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An Analysis of Volatility Co-Movement between Malaysia, US, UK and Japan Stock Markets

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Abstract

The main objective of this paper is to investigate the reaction of the Malaysian stock market on the international financial arena as a result of different inflows of information and economic shocks from the international stock markets. Simultaneously, the study will also encapsulate how stock market volatility has implications on financial and economic activities in Malaysia and the dynamics of major stock markets around the world can have ramifications on the Malaysian stock market. Using the stock price indices and returns over the period of 2000-2008, an analysis of volatility co-movement of Malaysian stock market with US, UK and Japan were estimated via Univariate GARCH model with asymmetric extensions and Vector Autoregression (VAR). The findings observed that the co-movements between the Malaysian market and other markets in the analysis is minimal and is not in line with the findings in the existing literature as it has been observed that Asian markets are vulnerable to movements with the US market. Additionally, Malaysian returns do not much affect other markets and is also quite contrary to the findings in the literature. The degree of co-movements indicates that there is still much scope for reaping risk minimization and return maximization benefits of portfolio diversification, at least in the short term by investing in Malaysia, as integration of the Malaysian market is not of a very high order. This

leaves sufficient room for switching between mature markets such as that of US, UK or Japan.

Keywords: volatility co-movement, GARCH model, VAR

1. Introduction

Asian stock markets have grown especially fast, with total trading volumes that nearly rival the US and UK markets. With the exception of Japan, however, Asia's stock markets are small to middle size. These governments have gradually moved towards internationalization and liberalization by removing statutory controls over their foreign exchange and capital markets. The current trend in Asia witnesses the establishment of multinational enterprises, removal of tariff barriers, issuance of securities overseas and the availability of international investment channels (Nurasyikin, Farrah and Shahnaz, 2008). On a global level, international resources such as goods, labor, finance and personnel have flowed smoothly bringing in rapid increases in international investment and capital movements leading to the formation of co-movements between stock markets globally. These factors have reduced the isolation of domestic markets and increased their ability to react promptly to news and shocks originating from the rest of the world. In view of these developments, the linkages between stock markets around the world have grown stronger and trends of stock market volatility is moving rapidly across countries

The degree of interdependence between the international equity markets has become an important issue in financial economics and is evidenced by the numerous studies done on this area. Primarily, researchers and policymakers are attracted to questions about cross-border capital flows and financial market integration; as such linkages have serious implications for international portfolio diversification as well as the macroeconomic policies of concerned countries. Several studies (Eun and Shim, 1989; Becker *et al* 1990; Kock and Kock, 1991; Karolyi and Stultz, 1996; Shamsuddin and Kim, 2002; Syriopoulos, 2005; Ciner, 2006; Zaidi, Cheong and Abu Hassan, 2007; Mukherjee and Bose, 2008) have concluded that market volatility, integration and volatility transmission have increased in recent years

Many researchers have studied the movements of aggregate stock market volatility and a great portion of these studies generally focuses on volatility in United States (US), Europe and Japan. Only of late, Asian stock markets are given some considerable attention but the literature on volatility co-movement of stock markets is sparse. Comparatively, little has been done on volatility co-movement between the Asian stock markets with the developed markets. The scarcity of such literature has spurred the interest of this study to investigate the volatility co-movements between Malaysian market with major stock markets. The notion of whether the Malaysian stock market's linkages with other stock markets can be analyzed to determine if there are any common forces driving the long-run movement of stock indexes or returns, or if each individual stock index or return is driven solely by its own fundamentals. Besides, strong linkage reduces the insulation of domestic market from any global shock whereas weak market linkage offers potential gains from international diversifications (Priyanka *et al* 2008).

2. Objectives of the Study

The Malaysian economy in recent years has been characterized by a trend towards increased liberalization, greater openness to world trade, a higher degree of financial integration, and greater financial development. The increased liberalization and openness have motivated a

high rate of increase in cross-border capital and direct investment flows. The purpose of this study is to investigate closely and deeply understand how the Malaysian stock market behaves on the international financial arena and how they react on different inflows of information and economic shocks from the international stock markets. Conspiringly, this study tries to encapsulate how stock market volatility has implications on financial and economic activities in Malaysia and the dynamics of major stock markets around the world can have ramifications on the Malaysian stock market.

The choice of Malaysia's stock market co-movement against other international stock market as the focus of this study makes the analysis especially relevant. The capital market in Malaysia has undergone a robust development since the late 1980s. The delisting of Malaysian and Singaporean companies from their respective stock exchanges at the end of 1989 was a milestone in the development of Malaysia's equity market. Equity investments by retail/individual, institutional, and foreign investors increased substantially, and market infrastructure was developed accordingly. Recent statistics from Bursa Malaysia shows that the trading participation by retail investors has grown from 28% in 2005 to 36% at the end of December 2007 (Nurasyikin *et al* 2008). Despite the issues facing the key player of the global market like the US, Malaysian capital market remains competitive due to several positive factors. The real GDP 2006 beats the forecasts at 5.9%; inflation is manageable while the Ringgit has strengthened. Further to this, the reforms of government-link companies (GLCs) have shown favorable result and the implementation of the 9th Malaysian Plan is on track.

The Malaysian economy in recent years has been characterized by a trend towards increased liberalization, greater openness to world trade, a higher degree of financial integration, and greater financial development. The increased liberalization and openness have motivated a high rate of increase in cross-border capital and direct investment flows. After the stock market liberalization of December 1988, expansion in the stock market capitalization of the Kuala Lumpur Stock Exchange (KLSE) (now known as Bursa Malaysia) was truly impressive. The ratio of market capitalization over GDP was 60% in 1985, but had increased to 132% by the end of 2001 (Beck *et al* 2003), comparable to that of developed countries, and among the highest market capitalization ratios in the emerging markets universe. For this reason, this study span the years of development of the stock market, and financial opening of the country. The analysis of the possible impact of these events in the behavior of the stock market becomes relevant for our understanding of the functioning of capital markets in an emerging market. In addition, Malaysia's capital control measures, introduced during the financial crisis of 1998, also created an ideal laboratory to investigate the behavior of stock market volatility (Garay, 2003). With volatility being contagious, it is crucial to know what takes place in other major markets and how volatility in the Malaysian stock market co-moves with that market. Such volatility co-movement can impact Malaysia in varying degrees on its corporate capital budgeting decisions, investor's decisions and business cycle.

A lot of work has been done on market linkages, market integration, influences and spillovers of one market on another. What the literature lacks are studies on stock market volatility co-movement with a focus on the Malaysian market in relation to world markets. This study serves to fill that gap and to contribute to this area by examining volatility co-movement

between the Malaysian stock market with three major stock markets, namely United States (US), United Kingdom (UK) and Japan representing three major regions of the world that is North America, Europe and Asia respectively. The following two research questions will be addressed:

i. What is the degree and nature of volatility co-movement between the Malaysian stock market with that of US, UK and Japan stock markets?

ii. How much of the movements in the Malaysian stock market can be explained by movements and innovations or shocks in the US, UK and Japan stock markets?

3. Literature Review

On a brief review of the financial literature, much research on stock market volatility over time and studies of co-integration, co-movement, contagion, correlation, spillover, linkages that exist among world markets are widely available. On a closer examination of these literatures, there is a glaring difference in the findings before and after the stock market crash of 1987. Earlier findings found vague correlation between stock markets as opposed to the period after the crash as early contributions to the literature after the market crash focused on US and the interdependence of other stock markets but the later studies incorporated more countries from Europe and Asia.

There have been numerous studies examining the relationships among national stock markets prior to the crash in 1987. Using weekly or monthly data from the 1960's and 1970's and adopting simple correlation and regression methods, studies by Granger and Morgenstein (1970), Levy and Sarnet (1970), Grubel and Fadner (1971), Agmon (1972) and Ripley (1973) found little or no correlation between national stock markets. General conclusions that are found in these papers are that national stock markets are segmented and risk reduction through international portfolio diversification is possible. The low degrees of co-movements between the stock markets are explained by barriers of international capital flows, differing policies in each country, higher taxes and transaction costs on international capital investments, and a low degree of information about foreign securities. Nevertheless, findings of Wheatley (1988) who used data on the US and seventeen other countries for the period 1960–1985, supports the notion of equity market integration.

Conversely, since the stock market crash of October 1987, the integration of global equity markets or stock price co-movement has been studied extensively. Though most of the studies initially had been conducted for developed markets, such as those of the US, Europe, and Japan, but the post-Asian crises literature has started to focus on emerging Asian markets. These studies have consistently indicated strong linkages among world equity markets, particularly between those with close economic ties or geographic proximity (Mukherjee and Bose, 2008).

Among the early contributions to the literature after the market crash are Eun and Shim (1989). Analyzing the daily stock market returns of Australia, Hong Kong, Japan, France, Canada, Switzerland, Germany, US and the UK, substantial interdependence among the national stock markets with US were established with a one or two days lag against US

innovations and shocks. Park and Fatemi (1993) and examined the linkages between the equity markets of the Pacific-Basin countries to those of the US, UK and Japan. The findings ascertain the influence of US compared to UK and Japan at differing levels on the Pacific-Basin's stock movements. Australia is sensitive to the US market where else Singapore, Hong Kong and New Zealand exhibited moderate linkages. Korea, Taiwan and Thailand had little linkage to any of these markets with the conclusion that stock movements of Pacific-Basin countries are influenced by domestic factors. Nevertheless, Janakiramanan and Lamba (1998) who empirically examined the linkages between the Pacific-Basin stock markets concluded that markets that are geographically and economically close and/or have large number of cross-border listings exert significant influence over each other.

Using daily and intraday price and stock returns data, Lin, Engle and Ito (1994) examined the bi-directional linkages between US, Europe and Asian countries. They found that foreign returns can significantly influence the domestic returns as in the case of Japan and US and cross-market interdependence in returns and volatilities is bi-directional between the New York and Tokyo markets. Johnson and Soenen (2002) investigated the degree of integration of equity markets in Asia with Japan's equity market. They found that the equity markets of Australia, China, Hong Kong, Malaysia, New Zealand, and Singapore are highly integrated with the stock market in Japan.

Lakshmi and Gamini (2004) investigated the importance of volatility in stock market in assessing investment and leverage decisions as volatility is synonymous with risk. Using daily returns from 1992 to 2002, they investigated the volatility co-movement between the Singapore stock market and the markets of US, UK, Hong Kong and Japan. The empirical results indicate that there is a high degree of volatility co-movement between Singapore stock market and that of Hong Kong, US, Japan and UK (in that order). In another study, Mukherjee and Bose (2008) examined the stock movements of Indian stock market and found a definite information leadership from the US market to all Asian markets but the US indexes do not uniquely influence the integration of Asian markets while Japan is found to play a unique role in the integration of Asian markets. The US market is seen not only to influence, but also to be influenced by information from most of the major Asian markets.

Hyginus (2006) find results for the distribution of realized volatility in two emerging stock markets that are similar to those in developed stock markets. The results suggest that part of the observed volatility and co-movement can be explained by external factors common to both markets. As such, policies to mitigate the observed volatility may be outside the control of the authorities. Consequently, defensive measures, such as improved regulation and risk management practices in financial institutions, may be the best policies to contain the impact of stock market volatility.

4.Data and Methodology

4.1 Sampling Design

As the study investigates the volatility co-movement of the Malaysian market with major stock markets in the world, three regions were identified namely North America, Europe and

Asia. Based on the criteria of leadership and influence in their respective regions, the US and UK stock markets were chosen to represent Northern America and Europe respectively while the vibrancy and robustness of Japan stock market will represent the Asian region.

4.2 Period Selection

The data used for the study were daily stock returns from Malaysia, United States (US), United Kingdom (UK) and Japan from January 2000 to February 2009 and adjusted to a total of 2252 observations in each of the selected markets.

The specific reason to choose the time-frame was to analyze the performance of Malaysian stock market in the 21st. century as the Malaysian economy moves towards increased liberalization, greater openness to world trade, a higher degree of financial integration, and greater financial development. The rationale of using the daily returns data is due to its characteristics of capturing all possible interactions within the market. Using weekly or monthly data may block out interactions that last for only a few days. The daily stock returns from Malaysia, US, UK, and Japan were subsequently computed for y_1 data using the formulae $y_1 = (lnP_t - lnP_{t-1}) * 100$.

Table 1 below provides information on the operating times of the various selected markets for this study with their indices and the sample period. The order in which the markets open for trading is: Japan, Malaysia, the UK and US. The operations timing of the Bursa Malaysia (Malaysian Stock Market) overlaps with the exchanges in Japan and concurring shocks that occur in Japan will affect the Malaysian stock market on the very same day without any time lag. Conspicuously, shocks from the US and UK markets do not overlap with the Malaysian market on the same day but gives effect the following day.

Table 1. Market Indices, Market Operating Times and Sample Period

Country	**JAPAN**	**MALAYSIA**	**UK**	**US**
Index	Nikkei 225	KL Composite Index (KLCI)	FTSE 100	Dow Jones Industrial Average (DJIA)
Local Time	09:00 – 15:00	09:00 – 16:00	08:00 – 16:20	09:30 – 16:00
GMT	00:00 – 06:00	01:00 – 08:00	08:00 – 16:20	14:30 – 21:00
Sample Period	4.1.2000 – 27.2.2009	3.1.2000 – 27.2.2009	4.1.2000 – 26.11.2008	3.1.2000 – 15.12.2008
Observations	2252	2252	2252	2252

4.2 Data Description

4.2.1 Correlation Analysis

Table 2 represents the correlation coefficients between daily markets returns from 2000-2008. From the tables, all markets shows at least a single integration namely the US integrates with UK; the UK has integration with US and Japan; and the Japanese market shows a strong integration with Malaysia but a weaker integration is visible with UK.

Table 2. Correlation Coefficients between Daily Market Returns: 2000 – 2008

INDEX	**NIKKEI (Japan)**	**KLCI (Malaysia)**	**FTSE100 (UK)**	**DOWJONES (US)**
NIKKEI	1.000			
KLCI	**0.116***	1.000		
FTSE100	**0.048****	-0.031	1.000	
DOWJONES	0.018	0.005	**-0.061***	1.000
** and ** denotes statistical significance at the 1% and 5% respectively*				

4.2.2 Description of Market Indices and Returns

Figure 1 shows the plot of stock price indices and returns of US, UK, Malaysia and Japan respectively over the period of 8 years. On comparison, the movement of US and UK stock price indices shows similar trends and pattern and this is substantiated by the significant correlation discussed earlier (Table 2). Malaysian stock price indices and returns does have some comparing movements with the Japanese stock market and it has been statistically proven to be correlated too (Table 2). All market indices exhibits a consistent dip or downward trend after 2007 and this is supported by the global economic crisis.

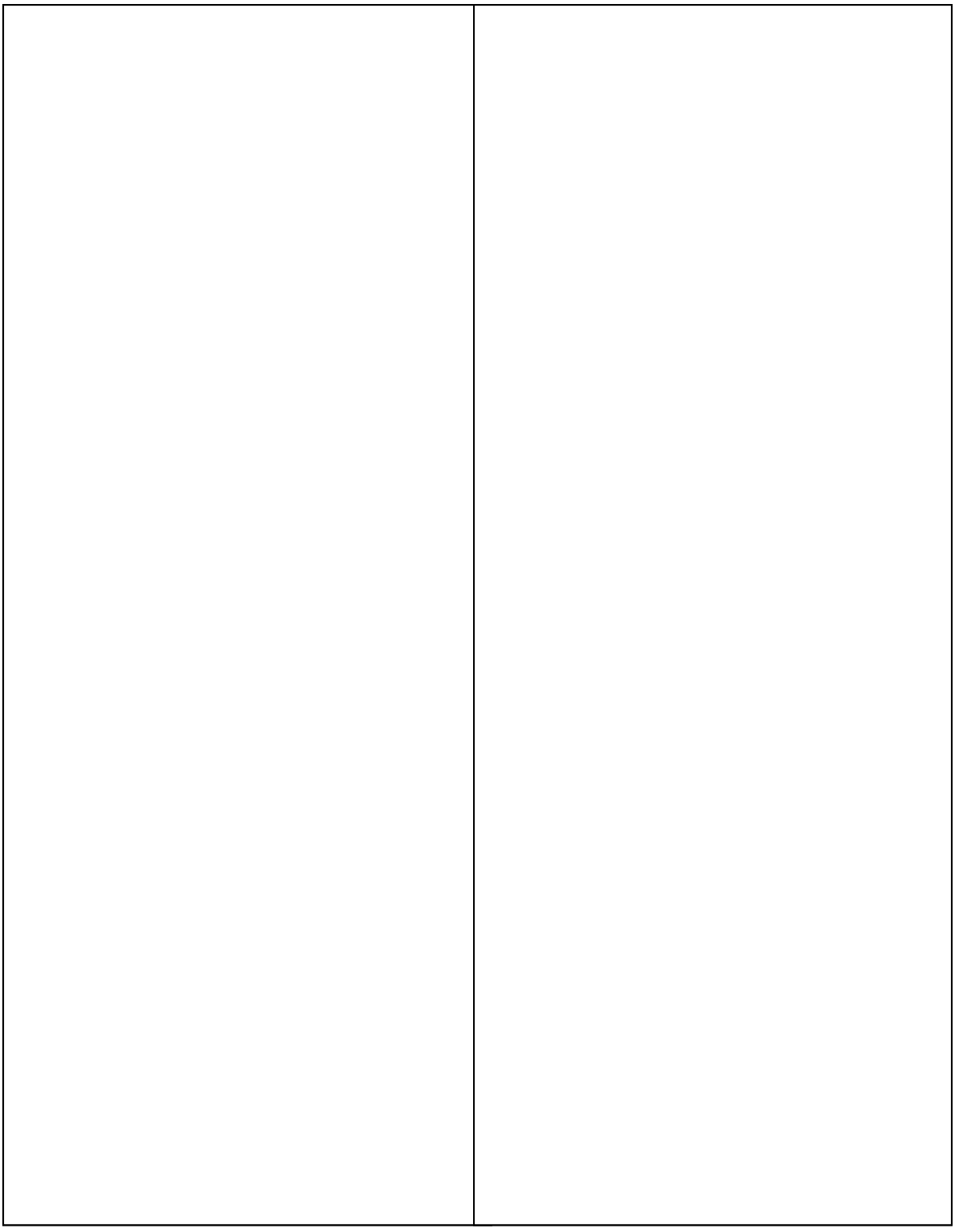

Figure 1. Plot of Stock Price Indices and Returns for US, UK, Japan & Malaysia from 2000 – 2008

4.2.3 Statistical Description of the Markets

Table 3 provides some statistical properties of daily market returns for the four stock markets. On comparing the mean for the logged stock market indices, Malaysia exhibits the lowest

positive mean returns of 0.004 as compared to negative mean recorded in other markets. Mean is a category of returns and Malaysia recorded a positive return during the analysis period compared to other more established markets. All markets have distributions with positive excess Kurtosis above 3 and are seen to have heavy tails. The implications that can be drawn from these values are the distribution of stock market indices in these countries tends to contain extreme values. This is supported by the negative skewness in all the markets thus implying the presence of variances in the stock market indices.

Table 3. Descriptive Statistics for Daily Market Returns in Local Currency Terms: 2000 – 2008

INDEX	NIKKEI (Japan)	KLCI (Malaysia)	FTSE100 (UK)	DOWJONES (US)
Mean	-0.041	**0.004**	-0.022	-0.013
Median	-0.01	0.03	0.02	0.04
Maximum	13.23	4.50	9.38	10.50
Minimum	-12.11	-9.98	-9.27	-8.20
Std. Dev.	**1.64**	0.99	1.32	1.29
Skewness	-0.34	**-0.87**	-0.14	-0.01
Kurtosis	9.77	**11.73**	9.93	11.63
Jarque-Bera	4346.69	**7437.03**	4509.42	6989.21
Observations	2252	2252	2252	2252

Japan exhibits the highest standard deviation of 1.64. Standard deviation is a measure of dispersion or spread in the series and is a measure of risk of a stock market. Standard deviation is used by investors as a gauge for the amount of expected volatility. The basic idea is that the standard deviation is a measure of volatility: the more a stock's return varies from the stock's average return, the more volatile the stock is said to be. Accordingly, the stock market is characterized by the trade-off between risk and return. As for Malaysia, the standard deviation exhibited is the lowest among the markets with 0.99. And going by the theory of investment, Malaysia can be summoned as a market with lowest risk and positive return (as opposed to high risk, high returns).

To further test whether the series is normally distributed, the Jarque-Bera was computed. The Jarque-Bera test statistic measures the difference of the skewness and kurtosis of the series with those from the normal distribution. According to the test, normality is rejected for all the returns series for all four markets. It can be said that the Malaysian stock market shows the most extreme values for the daily market returns compared to others. This indicates that volatility is comparatively much higher in the Malaysian market.

As a concluding remark, Malaysian stock market exhibits a positive return with low risk. It is also characterized by presence of variances in the stock market indices with a higher degree of volatility compared to other markets in the analyzed period of 2000-2008.

4.3 Data Analysis Techniques

Most studies on the co-movements between the stock market returns of different countries laid the emphasis on using GARCH, VAR or co-integration methods to test the

co-movements. Methodologically, this research is based on the papers of Laksmi and Gamini (2004), and Chin (2008), which developed in their works the model implemented in this study.

The estimation of volatility co-movements in the Malaysia, US, Japan and UK markets is based using a Univariate GARCH model with asymmetric extensions and Vector Autoregression (VAR).

4.3.1 The Univariate GARCH Model and Asymmetry Extensions

A common observation about the unexpected component of asset returns is that large shocks tend to be followed by larger shocks, and small shocks tend to be followed by more small changes, in either direction. In other words, the volatility of asset returns appears to be serially correlated. The econometric term describing this feature is the autoregressive conditional heteroscedasticity (ARCH), which states that the variance of time series is conditional on their past realizations. The standard ARCH model was introduced by Engle (1982) and generalized (GARCH) by Bollerslev (1986). In his model, Engle defines the conditional variance as a deterministic function of lagged squared residuals. In the ARCH (q) model the conditional variance is given by:

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-1}^2 \qquad (1)$$

where ω and α_i are non-negative constants (in order for σ_t^2 to be non-negative). The ARCH model given by equation (1) above and is formulated to depict volatility as the clustering of large shocks to the dependent variable.

Bollerslev extended Engle's specification by introducing lagged conditional variances in the conditional variance equation. This representation allows the number of parameters in the model to be considerably reduced and allows past conditional variances to enter equation (1). The intention of GARCH is that it can represent a higher order ARCH process. The GARCH model is commonly used in its most simple form, the GARCH(p,q) model, in which the conditional variance is given by :

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-1}^2 \ldots\ldots + \sum_{j=1}^{p} \beta_i \, \sigma_{t-1}^2 \qquad (2)$$

of which σ_t^2 is a function of lagged values of ε_t^2 and ω ,$\{\alpha_i\}$, $i=1...p$ and $\{\beta_i\}$, $j=1...q$ are non-negative constants.

Nelson's (1991) EGARCH specifications possess some advantages over the GARCH models. Firstly, EGARCH represents a more successful attempt to model excess conditional kurtosis in stock return indices based on a generalized exponential distribution. Secondly, the leverage effect can be captured and Nelson was the first investigator to model leverage effects by defining the down movements are more influential for predicting volatility than the upward movements. As noted in Hamilton (1994), evidence on asymmetry in stock price behavior has

been found by many researchers, such that the negative surprises seem to increase volatility more than positive surprises do. Since a lower stock price reduces the value of equity relative to corporate debt, a sharp decline in stock prices increases corporate leverage and could thus increase the risk of holding stocks. The general notion is that ε_t has a normal distribution. The exponential EGARCH model can be represented as follows:

$$log\sigma_t^2 = \omega + \sum_{i=1}^{p} \beta_i \, log\sigma_{t-i}^2 + \sum_{j=1}^{p} \alpha_j \frac{\left|\varepsilon_{t-j}^2\right|}{\sigma_{t-j}^2} + \sum_{j=1}^{p} \gamma_i \frac{\varepsilon_{t-j}}{\sigma_{t-j}} \qquad (3)$$

Equation (3) allows positive and negative values of ε_t to have different impacts on volatility. The EGARCH model is asymmetric because the level $|\varepsilon_{t-i}| / \sigma_{t-i}$ is included with coefficient γ_i. Since this coefficient is typically negative, positive returns shocks generate less volatility than negative return shocks assuming other factors remains unchanged.

The Threshold ARCH or TARCH was introduced independently by Zakoian (1990) and Glosten, Jaganathan and Runkle (1993). The specification for the conditional variance is given by:

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \, \sigma_{t-j}^2 + \gamma \, \varepsilon_{t-i}^2 d_{t-i} \qquad (4)$$

Where $d_t = 1$ if $\varepsilon_t < 0$, and 0 otherwise. In this model, good news $(\varepsilon_t > 0)$, and bad news $(\varepsilon_t < 0)$, have differential effects on the conditional variance: good news has an impact of α, while bad news has an impact of $(\alpha + \gamma)$. If $\gamma > 0$, the leverage effect exists. Inversely if $\gamma \neq 0$, the news impact is asymmetric. Hence it can be seen that markets are more volatile when there is bad or negative news.

4.3.2 Vector Autoregression (VAR) Model

The VAR model was developed by Sims (1980) with the purpose of estimating unrestricted reduced-form equations that have uniform sets of lagged dependent variables as regressors. VAR can capture the evolution and the interdependencies between multiple time series, generalizing the univariate AR models. All the variables in a VAR are treated symmetrically by including for each variable an equation explaining its evolution based on its own lags and the lags of all the other variables in the model. Based on this feature, Sims advocates the use of VAR models as a theory-free method to estimate economic relationships, thus being an alternative to the "incredible identification restrictions" in structural models. Since no

restrictions are imposed on the structural relationships between variables, the VAR system can be a flexible approximation to the reduced form of the correctly specified but unknown model of the actual economic structure. As structural models tend to be misspecified, VAR can be used for the purpose of stylizing empirical regularities among time series data. In this study, the VAR model is expressed as:

$$Z(t) = C + \sum_{s=1}^{\infty} A(s)\, Z(t-s) + \varepsilon(t) \tag{5}$$

where *Z(t)* is a 4 x 1 column vector of rates of return of four stock markets (Malaysia, US, UK, and Japan), *C* is the deterministic component comprised of a constant, *A(s)* are respectively , 4 x 1 and 4 x 5 matrices of coefficients, *m* is the lag length, and *e(t)* is the 4 x 1 innovation vector. By construction, *e(t)* is uncorrelated with all the past *Z(s)*.

The estimated VAR can be inverted to form the moving *average* representation of the system expressed as:

$$Z(t) = \sum_{s=0}^{\infty} B(s)\, \varepsilon(t-s) \tag{6}$$

where Z_t is a linear combination of current and past one-step-ahead forecast errors or innovations. The *i, j*th component of *B(s)* shows the response of the *i*th market in *s* periods after a unit random shock in the *j*th market. The *e(t)s* are serially uncorrelated by construction, although they may be contemporaneously correlated.

In order to capture 'pure' responses, it is important to transfer the error terms. A lower triangular matrix *V* is chosen to obtain the orthogonalized innovations *u* from *e=VU*. The *i,j*th component of *B(s)V* in equation (7) below represents the impulse response of the *i*th market in the *s* periods to a shock of one standard error in the *j*th market:

$$Z(t) = \sum_{s=0}^{\infty} B(s) - V\varepsilon(t-s) \tag{7}$$

The orthogonalization also provides $\Sigma C_{ij}^{2}(s)$ which is the component of forecast error variance in the *t+1* step ahead forecast of Z_i that is accounted for innovation in Z_j. This decomposition of the forecast error variance gives a measure of how important one variable is in generating fluctuations in its own and other variables. As impulse responses are highly non-linear functions of the estimated parameters, Monte Carlo integration techniques will be used to calculate the confidence bands (Soydemir, 2000).

5. Findings

5.1 Univariate GARCH Analysis and Asymmetric Extensions

Table 4 reports the parameter estimates from fitting an Autoregressive error specification or

AR (p) model for Japan, Malaysia, UK and US for the period 2000 to 2008.

The AR specification appears to indicate an autoregressive component. As reported in the table, Malaysia, US and UK has the first order component of AR (1) and is significant. Japan did not indicate significance at AR (1) and the fitting was repeated until a significant fitting was obtained. Evidently, Japan only showed a significant fitting with the seventh order component AR (7). The estimation of fitting for AR is important to be determined to proceed with the parameter estimates of fittings for GARCH (1, 1), EGRACH and TARCH.

Table 4. Parameter Estimates from Fitting AR (p) For Japan, Malaysia, UK & US from 2000-2008

Parameter estimates:	**NIKKEI (Japan)**	**KLCI (Malaysia)**	**FTSE100 (UK)**	**DOWJONES (US)**
AR (1)	-0.04	**0.17***	**-0.07***	**-0.08***
	(0.09)	**(0.00)**	**(0.00)**	**(0.00)**
AR (2)	-0.02			
	(0.24)			
AR (3)	-0.027			
	(0.38)			
AR (4)	-0.02			
	(0.30)			
AR (5)	-0.02			
	(0.30)			
AR (6)	-0.02			
	(0.24)			
AR (7)	**0.04***			
	(0.05)			
AIC	3.82	2.78	3.39	3.34
SIC	3.84	2.79	3.39	3.34
Log Likelihood	-4284.28	-3131.35	-3811.67	-3757.02

Numbers in the parentheses are p-values

** denotes statistical significance at the 1% level.*

Table 5 reports the results of fitting GARCH (1, 1), EGARCH and TARCH models for Japan, Malaysia, UK and US from 2000 – 2008. The empirical results will be able to provide details of reactions towards shocks and its corresponding volatility (values from EGARCH and TARCH), leverage effects and subsequently which fitting would best capture the volatility dynamics of the stock markets.

From Table 5, the coefficients of the α_1, β_1 and γ_1 are all significant for all markets. Based on minimum AIC/SIC values and Maximum Log Likelihood values, the EGARCH model best captures volatility dynamics of all the stock markets and the summary of selected parameter coefficients and its implications are shown in Table 6 below.

Table 5. Parameter Estimates of Fitting GARCH (1, 1), EGRACH and TARCH for US, UK, Japan & Malaysia From 2000-2008

MODEL	GARCH (1,1)	EGARCH	TARCH
NIKKEI (JAPAN)			
AR (1)	-0.01 (0.77)	-0.01 (0.75)	0.00 (0.88)
AR(2)	0.00 (0.90)	0.01 (0.57)	0.01(0.68)
AR(3)	0.00 (0.93)	0.01 (0.69)	0.01 (0.71)
AR(4)	-0.01 (0.57)	-0.01 (0.67)	-0.00 (0.84)
AR(5)	-0.02 (0.35)	-0.02 (0.41)	-0.01 (0.49)
AR(6)	-0.02 (0.42)	-0.01 (0.62)	-0.01 (0.64)
AR(7)	0.01 (0.51)	0.03 (0.20)	0.02 (0.31)
ω	0.03* (0.00)	-0.13* (0.00)	0.04* (0.00)
α_1	0.09* (0.00)	0.18* (0.00)	0.04* (0.00)
β_1	0.89* (0.00)	0.97* (0.00)	0.89* (0.00)
γ_1		-0.09* (0.00)	0.11* (0.00)
AIC / SIC	3.52 / 3.54	3.50 / 3.53	3.50 / 3.53
Log Likelihood	-3939.81	-3915.29	-3920.76
KLCI (MALAYSIA)			
AR (1)	0.19* (0.00)	0.19* (0.00)	0.20* (0.00)
ω	0.01* (0.00)	-0.18* (0.00)	0.02* (0.00)
α_1	0.13* (0.00)	0.22* (0.00)	0.08* (0.00)
β_1	0.86* (0.00)	0.97* (0.00)	0.86* (0.00)
γ_1		-0.08* (0.00)	0.17* (0.00)
AIC / SIC	2.52 / 2.53	2.49 / 2.50	2.51 / 2.52
Log Likelihood	-2829.20	-2797.29	-2816.15
FTSE (U.K.)			
AR (1)	-0.08* (0.00)	-0.03* (0.01)	-0.07* (0.00)
ω	0.01* (0.01)	-0.08* (0.01)	0.01* (0.00)
α_1	0.11* (0.00)	0.09* (0.00)	-0.01 (0.14)
β_1	0.88* (0.00)	0.98* (0.00)	0.92* (0.00)
γ_1		-0.13* (0.00)	0.17* (0.00)
AIC/SIC	2.86 / 2.87	2.82 / 2.83	2.82 / 2.83
Log Likelihood	-3216.23	-3167.61	-3171.50
DJIA (U.S.)			
AR (1)	-0.05* (0.02)	-0.06* (0.01)	-0.06* (0.02)
ω	0.01* (0.00)	-0.08* (0.00)	0.01* (0.00)
α_1	0.08* (0.00)	0.10* (0.00)	-0.01* (0.02)
β_1	0.91* (0.00)	0.98* (0.00)	0.93* (0.00)
γ_1		-0.12* (0.00)	0.14* (0.00)
AIC / SIC	2.86 / 2.87	2.82 / 2.83	2.82 / 2.83
Log Likelihood	-3214.32	-3164.89	-3169.50

Numbers in the parentheses are p-values.

** denotes statistical significance at the 1% level.*

Table 6 represents the summary of selected parameters estimates of fitting GARCH (1,1), EGRACH and TARCH for Japan, Malaysia, UK and US from 2000 – 2008 based on Table 5. On comparing the results and its implications for the Malaysian market, we can see that Malaysia exhibits comparatively higher α value than the other three markets in all three models. This implies that the effects of shocks in earlier periods tend to linger around for a longer period than it does in other stock markets. This may imply that the Malaysian stock market shows less market efficiency than the other markets as the effects of the shocks take a longer time to dissipate. The β_1 parameters capture long term influences on volatility. What is interesting to note that all five markets exhibit very similar β_1 values between the ranges of 0.97 to 0.98. This shows that long term effects have similar influences on market volatility in all the markets. Referring to EGARCH and TARCH models, Malaysia and UK's γ_1 value of (0.17) is comparatively higher than that exhibited by US (0.14) and Japan (0.11). This means that the leverage effect is higher in the Malaysian and UK stock markets as compared to other experienced markets. The impact of bad and good news and shocks has a much greater effect on Malaysia too. On the whole, it can be seen that the Malaysian market is vulnerable to external volatility movements in major markets. The standard representation of the persistence of a volatility shock is its half-life (Bollerslev *et al* 1994). It measure how many days it takes until half of the initial shock is absorbed in the variance and based on the estimated coefficients, half-life of a shock to variance is 69 days for all markets except for Japan which has a half-life of 34 days. EGARCH model is the best model to capture to volatility dynamics of all the markets based on the criteria of minimum AIG/SIG values and Maximum Log Likelihood.

Table 6. Summary of Selected Parameter Estimates of Fitting GARCH (1, 1), EGRACH and TARCH for Japan, Malaysia, UK & US from 2000-2008

Model Fittings	**Parameter Coefficients**	**Implication**	**NIKKEI (Japan)**	**KLCI (Malaysia)**	**FTSE (U.K)**	**DJIA (U.S)**
GARCH (1,1)	α_1	Effects of shocks in earlier periods	0.10	0.13	0.11	0.08
EGARCH	α_1		0.18	0.23	0.09	0.10
TARCH	α_1		0.04	0.08	-0.01	-0.01
GARCH (1,1)	β_1	Long term influences on volatility	0.89	0.87	0.88	0.91
EGARCH	β_1		0.97	0.97	0.98	0.98
TARCH	β_1		0.89	0.83	0.92	0.93
EGARCH	γ_1	Shock effects	-0.09	-0.08	-0.13	-0.12
TARCH	γ_1	Leverage effects	0.11	0.17	0.17	0.14
TARCH	α_1	Good news effects	0.04	0.08	-0.01	-0.01
TARCH	$\alpha_{1+}\gamma_1$	Bad news effects	0.15	0.25	0.16	0.13
TARCH	$\alpha_{1+}\beta_1$	Degree of volatility	0.93	0.94	0.91	0.92
EGARCH	$\frac{ln(0.5)}{ln(\alpha_1+\beta_1)}$	Half-life	34 days	69 days	69 days	69 days
Best Represen-tative Model	Based on min AIC/SIC & Max Log Likelihood	To capture the market movements	EGARCH	EGARCH	EGARCH	EGARCH

5.2 Results for Vector Autoregression (VAR) and Impulse Response Analyses

Before running the VAR test, a unit root tests was done to analyze time-series properties of the price series for each of the markets. In statistics, a unit root test tests whether a time series variable is non-stationary using an autoregressive model. The most famous test is the augmented Dickey–Fuller test and the Phillips–Perron test. Both these tests use the existence of a unit root as the null hypothesis. The results from the Augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) tests reveal that all the series are stationary in the form of first differences.

Table 7 shows the parameter estimates obtained from fitting a VAR model. The VAR results indicate that there is a unidirectional causality from US towards Malaysia and UK in lag 3 and 1 respectively. Similarly UK has a unidirectional causality towards US in lag 1 and 3 and Japan in lag 3. Lastly, Japan appears to cause the US stock market in the first lag.

Table 7. Vector Autoregression Estimate for Japan, Malaysia, UK & US from 2000 – 2008

	NIKKEI (Japan)	**KLCI (Malaysia)**	**FTSE (U.K)**	**DJIA (U.S)**
JAPAN(-1)	-0.03 (0.171)	0.05* (0.00)	0.01(0.73)	0.03** (0.04)
JAPAN(-2)	-0.03 (0.15)	0.02 (0.2)	-0.02 (0.21)	-0.02 (0.16)
JAPAN(-3)	-0.03 (0.14)	0.01 (0.35)	0.01 (0.7)	-0.01 (0.4)
M'SIA (-1)	-0.06 (0.11)	0.16*(0.00)	0.01(0.7)	0.00 (0.9)
M'SIA (-2)	0.08** (0.03)	-0.02 (0.32)	0.03 (0.4)	0.07* (0.00)
M'SIA (-3)	0.03 (0.41)	0.03 (0.2)	0.09 (0.8)	0.02 (0.6)
UK(-1)	0.02 (0.6)	-0.01 (0.5)	-0.08* (0.00)	0.04* (0.00)
UK(-2)	0.01 (0.6)	0.01 (0.6)	-0.08* (0.00)	-0.01 (0.6)
UK(-3)	0.04*** (0.09)	0.00 (0.8)	-0.10* (0.00)	0.06* (0.00)
US(-1)	0.01 (0.65)	0.01 (0.66)	0.09* (0.00)	-0.08* (0.00)
US(-2)	0.00 (0.95)	0.00 (0.80)	0.01 (0.73)	-0.10* (0.00)
US(-3)	0.00 (0.94)	0.04* (0.00)	0.02 (0.25)	0.07* (0.00)
C	-0.04 (0.24)	0.00 (0.73)	-0.02 (0.37)	-0.01 (0.69)
, ** and * denotes statistical significance at the 1%, 5% and 10% respectively*				

The analysis proceeded to obtain the variance decompositions between the markets. The decomposition of variance of the forecast errors of the returns of a given market indicates the relative importance of the various markets in causing the fluctuations in returns of that market. Briefly, the forecast error variance decomposition explains the proposition of the movements in a sequence due to its own shocks versus shocks to the other markets. Two points are worth mentioning: firstly, the variables are ordered in accordance with the sequence of closing times of the four markets. Second, the forecast error variance decomposition is estimated under the assumption that the contemporaneous effects of innovations in a certain market which is passed on to the other markets will occur only in the markets that close later on the same day, not the other way around. A leading market is one which explains a large percentage of the error variance of other markets while its own forecast error is not explained by innovations in other markets (Friedman and Shachmurove, 2005)

Table 8. Variance Decompositions for US, UK, Japan & Malaysia From 2000-2008

		Innovation in market of:			
Variance Decomposition in markets of:	**Horizon (days)**	**DJIA (U.S)**	**NIKKEI (Japan)**	**KLCI (Malaysia)**	**FTSE (U.K)**
U.S	5	**99.36**	0.31	0.34	0.77
	10	**99.35**	0.31	0.34	0.78
	15	**99.35**	0.31	0.34	0.78
JAPAN	5	0.01	**98.77**	0.39	0.12
	10	0.02	**98.76**	0.39	0.13
	15	0.02	**98.76**	0.39	0.13
MALAYSIA	5	0.34	2.75	**96.72**	0.04
	10	0.34	2.76	**96.72**	0.04
	15	0.34	2.76	**96.72**	0.04
U.K	5	0.70	0.30	0.23	**98.67**
	10	0.70	0.30	0.24	**98.67**
	15	0.70	0.30	0.24	**98.67**

Table 8 presents the decompositions of the forecast error variance for 5-day, 10-day and 15-day horizons. We begin by considering the effect of a shock that originates in the US and then moves to Japan, Malaysia and UK. The markets have been ordered according to closing times. Entries show the percentage forecast error variance of the market in the first column explained by the market in the first row.

As shown in Table 8, results indicate that all the stock markets are exogenous since the percentage of these stock market innovations explained by their own innovations equals about 95% to 99%. Almost all the markets accounts for less than 3% of the forecast error variance of the other markets. In the case of Malaysia, all stock market seem to have minimal effect of less than 1% of its forecast error variances except for Japan. Japan tops the list and accounts for approximately 2.75% of impact on Malaysia's forecast error variances followed by US and UK with error variances of 0.34% and 0.04% respectively. With such a minimal effect on Malaysian market's forecast error variance explained by the other markets in the system, this signifies that the Malaysian market is the least exogenous market among these markets and is not open and vulnerable to shocks occurring in leading stock markets. Comparatively, other markets do not seem to exert any considerable influence on Malaysia.

Two observations are notable from the variance decompositions of the stock markets index in Table 8. First, as all markets exhibit an exogenous market trends and no market is said to influence a sizable fraction of the daily forecast error variance of another market. Second, though all the countries in the analysis have implemented significant changes in their domestic policies: the opening of different sectors of the economy to foreign investors, a wider and broader range of financial and institutional reforms, and the privatization of state-owned enterprises but the analysis proves foreign participation has been negligible. Firmly, the variance decomposition analysis shows that the degree of co-movement in stock price indices among the four countries is minimal.

Continuing on from the analysis on variance decomposition, the pattern of dynamic impulse response of Malaysia to shocks in US, Japan and UK were investigated. The primary aim of obtaining this result is to have an insight on the efficiency of Malaysian market due to the information contained in such shocks. The impulse response coefficients are normalized such that the unit is the standard deviation of the orthogonalized innovation. The initial shock in a variable is set equal to one standard error of innovation at s = 0 (Laksmi and Gamini, 2004). The normalized coefficients will represent simulated impulse responses of one selected market to other markets to a positive, one-standard deviation shock. The market in response here is set to Malaysia.

Figure 2 shows the impulse response of Malaysia to the other stock markets. It should be noted that the response becomes statistically insignificant when the lower band crosses the horizontal axis. If the bands are far from the zero line, then the responses are said to be significant. The first panel shows the response to a shock in the Japanese market. Significant peak response occurs from the first day to the end of the second day of the shock. The impact of the shock takes a longer period of almost five days to subside though not significant from day 3 onward. Continuing on, the second panel represents Malaysia's response to a shock from the UK market. Although not significant peak response occurs with a one day lag and reaches its peak on the third day and subsides from the fourth day onwards. The third panel shows the response of the Malaysia stock market to a shock in the US market. Malaysia's peak response occurs on day three (i.e. day four in the plot). There is a one day lag due to the time difference as US is one day behind. By day four, the impact of the shock fades. The fourth and final panel shows Malaysia's stock market response to its own domestic shocks panel and seen to have one day lag. From all four panels, it's notable that the magnitude of Malaysia's response to shock from Japan is the highest approximately 0.13. Shocks from US and UK did not make a sustained impact as the magnitude is between 0.01 and 0.03 only; hence, we can say that Malaysia is most sensitive to shocks from Japanese market but less sensitive to other markets.

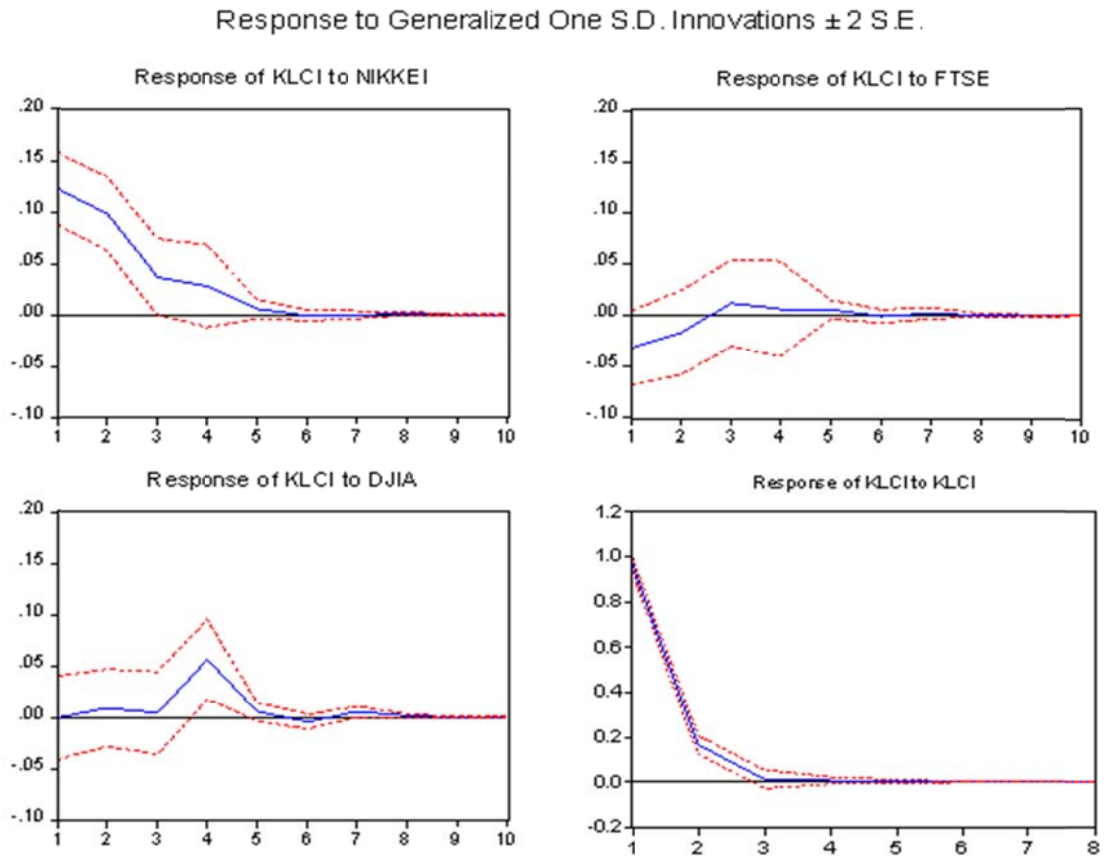

Figure 2. Response of Malaysia to Shocks in US, UK & Japan From 2000 – 2008

6. Conclusion

On a statistical note, Malaysia exhibited is the lowest standard deviation of 0.99 together with a positive mean returns of 0.004 and can be summoned as a market with lowest risk and positive return (as opposed to high risk, high returns). The analysis of Univariate GARCH have exposed Malaysia to be susceptible to shocks and having a higher leverage effect as compared to other markets in the analysis. The analysis further proved the Malaysian market to be less vulnerable to external volatility movements in major markets but is subjected to a low degree of vulnerability from US and Japan only. The analysis of VAR and Impulse Response exhibited the minimal effect of forecast error variances from all markets towards Malaysia. Japan tops the list and accounts for approximately 2.75% of forecast error variances followed by US with 0.34%. Malaysia has hardly any impact on the US and UK markets as its effects accounts for hardly 0.4%. The variance decomposition results showed that the magnitude of Malaysia's response to shock from

Japan is the highest with approximately four days. Shocks from US and UK did not make a sustained impact. Hence we can say that Malaysia is most sensitive to shocks from Japanese market but less sensitive to other markets.

As a concluding remark, the observation that the co-movements between the Malaysian market and other markets in the analysis is minimal is not in line with the findings in the

existing literature. Contrary to the findings in the literature, it has been observed that Asian markets are vulnerable to movements with the US market. Additionally, Malaysian returns does not much affect others is also quite contrary to the findings in the literature.

The analysis of volatility co-movement between Malaysia and US, UK and Japan have yielded some encouraging outcomes to be considered by market analyst and investors. From the analysis, Malaysia is the only market in the analysis with a positive returns (positive mean) and low risk (lowest standard deviation). The analysis also proved that the Malaysian market is less vulnerable to external market movements though it is receptive Japan and US. These characteristics could well be manipulated by investors in their effort to diversify their investments as Malaysia portrays a safe haven for investment diversifications.

The findings also highlights that there are no asymmetric effects and the volatility transmission from other countries have only a minimal effect on Malaysia. But local good news and bad news has an influence on the volatility of the Malaysian market and the effects of shocks are persistent too. As these shocks take a longer period to dissipate, the Malaysian stock market can be characterized as less efficient from the theory of Markowitz. As such, an investor could increase their return at any given level of risk or could reduce their risk of investment with any given level of return.

With regard to the policy implications of our this study, the findings suggest that the nature of Malaysian market co-movement with other markets in the study is neither fully integrated nor completely segmented and does not yet warrant any immediate concern regarding possible contagion in the region. The degree of co-movements also indicates that there is still much scope for reaping risk minimization and return maximization benefits of portfolio diversification, at least in the short term by investing in Malaysia, as integration of the Malaysian market is not of a very high order. This leaves sufficient room for switching between mature markets such as that of US, UK or Japan.

We need to take into consideration both the local, regional and global events and should not take indiscriminate cue from other world markets to encapsulate the movements of Malaysian stock market. The importance of regional economic and political events need to emphasized as seen in the recent world financial turmoil which did not make an impressive impact on Malaysia. Perhaps, the KLCI (Malaysian stock index) has “matured” and now has its own identity and is now dependent on other domestic variables which need further studies. After all, it is often stated that the stock market is also a barometer of the economic well being of a country.

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