between venture capital style investments and Top 100 index which reflects approximately 90% of the Malaysian stock market capitalization.

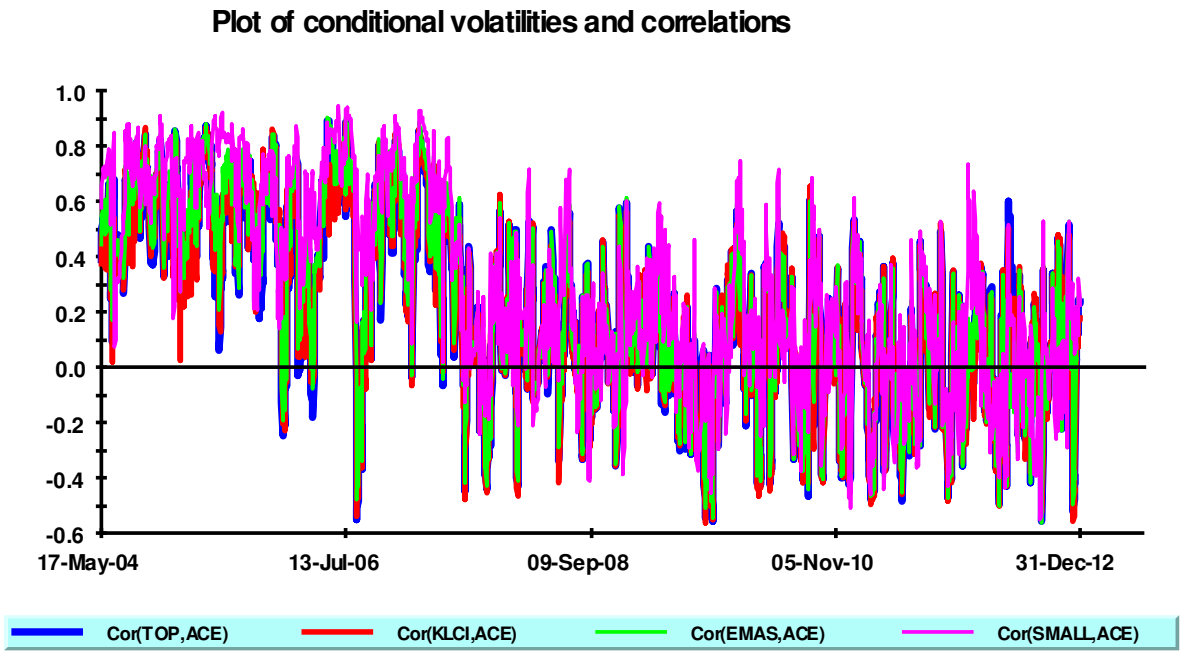

Figure 2: Conditional correlations between TOP-ACE, KLCI-ACE, EMAS-ACE and SMALL CAP-ACE from the period of May 2004 till December 2012

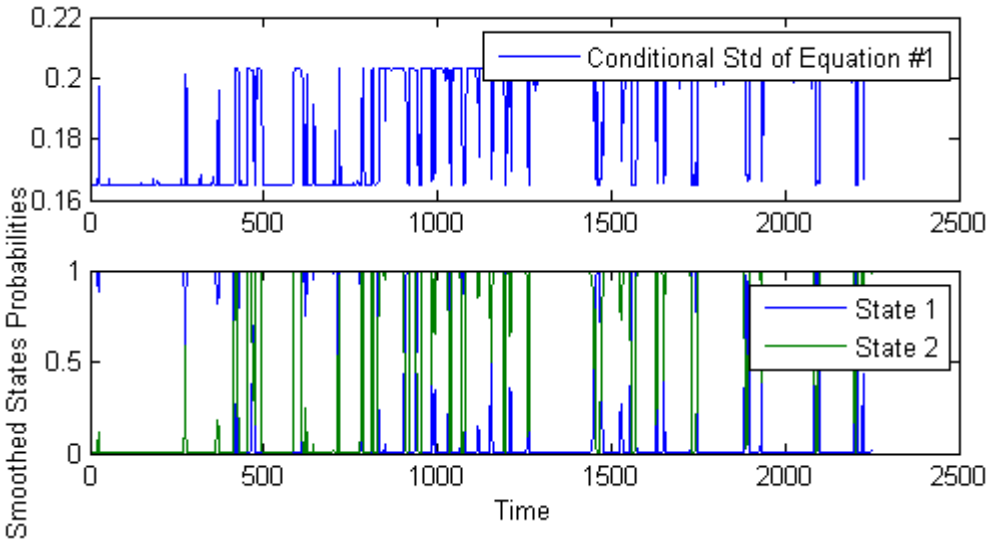

Figure 3: Detecting for regime change of correlations between TOP and ACE indices from the period of April 2004 up until December 2013 utilising daily log returns data. Correlation between the other indices and ACE are in **Appendix III**

This confirms our earlier hunch that a market underwent a transitions from 2006 up until 2012. Focusing on the regime switch from 2006 to 2012 we can see some interesting behaviour, correlations begins to decrease even though within this same period market volatility was on an increasing trend. It then continues to decrease rapidly and comes to a point when there is negative correlation between VC investments and stock indices and fluctuate around this point, indicating persistence in the regime switch. By extending the regime switching probabilities to incorporate time variance gives us a better insight into both the nature of the time series as well as the theorized relations between VC style investments and stock indices.This answers our third research question on how the market would react in the event of a regime shift.

Analyzing diversification benefits over different timescales

Having discovered portfolio diversification opportunities through the inclusion of VC style investments, the next part of our research question comes in understanding whether these diversification benefits are similar across different timescales. This is to identify if diversification benefits apply to all forms of traders.

To achieve this we conducted a covariance analysis. We decomposed the daily weekly market returns applying the MODWT with a Daubechies least asymmetric (LA) wavelet filter of length L = 8, commonly denoted as LA (8).This function measures the linear synchronization between the stock market index and venture capital style investments between our four market indexes. The results of wavelet correlation between stock market index and our portfolio are reported in Figure 3

Figures 4 present the estimated MODWT and covariance between our proxy of venture capital style investments and key bench mark indexes of the Malaysia stock market. We divided our scales according to weekly observations from scale 1 (one week) up to scale of 123 (approximately two market years). Investment timescale are shown on the horizontal axis, while the vertical axis refers to the investment covariance. The dotted black lines shows the upper and lower limit of the 95% confidence interval.

A first layman glance confirms that risk reduction of the portfolio is only successful for investors that invest over the long run. We find that for short holding periods consisting of 2-4 weeks covariances were relatively high. However, moving towards medium investment horizons consisting of 64-128 weeks we observed drastic reduction covariances over the long term. Thus implying that diversification benefits of venture capital style investments are only applicable over the long term. This is in line with established theory that implies that venture capital is long term investment that needs gestation period of at least 2-3 years before you are able to realize any returns. Mutual fund manager and Islamic asset managers with long investment cycles are in the best position to benefit from these diversification opportunities. This answers our last question and establishes the fact that diversification benefits from venture capital style investments are only applicable over the long term.

Although through this research paper we have showcased the possibility that there are indeed evidences that suggest that PLS financing in the form of VC investments may have potential to provide portfolio diversification opportunities. There are certain limitations to this research that a reader must be aware about:

1. Due to a limitation of information on the venture capital industry, the proxy we utilized may not be exact reflection of venture capital style investments. VC investments are generally illiquid, have long gestation periods and the returns are determined based on a myriad of factors. The skill of the venture capitalist determines the profitability potential of a fund, which may not be easy to determine.

2. We only utilised Malaysia as a case study, the performance of the Malaysian stock market and technology sector may differ from that of other Islamic regimes and therefore this research may not be applicable across all countries.

3. We are basing our conclusions on historical data which may not be representative of future performance benchmark and returns.

4. Owing to limitation of information the scope of research is quite limited. Regulators should consider establishing rules for collection of research for VC and PLS investments, so that more detail studies can be carried out in these area in order to bolster industry performance.

Recommendations and Conclusions

Based on our 4 main questions we were able to uncover evidences that would suggest the following:

1. **Whether there exists diversification benefits and portfolio optimization opportunities by the inclusion of VC style investments in a portfolio comprising of stocks.**

   Through MGARCH and DCC modelling there was evidence to suggest portfolio diversification opportunities through the inclusion of venture capital style investments in stock market portfolios. Correlation between the two asset classes were low as compared and to other stock investments which had higher degrees of correlation. This information

may be beneficial to Islamic fund managers that are looking for alternative investment options for the purpose of portfolio optimization.

2. **To determine if the correlation between VC style investments and stock are consistent, and how does adverse market conditions impact the variances of these asset classes.**

   By plotting the conditional correlations we were able to determine that venture capital style investments were weakly correlated to other stock indices for a long period of time. In fact there was evidence to suggest that in times of crisis these correlation with drop even further into negative correlations. This coincides with theories that more money may be invested into R&D during times of crisis.

3. **To identify regime changes that may occur over a passage of time, so that fund managers can design optimal portfolio management strategies based on a dynamic environment**.

   Utilising Markov switching techniques we were able to determine regime changes in the correlation between venture capital style investments and stock market indices. Evidence suggest that even before a credit crisis, we entered a regime of low correlation that persisted only until the end of the financial crisis. This could help guide practitioners to explore the possibility of investing more funds in VC/PLS instruments prior to a crisis.

4. **To identify the investment horizon that would benefit the most from portfolio diversification opportunities between VC style investments and the stock market.**

   Through wavelet transform, we were able to determine that in order to benefit from portfolio diversification opportunities through venture capital style investments, investors had to invest over longer gestation periods of between 2-5 years. This means that this strategy would be more worthwhile for pension, insurance funds and hedge fund managers that invest over a longer timeframe.

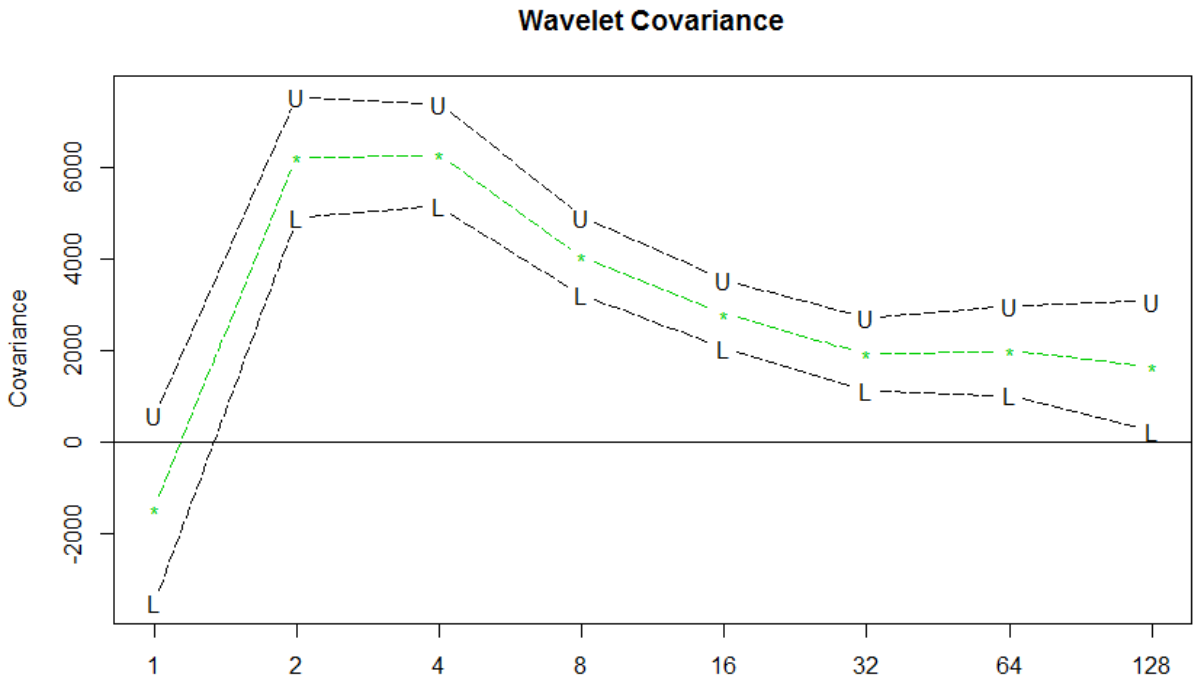

Figure 4a: Weekly covariance data between Small Cap and ACE Indices

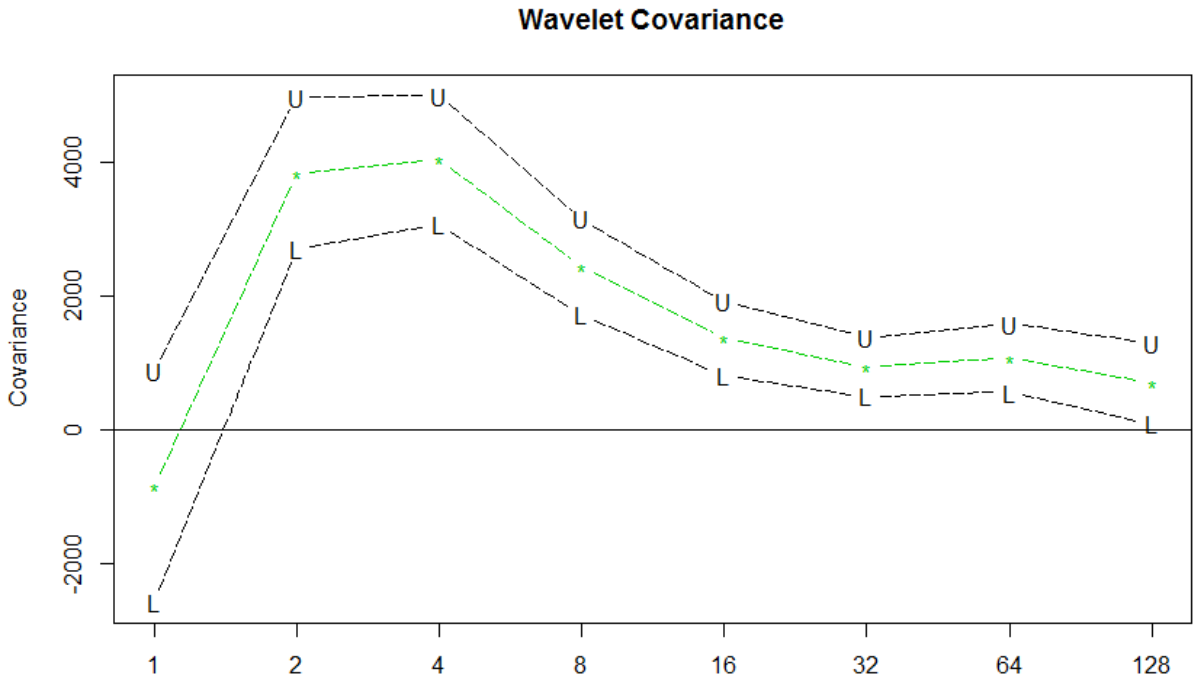

Figure 4b: Weekly covariance data between EMAS and ACE Indices

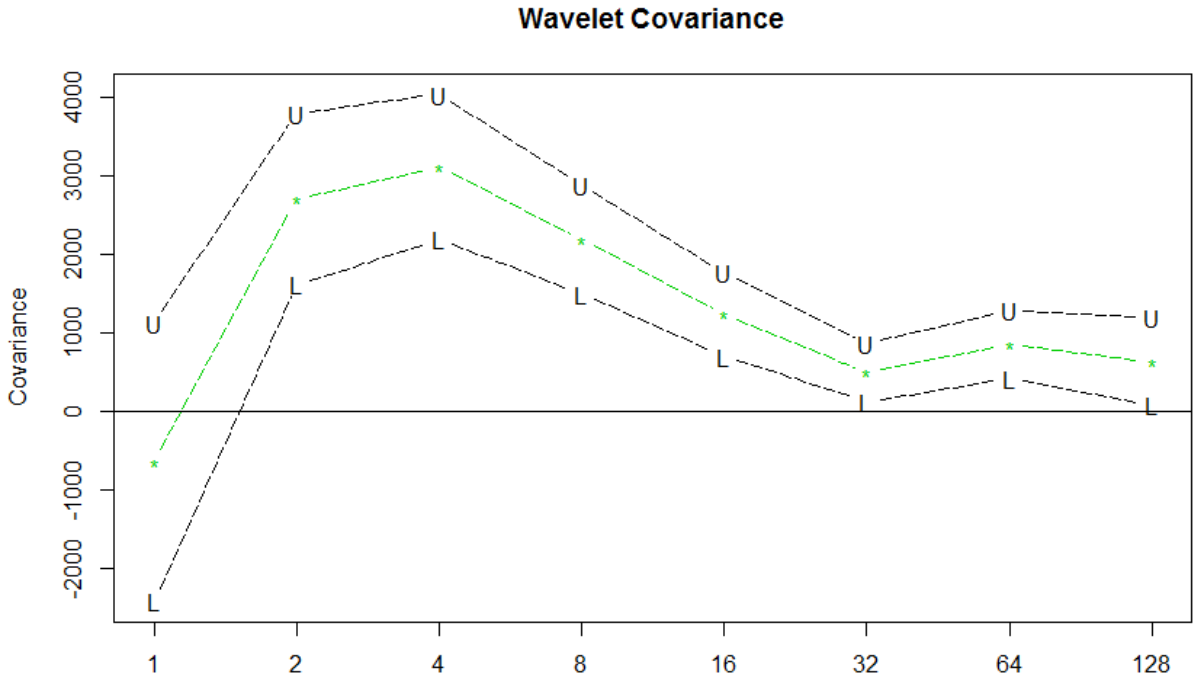

Figure 4c: Weekly covariance data between KLCI and ACE Indices

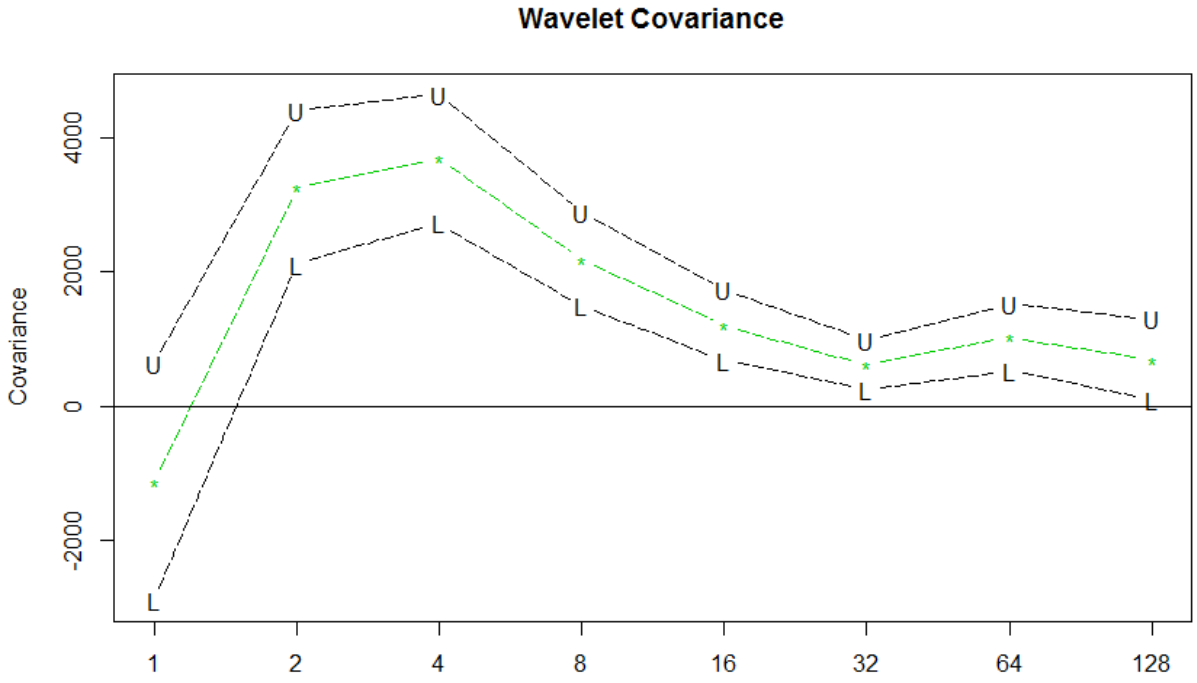

Figure 4d: Weekly covariance data between TOP and ACE Indices

References

1. Aas, K. and D. Berg, 2009, *Models for construction of multivariate dependence: A comparison study.* European Journal of Finance Vol. 15, pp.639-659

2. Archibugi, D., A. Filippetti, M. Frenz, 2012, Economic crisis and innovation: Is destruction prevailing over accumulation, Research Policy, Elsevier.

3. Ernst and Young, 2011, *Tracking global trends: how six key developments are shaping the business world, EGYM Limited*

4. Ernst and Young, 2013. *Turning the Corner: Global Venture Capital Insights and Trends.*

5. Fantazzini, D. 2009, *Value at Risk for High-Dimensional Portfolios: A Dynamic Grouped-T Copula Approach.* The VAR Implementation Handbook, McGraw-Hill, pp. 253-282,

6. Grubel, H. (1968), Internationally diversified portfolios: Welfare gains and capital flows, *American Economic Review*, Vol. 58, pp. 1299–1314.

7. In, F. and S. Kim (2013). *An introduction to wavelet theory in finance*. World Scientific Publishing: Singapore.

8. Iqbal, Z. and A. Mirakhor. 2007. *An Introduction to Islamic Finance – Theory and Practice*. Singapore: Wiley.

9. ISpring Capital (2011). *Overview and Recommendations for the Venture Capital Industry in Malaysia- Report for the Special Innovation Unit Malaysia*

10. Keilbach, M. and D. Audretsch *(2010). Entrepreneurship Capital and Economic Performance,* Regional Studies, Vol 38, pp 949-959.

11. Ling, X. and G. Dhesi (2010). Volatility spillover and time-varying conditional correlation between the European and US stock markets, *Global Economy and Finance Journal*, Vol. 3, pp. 148–164.

12. Mirakhor, A., Z. Iqbal, H. Askari, and N. Krichene, (2012). *Risk Sharing in Finance-The Islamic Alternative*, Wiley Finance

13. Muhammad, A. 2007. *Understanding Islamic Finance*. England: Wiley.

14. National Venture Capital Association America. (2011). *Venture Impact: The Economic Importance of Venture Backed Companies in the U.S*
15. Norsworthy, J., D. Li and R. Gorener (2000) "Wavelet-Based Analysis of Time Series: An Export from Engineering to Finance." Manuscript presented at the 2000 IEEE International Engineering Management Society Conference.

16. Pesaran, B. and M.H Pesaran, 2007. *Modelling Volatilities and Conditional Correlations in Futures Markets with a Multivariate t Distribution:* Oxford University Press.

17. Righi, M. B. and P. S. Cerreta, Global risk evolution and diversification: A copula DCC Garch Model Approach, *Rev Bras Financas,* Vol 10 No.4 pp. 529-550

18. Samuel Kortum and Josh Lerner, (2001) "Does venture capital spur innovation?" Vol. 13, pp.1 – 44

19. Usmani, M. T. 2002. *An Introduction to Islamic Finance*. The Hague: Kluwer Law International.