Dynamic Integration of Domestic Equity Price, Foreign Equity Price and Macroeconomic Indicators: Evidence from Malaysia

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Abstract

How does the extent of integration of the Malaysian equity market with the equity markets of Japan and USA vary at different time scales? How dynamic is the extent of co-movement of equity price with the major macroeconomic indicators of Malaysia? In order to answer these two major issues, this study attempts to investigate the dynamic integration of the Malaysian equity market with the equity markets of Japan and USA, along with the three major macroeconomic control variables: exchange rate, consumer's price index (CPI) and industrial production (IP) of Malaysia. The methodology applied initially used the standard time series techniques such as, Johansen cointegration technique, vector error correction model (VECM), variance decompositions (VDCs), followed by the application of the recent dynamic rolling cointegration, Beveridge-Nelson (BN) time series decompositions and finally, wavelet coherence of time-scale decompositions on monthly data starting from February,1990. The study finds one significant cointegrating relationship, which could be an indication of incomplete integration process as evidenced in the dynamic rolling cointegration approach. VECM and VDC indicate that the Malaysian equity market appears to be more influenced by the Japanese equity market and CPI of Malaysia. BN decompositions evidence almost simultaneous co-movement of permanent and transitory components of all variables and the co-movement appears to be closer during the financial crises. Finally, the wavelet coherence suggests closer co-movement of the Malaysian equity market with the Japanese equity market, which tends to vary according to different time scales. The findings of wavelet coherence on co-movement of the equity prices at different time scales tend to be different from those of the standard time series techniques such as, VECM and VDCs. The results of the study have strong policy implications.

Key Words: Domestic stock price, foreign stock price, exchange rate, consumer's price index, industrial production, dynamic cointegration, Beveridge-Nelson time series decompositions, wavelet coherence

JEL Classification: E44, E52, E58, F31, F36, G15

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1. Introduction

Stock market, claimed to be the heart of a financial system, is interlinked with an array of factors, both domestic and international. Domestic factors mainly include major macroeconomic indicators, such as exchange rate, industrial production index, interest rate, gross domestic product, money supply, inflation, investors' attitude and confidence etc. On the contrary, major international factors may include business cycle in the global market, oil price, international political issues, major wars, financial contagion etc. Empirical studies found that the growth of equity market is found to be correlated with the growth of the real sector and macroeconomic development. Studies also supported the view of cross border equity market integration for fostering economic growth. The dynamic interactions between equity prices and macroeconomic variables have been one of the major interest areas among the academicians, researchers, and policymakers over a long period of time. The significance of the stock price determination is associated with the future direction of the economy, especially, in the case of capital market based economy. Policy makers usually consider the consequences of changes in macroeconomic indicators on stock price and over all equity market growth while formulating and implementing monetary and fiscal policy measures. Similarly, policy makers and practitioners are usually interested in the co-movement of the domestic equity market with major international equity markets in order to enhance competitiveness of the domestic market and for efficient allocation of investment in financial instruments across the markets. This co-movement between equity markets and macroeconomic indicators could be of two types, static and dynamic. Static co-movement measures an average relationship among the variables over the estimation period. On the contrary, dynamic co-movement measures degree of integration according to changes in time. Measurement of dynamic integration claims to be more realistic and meaningful due to time to time adjustment of macro fundamentals, financial contagion, and changes in multilateral trade and investment relationship among countries. This measurement is usually important to answer the vital questions: which macro variable is more important in explaining the variation in domestic stock price? And which foreign markets appear to be more dominant to influence the stock price in domestic market? Obviously, the answers to these two questions, generally, vary from one economy to another economy.

There are different theoretical models to investigate the dynamic relationship between equity markets and macroeconomic indicators. Several studies have attempted to capture the effect of economic forces on stock returns in different countries. Major theoretical models explaining this dynamic relationship includes arbitrage pricing theory (APT), International arbitrage pricing theory (IAPT), and dividend discount model (DDM). Chen at al. (1986) applied APT developed by Ross (1976) on some macroeconomic variables to explain stock returns in the US markets. Findings of the study revealed that industrial production, changes in risk premium, and changes in the term structure are positively related with the expected stock returns, while both anticipated and unanticipated inflation rates were negatively related to the expected stock returns (Gan et al., 2006). Portfolio investors and arbitragers usually invest in foreign stock markets in order to maximize their returns. Given this investment behavior, classical APT has been revised to International APT to incorporate possible integration of foreign stock markets. Since then, exchange rate channel of monetary policy transmission has been investigated by several studies. Applying IAPT, Bracker et al. (1999) found that macroeconomic variables were significantly influenced by the extent of international stock market integration. The interdependence in stock prices across countries reveals economic integration in the form of foreign direct investment and trade linkages (Rahman et al. 2009). Dividend discount model (DDM) states that current price of a stock is equivalent to the discounted value of expected cash flows, which in turn depends on firm's growth. Firm's growth depends on the status of domestic macroeconomic indicators and condition of country's trading partners. Hence, co-movement of macroeconomic indicators and foreign equity markets tend to exert influence on domestic equity price (Rahman et al. 2009).

A number of studies have been conducted to find out the long run relationship between stock price and major macroeconomic variables in Malaysia. Most of these studies have considered stock price, exchange rate, interest rates, and money supply of Malaysia and used Johansen cointegration approach and vector error correction model. Using almost identical methods, some other studies attempted to explore the relationship between Malaysian stock price and US stock price using Dow Jones Index. Possibly, this study would be the first study to investigate the status of dynamic integration of the Malaysian equity market with the major foreign equity markets and major macroeconomic indicators of Malaysia. This study used initially the standard time series methods such as, Johansen cointegration technique, vector error correction model (VECM), variance decompositions (VDCs), followed by the recent dynamic rolling cointegration, Beveridge-Nelson (BN) time series decompositions and finally, wavelet coherence of time-scale decompositions.

Given the inculcated theories and concept of integration and the benefits of applying the modern approaches, the main objective of this study is to investigate the dynamic integration of stock price and major macroeconomic indicators in Malaysia. In addition, this study attempts to examine how and to what extent the Malaysian equity market is integrated with the major foreign equity markets such as Japanese and US equity markets. The objective of the study claims to be significant since the Malaysian economy has been growing fairly enough in the last two decades amid the 1997 Asian financial crisis and 2008 global financial crisis. Moreover, the Malaysian equity market has been proliferating rapidly concomitant with other leading equity markets in the Asian continent. Given this trend of growth and flourishment, it would be valuable to study how the Malaysian equity market is responsive and concomitant with changes in major macroeconomic indicators and foreign equity markets. The outcome of this study would be valuable for the policymakers to set their future strategies on stock market in Malaysia. In addition, market players and potential investors may use the outcome of this study for their investment decisions.

The findings from the results of different approaches regarding the extent of integration are not uniform. Results of the study reveal that there exists one cointegrating relationship, which could be an indication of weak and incomplete process of integration as evidenced in the results of dynamic rolling cointegration. VECM indicates that the Malaysian equity price appears to be dependent on innovations in Japanese and US equity prices and changes in exchange rate and inflation of Malaysia. VDC Finds that the Japanese equity price and Malaysian inflation rate appear to be leading equity market and macroeconomic indicator to influence Malaysian equity rice. BN decomposition results address almost simultaneous co-movement of permanent and transitory components of the concerned time series of equity prices and macroeconomic indicators and the co-movement appears to be disturbed during the financial crises. Wavelet coherence of time-scale decomposition suggests closer co-movement of the Malaysian equity price with the Japanese equity price, which tends to vary according to different time scales. Also findings suggest that the Malaysian equity price is highly responsive to the changes in exchange rate in time scales. The equity price is also found to be responsive to the changes in inflation rate and industrial production. The findings of wavelet coherence tend to be different from those of the standard time series techniques such as, VECM and VDCs.

The remaining part of the study is organized as follows: section two discusses theoretical underpinnings; section three summarizes review of the recent literatures; data description and methodology are presented in section four; section five reports results and empirical analysis, and finally, the study wraps up with concluding remarks in section six.

2. Theoretical Underpinnings

This study is an attempt to explore the dynamic convergence of equity markets and major macroeconomic variables of Malaysia. The main focus is on how these macro variables (MYR/US$ exchange rate, Industrial Production Index and Consumer Price Index) and major equity markets (Japan and the United States) are moving in the long term and thereby exert influence on Malaysian equity market. Explanatory power of macroeconomic variables is well established through a number of studies to explain short run and long run behavior of equity price. Equity price in an economy could be impacted by many factors, both domestic and global. Among the international factors, unusual price swings and major policy changes in leading equity markets, generally, may affect price movement in both neighboring and distant equity markets. This market contagion issues would be more dominant during the economic turbulence period in particular. Illustration may concern about recent 2010 Eurozone crisis, 2008 global financial crisis, and 1997 Asian financial crisis. It is to be noted that, in most of the cases, these crises enveloped either a particular region or a large group of economies in the continent. Clear understanding of the theoretical framework of equity price and other macroeconomic indicators is significant to explain the co-movement of equity prices and macroeconomic variables.

2.1 Stock Price and Exchange rate

Generally, two approaches lead to explain the theoretical nexus between equity and foreign exchange markets. One is traditional approach and the other is portfolio balance approach. Traditional or classical approach states that movements in exchange rates lead stock prices to change. As an illustration, “flow oriented” models of exchange rate determination (Dornbusch and Fisher, 1980) addresses that currency movements tend to affect international competitiveness and balance of trade position, and consequently the real output in the economy, which in turn affects current and future cash flows of companies and their stock prices. On the other hand, portfolio balance approach states that exchange rates are determined by market mechanism, i.e. changes in stock prices might have impact on exchange rate movements. This latter approach states that stock price is expected to have negative relation with exchange rates. A decrease in stock prices reduces domestic wealth which leads to lower domestic money demand and interest rates. Also foreign investors trim their investment in domestic assets and currencies due to lower rate. That means domestic assets and currencies are in low demand to both domestic and foreign investors. These shifts in demand and supply of currencies cause capital outflows and the depreciation of domestic currency, or increase in exchange rate. On the other hand, when stock prices rise, foreign investors become willing to invest in a country's equity securities. Thus, they will get benefit from international diversification. This situation will lead to capital inflows and a currency appreciation (Granger et al., 2000, Caporale et al., 2002, Stavárek, 2005 and Pan et al., 2007). In spite of the perceived causal relations between stock prices and exchange rates according to theory, existing evidence on a micro level provides mixed results. Jorion (1990, 1991), Bodnar and Gentry (1993), and Bartov and Bodnar (1994) all failed to find a significant relation between simultaneous dollar movements and stock returns for U.S. firms.

Hau and Rey (2006) argued that exposure to exchange rate risk implies that the international investors generally concern about both the volatility of the exchange rate and the correlation structure of exchange rates and foreign equity returns. For example, higher exchange rate volatility tends to induce a home equity bias. On the other hand, a negative correlation between foreign exchange rate returns and foreign stock market returns reduces the return volatility in home currency terms and makes foreign investment more attractive. Portfolio choice therefore depends on exchange rate dynamics. But dynamic portfolio choice should simultaneously affect the exchange rate. He and Ng (1998) found that only about 25 percent of their sample of 171 Japanese multinationals has significant exchange rate exposure on stock returns. Griffin and Stulz (2001) concluded that weekly exchange rate shocks have a negligible impact on the value of industry indexes across the world.

2.2 Stock Price, Consumer Price Index (CPI) and Inflation

Consumer price index is a measure of the weighted average of prices of a basket of consumer goods and services, such as transportation, food and medical care. It is calculated by taking price changes for each item in the predetermined basket of goods and averaging them. The goods are weighted according to their importance. Changes in CPI are used to assess price changes associated with the cost of living, which is called inflation. Therefore, CPI and inflation tends to influence stock price in a similar fashion. Theoretically, there are two ways to explain the impact of inflation on stock prices.

In most of the cases, inflation tends to be negatively associated with stock price as evidenced by the studies by Fama and Schwert (1977), Chen, Roll and Ross (1986), Nelson (1976) and Jaffe and Mandelker (1976). They argued that an increase in the rate of inflation is likely to lead to economic tightening policies, which in turn increases the nominal risk-free rate and hence raises the discount rate in the valuation model. The effect of a higher discount rate would not necessarily be neutralized by an increase in cash flows resulting from inflation, primarily because cash flows do not generally grow at the same rate as inflation. DeFina (1991) attributes this to nominal contracts that disallow the immediate adjustment of the firm's revenues and costs. Cash flows would probably decrease initially if the cost of inputs adjusts faster to rising inflation than output prices.

In some cases, inflation may relate positively with stock price as it is argued that inflation increases the returns to shareholders since price of products rise faster than wage rates. According to Jhingan (1997), when there is inflation, most prices are rising, though some price rise faster than others. Asogu (1991) states that inflation rate is expected to vary ceteris paribus, positively in relation to changes in prices.

2.3 Stock Price and Industrial Production

Industrial Production Index (IPI) generally measures the volume of output from the manufacturing, and public utilities, which include generation of electricity, gas and water. IPI usually excludes construction sector. The precise measure and coverage may vary from country to country. Therefore, it indicates overall productive capacity of an economy, which in turn contributes to the future cash flow generating capacity of the firms in an economy as addressed by Fama (1990) and Geske and Roll (1983) who are the proponents of positive relationship between industrial production and expected cash flows of the firms. Procyclicality nature of industrial production was addressed by Tainer (1993), by which he argued that economic expansion leads to growth of industrial production and reverse happens during recession. Therefore, economic growth leads to the growth of industrial production, which in turn increases expected cash flows of the firms. Higher stock price is usually concomitant with higher productivity and cash flows of the firms. Based on a US stock portfolio, Chen, Roll and Ross (1986), argued that future growth in industrial production was a significant factor in explaining stock returns. Hence, suggesting a positive relationship between real economic activities and stock prices.

2.4 Domestic and Foreign Stock Price

Shock in one stock market is spilled over to another stock market when markets are integrated. In most of the cases, movement in major stock markets tend to influence the movement in smaller markets in the same direction when smaller markets are integrated with the major markets. A number of empirical studies by Hung and Cheung (1995), Arshanapalli et al. (1995), Masih and Masih (1999), Daly (2003), Ibrahim (2005) have addressed the issue of international stock market integration. Stock market integration suggests that separate stock markets move together and have high correlations, so there are fewer benefits from portfolio diversification across countries.

This study, taking the above theoretical relationships into account, intends to explore the dynamic integration process of equity markets of Malaysia, Japan and United States along with three major macroeconomic indicators of Malaysia.

3. Recent studies on convergence of stock markets and macroeconomic indicators

Up until now, several studies have been conducted to investigate the integration of stock markets around the world, which can be distinguished in to two broad groups. One group merely focuses on how equity markets are integrated in different groups and regions and how the convergence process change over time in accordance with various domestic and international factors, such as financial crises, market liberalization, oil price shock etc. On the contrary, the other group of studies tends to examine how stock prices are integrated with major macroeconomic indicators in and across the border. Notwithstanding this fact, interestingly, our study is a combination of the above two types, in which we attempt to investigate the dynamic integration of Malaysian stock market with two other major stock markets of Japan and United States and with three major macroeconomic indicators (exchange rate, industrial production and consumer price index) of Malaysia. In order to get a more detailed picture of dynamics of integration, unlike other studies, this study applied Johansen cointegration, dynamic cointegration, Beveridge-Nelson time series decomposition and wavelet coherence.

Nikolaos and Christos (2010) investigated the time varying long-run relationship among four major European stock market indices in the post euro era. The study employed dynamic coingration technique on daily equity index prices of the largest and most developed financial markets: Germany, France, Spain, and Italy from January 4, 1999 to July 23, 2009. Empirical results of the study suggest that although some convergence has been taking place over time, but it has not yet been fully achieved. The results also showed that among the four European stock markets, the German and France markets seem to have experienced higher convergence as evidenced by the faster speed of adjustment to equilibrium coefficients.

As for the linkage between financial integration and financial stability, Umutlu et al (2010) asserted that financial integration would benefit the region through more efficient allocation of capital, a higher degree of risk diversification, a lower probability of asymmetric shocks and a more robust market framework. In contrast to this assertion, Beine et al (2010) argued that intensified financial linkages in a world of high capital mobility may also harbor the risk of cross-border financial contagion, in particular when the region's economies become more inter- dependent.

I.-W. Yu et al. (2010) investigated the extent of equity market integration in Asian region as the economies in Asia recently experienced economic integration both in regional and global markets. This study covered ten economies in the Asian region: Japan, Malaysia, Mainland China, Hong Kong SAR, Taiwan, South Korea, Singapore, Thailand, Indonesia, and Philippines. This study employed six different measures: Cross-market return dispersion, Handane and Hall Kalman filter method, Dynamic (rolling) cointegration analysis, Common component approach, Market cycle synchronization and Dynamic conditional correlation (DCC) model on data from 16 March 1994 to 19 December 2008 are used in estimation. The findings of the study indicated that equity market integration in this region dropped in 2002 and 2006 and again geared up during 2007 – 08 periods. Nevertheless, the process of integration is not complete and the degree of integration between mature and emerging equity markets is different. On the issue of relative importance of regional vs. global factors, interestingly, the study found that the regional factor is more dominant for the Asian equity markets than the global factor.

Michel, Antonio & Robert (2010) measured stock market co-exceedances using the methodology of Cappiello, Gerard and Manganelli (2005), which is suitable for measuring co-movement at each point of the return distribution. First, the study constructed annual co-exceedance probabilities for both lower and upper tail return quintiles using daily data from 1974–2006. Next, these probabilities are explained in a panel gravity model framework. Results showed that macroeconomic variables asymmetrically impact stock market co-movement across the return distribution. Financial liberalization significantly increases left tail co-movement, whereas trade integration significantly increases co-movement across all quintiles.

Pascual, A. G. (2003) investigated comovements in the UK, French and German stock markets using recursive cointegration technique and suggested a recursive speed of adjustment technique as an alternative measure of dynamic stock market integration. Large values of the speed of adjustment coefficients indicate a greater response of the short term dynamics to the previous period's deviation from the long run equilibrium.

Bekaert and Harvey (1995) proposed a conditional regime switching model to measure capital market integration. This model allowed to describe expected returns in countries that are segmented from the world market in one part of the sample and integrated in the subsequent part. The study found empirical evidence of time varying integration in a number of emerging countries.

A few studies applied wavelet approaches to investigate the co-movement of stock markets across different regions. Madaleno and Pinho (2012) applied Coherence Morlet Wavelet technique in order to explore stock market linkages considering financial crisis episodes. The study used daily price of stock indices, namely the FTSE 100 of UK, the Bovespa of Brazil, the Nikkei 225 of Japan and DJ Industrial average 30 (DJIA30) of USA from 1 October 1997 to 6 March 2009, measured in domestic currencies. Results of the study indicate that the relation among indices was strong but no homogeneous across scales, that local phenomenon's are more felt than others in these markets and that there seems to be no quick transmission through markets around the world but with significant time delay. The study also found that the relation among these indices has changed and evolved through time, mostly due to financial crisis that occurred at different time periods. Results of the study also favor the view that geographically and economically closer markets exhibit higher correlation and shorter run co-movements among them.

Rua and Nunes (2009) also tested the stylized fact that co-movement has changed over time using monthly data from Germany, Japan, UK and US. The analysis is done both at the aggregate and sector levels. The degree of co-movement of Germany with the US and UK markets are characterized by some permanent changes over time: a gradual but steady increase of co-movement at lower frequencies and also a sudden increase after the end of the nineties for other frequencies.

Sharkasi et al. (2005), employing wavelet technique, investigated the price interdependence between seven international stock markets. The study found evidence of intra-European market co-movement with the US market, while US markets impact Asian markets, which in turn influence European markets. The study also found an increase in the importance of international spillover effects since the mid 1990s, having this importance decreased since the beginning of this century.

Lee (2004) studied international transmission effects between US, Germany and Japan and two emerging markets in the Middle East and North Africa (MENA) region, namely Egypt and Turkey. The study reported that movements from the developed markets affected the developing markets but not vice versa.

A good number of studies indicate that macroeconomic and financial variables are interrelated. In an international setup, Martin K. H. (2004) examined the transmission mechanisms of macroeconomic shocks on the stock market of a small open economy in an increasingly integrated world using a time-varying vector error correction model (VECM) that allows analysis of asymmetric impacts that depend on the state of the business cycle. Giving a special focus on monetary policy surprises, the study found that foreign shocks exert a strong influence on an integrated stock market and the stage of the business cycle heavily affects the signals of the shocks.

Beine and Candelon (2011), employing time varying cross-country correlation and panel techniques, examined the impact of trade and financial liberalization on the degree of stock market co-movement among emerging economies. Using a sample of 25 developing countries observed over 15 years, result analysis of the study found strong evidence of a positive impact of trade and financial liberalization reforms on the degree of cross-country stock market linkages.

Walid et al (2011) applied Markov Switching technique in EGARCH framework (MS-EGARCH) to investigate the dynamic linkages between equity price volatility and exchange rate changes for four emerging economies during 1994 and 2009. The analysis results identified two different regimes in both the conditional mean and the conditional variance of stock returns. The first one indicated high mean-low variance and the second one advocated for low mean-high variance regimes. The study further argued strongly that the relationship between stock price and foreign exchange markets is regime dependent and stock-price volatility responds asymmetrically to events in the foreign exchange market.

Applying cointegration and three types of Granger causality tests, Alagidede et al (2011) examined the nature of the causal linkage between stock markets and foreign exchange markets in Australia, Canada, Japan, Switzerland, and UK from January 1992 to December 2005. The analysis results of the study found no evidence of cointegration and causality from exchange rates to stock prices is found for Canada, Switzerland, and UK. The study, further, applied the Hiemstra-Lones test to investigate the possibility of non-linear causality between stock markets and foreign exchange market and found the evidence of non-linear causality from stock prices to exchange rates in Japan and weak causality of the reverse direction in Switzerland.

Several studies attempted to explore the interconnection between stock and macro variables in developed economies like the United States. For instance, Ratanapakorn and Sharma (2007), applying Granger causality and variance decomposition tests, investigated the nexus between stock price (S&P 500) and selected macro variables such as long-term interest rate, short-term interest rate, money supply, industrial production, inflation, and exchange rate in the United States. The study used quarterly data starting from 1975 to 1999. Results of the study supported negative relation between stock price and long-term interest rate, but positive relation between stock price and other macro variables. Granger causality results found that every macroeconomic variable causes the stock prices in the long-run but not in the short-run. Patelis (1997), applying long horizon regressions and short horizon autoregressions, examined whether shifts in the stance of monetary policy can account for the observed predictability in excess stock returns. Findings of the results suggest that monetary policy variables are significant predictors of future returns, although they cannot fully account for observed stock return predictability.

Some of the studies also addressed the issue of equity market integration and macroeconomic influence in Malaysia. Baharumshah (2004), applying multivariate cointegration, vector error correction, and causality tests, investigated the money demand function for Malaysia during 1971 and 1996. The analysis of the study found a stable long-run relationship exist between real money supply (M2), the interest rate differential, income and stock prices. The results also indicated that stock prices have a significant negative substitute effect on long-run as well as short-run broad-money demand (M2). The study, in conclusion, prescribed that money supply cannot be fully controlled by Bank Negara (The Central Bank of Malaysia) due to its endogeneity nature.

Using cointegration and vector auto regression (VAR) methods, Ibrahim and Aziz (2003), investigated dynamic inter-linkage between stock prices and macroeconomic variables of Malaysia. Results of the study found the evidence of both short-run and long run co-movement between these variables and stock prices. The study also found predictive role of the stock prices for the macro variables with significant impact of financial crisis. The study further explored that interaction between stock price and exchange rate seems to be unstable and immediate positive effect of money supply shocks disappears over time.

On the issue of long-run relationship and dynamic interactions between stock price and macroeconomic variables in Malaysia, Ibrahim (2003) found statistically significant integration by applying cointegration and vector autoregression (VAR) approaches. Application of variance decomposition and impulse response in this study also suggested major influence of money supply on stock prices. By including US and Japanese equity prices in the cointegrating and VAR modeling, the study further argued that Malaysian equity market bears significant impacts from these two major equity markets, which policy makers should undertake prudently.

By including the effect of stock prices and bilateral exchange rates (Malaysian Ringgit/US Dollar and Malaysian Ringgit/Japanese Yen) in the augmented monetary model, Baharumshah et al (2002) found the evidence of cointegration in the augmented monetary model. The findings also suggested parameter instability and that the parameter time dependency can be attributed at least partly to a particular subset of the variables in the system including stock prices. The findings of the study further articulated that the equity market is significant in affecting the exchange rate and in explaining at least in part the parameter instability evidenced in the cointegrating system.

Ibrahim (1999), employing cointegration and Granger causality tests, investigated the dynamic nexus between seven macroeconomic variables and stock price in Malaysia. Results of the study found evidence of cointegration between stock prices and three macro variables (consumer prices, credit aggregates, and official reserves). The results strongly documented informational inefficiency in the Malaysian market. Granger causality tests showed that the stock prices Granger caused official reserve and exchange rates in the short-run.

The study by Habibullah and Baharumshah (1996) attempted to investigate whether money supply and output could predict stock price in Malaysia. Findings of the study indicated the presence of informational inefficiency in Malaysian stock market with respect to money supply and output.

Sagacious review of the existing literatures may argue that (a) in most of the cases equity markets found to be integrated, my not be completely, (b) incomplete process of integration may inspire the portfolio managers and investors to diversify their investment in the stocks of weakly integrated markets, and (c) major macroeconomic indicators also tend to converge with stock price in an economy, may be at a weaker or moderate level. These arguments may, even though true for Malaysia, not completely yet tested and consequently there would be a knowledge gap. In order to fulfill this gap, this study attempts to investigate the dynamic co-movement of Malaysian equity market with two major foreign markets, Japan and Malaysia, and with three major macroeconomic indicators of Malaysia.

Approaches of this study could be distinguished from the existing literatures in the following respects: (a) emphasis on investigation of dynamic co-movement as structural break may change the behavior of equity markets and macro indicators, (b) application of more realistic methods, (c) use of comprehensive information, and (d) use of more methods to check the robustness of the results.

Therefore, based on the above distinguishing criteria, revisiting this long run and short run co-movement, as presented by the approaches of this study, would convey a new spectrum of knowledge in order to foster equity market growth, efficiency and over all development in Malaysia.

4. Data description and methodology

4.1 Time series properties of the data

For the purpose of empirical analyses of the study, we use Malaysian equity market index, Japanese equity market index, US equity market index, and three major macroeconomic indicators of Malaysia such as exchange rate, consumer price index and industrial production index. We use 1683 monthly observations (273 monthly data of each variable) stating from February, 1990 to October, 2012. We use monthly data as it is the lowest frequency of availability of macroeconomic indicators, notwithstanding, stock prices are available even at daily frequency. The study considers Japanese equity market index and US equity market index as proxy for foreign stock markets to study the responsiveness of Malaysian equity market to major neighboring and global markets. The study uses two dummy variables (D1 & D2) in order to assess the impact of 19997 Asian financial crisis and 2008 Global financial crisis on Malaysian equity market and macroeconomic indicators. All data used in this study are collected from Datastream database. In addition, owing to the operating time differences among the stock markets, we made required time adjustment following Universal Co-ordinated Time (UTC – 6.00 Hours) in order to maintain time homogeneity in data, which depicts the picture more accurately. Following table 1 reports the data with short description:

Table 1: Data description

Variable	Description
LMY	Logarithmic value of FTSE Bursa Malaysia KLCI (FBMKLCI) price index
LJP	Logarithmic value of NIKKEI price index (Japan)
LUS	Logarithmic value of Standard and Poor 500 price index (SP500)
LER	Logarithmic value of MYR/US$ Exchange Rate
LCP	Logarithmic value of Malaysian Consumer Price Index
LIP	Logarithmic value of Malaysian Industrial Production Index
D1	Dummy variables as a proxy for 1997 Financial Crisis, with 1997M4 to 1998M12 being 1, otherwise 0
D2	Dummy variable as proxy for 2008 Global Financial Crisis, with 2008M1 to 2009M12 being 1, otherwise 0

Non-stationarity property of the data should be ensured in order to perform conintrgration analysis. Keeping that in mind, the study employs Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests at level and first difference of the variables. Akaike Information Criteria (AIC) and Schwarz Information Criteria (SBC) are used to determine the appropriate lag order of the variables. The Augmented Dickey-Fuller (ADF) (1979, 1981) test involves the estimation of the following general specification:

$$\Delta X_t = \alpha_0 + \alpha_1 T + \beta X_{t-1} + \sum_{J=1}^{P} \delta_J \Delta X_{t-J} + \varepsilon_t \qquad (1)$$

The Phillips-Perron (PP) (1988) test suggests a non-parametric method of controlling for higher order autocorrelation in a time series and is based on the following equation:

$$\Delta X_t = \alpha_0 + \beta T + \beta_1 X_{t-1} + \sum_{J=1}^{P} \delta_J \Delta X_{t-J} + \varepsilon_t \qquad (2)$$

In both ADF and PP equations, Δ represents the difference operator, α, β, and δ are coefficients to be estimated. X stands for the variable in question to check stationarity and ε is the residual term. The critical values for the Phillips-Perron test are the same as those for the Dickey-Fuller test (DF) and depend on whether the DF regression contains an intercept term or a time trend.

Figure 1 (a) and 1 (b) below presents the plot of the variables (stock indices & macro indicators) both at level and first difference form:

Figure 1(a) : Plot of Stock Prices (Level & First Difference)

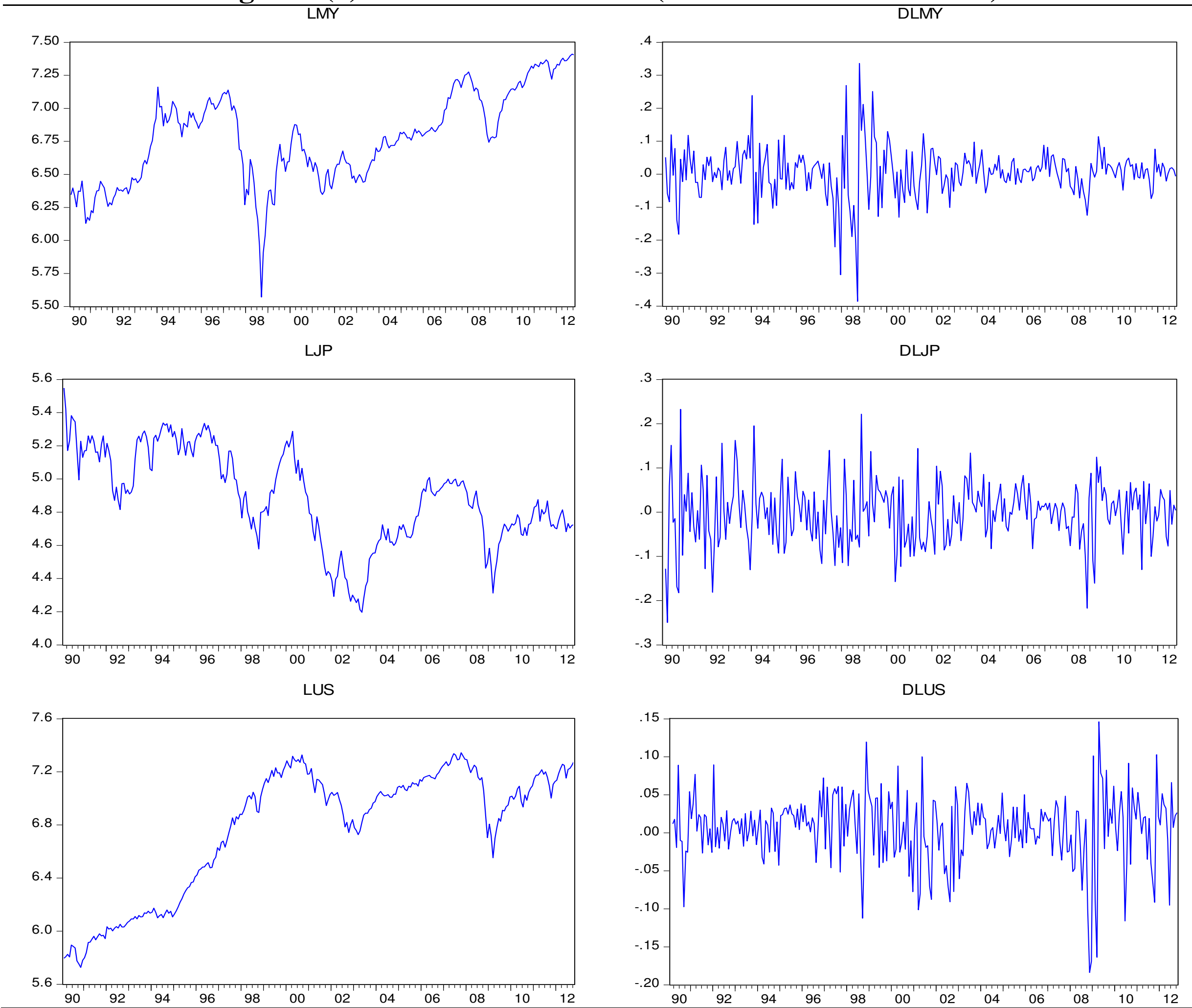
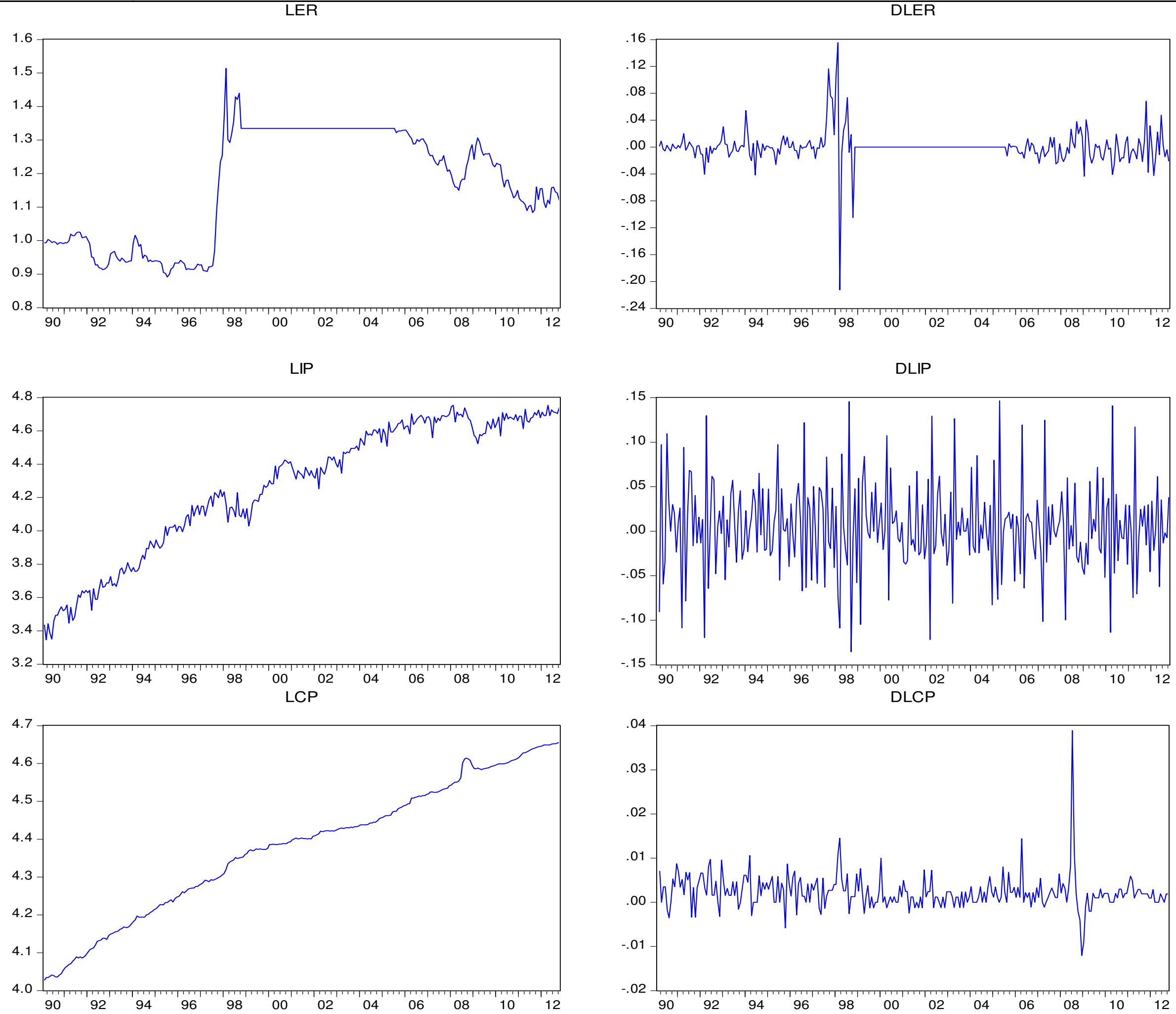


Figure 1 (b): Plot of Macroeconomic Variables (Level & First Difference)



Plots of the level form variables clearly indicate that the variables are non-stationary. Any prediction with the non-stationary variables would be wrong as the mean and variance (average deviation of the individual price from the mean price) of the variables are not constant over time. On the contrary, plots of the first difference form of the same variables seem to have constant mean and variance over time, which shows that the variables concerned are stationary in their first difference form and thereby, it fulfills the precondition of employing Johansen cointegration analysis with a view to assess the long run relationship among the concerned equity markets and macroeconomic indicators of Malaysia.

4.2 Johansen cointegration analysis

Johansen cointegration technique can be applied to test the long run relationship among the variables when the variables found non-stationary at levels and stationary at first difference, i.e. for the I(1) variables. After checking the stationarity property of the variables, this study applies Johansen cointegration method in order to investigate the presence of long run relationship (long run co-movement) among the equity indices and macroeconomic indicators. Johansen (1988) and Johansen and Juselius (1990) suggested considering the vector autoregressive (VAR) model of the following form:

$$\Delta Y_t = C + \sum_{i=1}^{k} \Gamma_i \, \Delta Y_{t-1} + \Pi Y_{t-1} + \varepsilon_t \qquad (3)$$

Where, Y_t is a vector of non-stationary variables and C is a constant term. The matrix Γ_i consists of the short run adjustment parameters and matrix Π contains long run equilibrium relationship information between the Y variables. The Π could be decomposed into the product of two $n \times r$ matrix α and β so that $\Pi = \alpha\beta'$, where β matrix contains r number of conintegration and α represents the speed of adjustment parameters. Johansen (1988) and Johansen & Juselius (1990) developed two statistics for identifying the number of cointegrating vectors, which are Trace statistic (λ_{Trace}) and the maximum Eigenvalue statistic (λ_{Max}). These two statistics can be expressed as follows:

$$\lambda_{Trace} = -T \sum_{i=r+1}^{N} \ln(1 - \hat{\lambda}_i) \qquad (4)$$

and,

$$\lambda_{Max} = -T ln\left(1 - \hat{\lambda}_{r+1}\right) \qquad (5)$$

Where, λ_i is the estimated value of the ith characteristics root obtained from the estimated parameter matrix Π and T is the number of usable observations. The λ_{Max} statistic tests the null hypothesis that there are at least r cointegrating vectors as against the alternative of (r+1) cointegrating vectors.

There exists a theoretical relationship among the variables in presence of cointegration and this long run relationship tends to persists notwithstanding short run deviation from each other. Masih et al (2010) stated that a test of cointegration can also be considered as a test of the extent of the level of arbitrage activity in the long-term. Cointegration implies that these variables are interdependent and highly integrated (as if they are constituents of one integrated market). Cointegration also implies that each variable contains information for the prediction of other variables. Moreover, the evidence of cointegration has implications for portfolio diversification by the investors. The possibility of abnormal gain through portfolio diversification would be limited in the long run when the markets found to be cointegrated.

4.3 Error correction modeling (ECM) and test of endogeneity(exogeneity)

Presence of cointegration, however, is not sufficient information to indicate the direction of causality between the variables, i.e. which variable is leading and which variable is lagging (i.e., which variable is exogenous and which variable is endogenous) (Masih, et al, 2010). The Vector Error Correction Model (VECM) can be applied to figure out the endogeneity/exogeneity of the variables. The error correction term (ECT) stands for the long term relations among the variables. At least one of the ECT terms should be significant for the validity of the cointegrating relationship among the variables in the long term. If the error correction term is insignificant, the corresponding dependent variable is 'exogenous'. On the contrary, if the error correction term is significant, the corresponding dependent variable is 'endogenous'. This study estimates Vector Error Correction Model (VECM) following finding cointegration among the indices. The VECM implies that changes in the dependent variable are a function of the level of disequilibrium in the cointegrating relationship i.e., the departure from the long-run equilibrium as well as changes in other explanatory variables. Considering the variables of this study, the VECM can be represented as follows:

$$\Delta Y_t = C + \Pi Y_{t-k} + \Gamma_1 \Delta Y_{t-1} \dots\dots\dots\dots\dots. + \Gamma_{k-1} \Delta Y_{t-(k-1)} + \varepsilon_t \qquad (6)$$

In equation (6), $\Pi = \left(\sum_{i=1}^{k} \beta_i\right) - I_g$ is the long run coefficient matrix of the lagged Y_t and $\Gamma_i = \left(\sum_{j=1}^{i} \beta_j\right) - I_g$ is a coefficient matrix of k-1 lagged difference variables, ΔY_t.

For intensive analysis, the generalized (reduced) form of VECM is derived as follows:

$$\Delta Y_t = C + \Pi Y_{t-k} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \quad (7)$$

In equation (7), ΔY_t is the vector of first differences of the variables. The long run parameter matrix, Π with r cointegrating vectors$(1 \leq r \leq 6)$, Π has a rank of r and can be decomposed as $\Pi = \alpha\beta^{'}$, both α and β are $6 \times r$ matrices. β matrix contains the parameters in the cointegrating relationships and α matrix contains the adjustment coefficients which measure the strength of the cointegrating vectors in the VECM. Following estimation of VECM, this study performs variance decomposition technique to break down the variance of the forecast error for each variable into proportions attributable to each variable in the model including its own. The variable which is explained mostly by its own past is the most leading variable.

4.4 Dynamic cointegration analysis

Johansen cointegration technique fails to investigate the extent of cointegration with variation of time, which can be detected by the dynamic cointegration. Dynamic cointegration technique assesses whether the integration process would be completed or not over a fixed period of time (I.-W. Yu et al., 2010). Dynamic cointegration test examines the time varying nature of convergence in order to exhibit the dynamics of convergence between markets and assets. Under dynamic cointegration, if variables are cointegrating or converging, the standardized trace statistics, which is the ratio between the trace statistics and the corresponding 95% critical values, should be consistently greater than one, suggesting that null hypothesis of no cointgration can be rejected. On the contrary, if variables are diverging or not cointegrated, the standardized trace statistics will be less than one (I.-W.Yu et al., 2010, Pascual, 2003 and Nikolaos and Christos, 2010). In this study, we apply dynamic cointegration technique with a window (sample) size of 84 monthly observations (7 years) and window (sample) size of 108 monthly observations (9 years) in order to investigate the dynamics of convergence process among the equity markets and macroeconomic variables in concern. First, the trace statistics are computed for a rolling 84 observations by adding one observation to the end and removing the first observation and we repeat the same process for the subsequent observations. In other words, we start with observations 1 – 84 and compute trace statistic for this sample. Similarly, we compute trace statistics for samples of 2 - 85, 3 – 86 and so on and thereby we get the time series of trace statistics, which are scaled by their corresponding 5% critical values. We repeat the same process to compute trace series for window size of 108 observations. Selecting window size of 84 and 108 observations provide a time series of 189 and 165 trace statistics. That is bigger the size of window, the larger will be the observations loss at the end of the study period. The study used VAR order of 2 as suggested by the AIC and SC lag length criteria.

4.5 Beveridge-Nelson (BN) time series decomposition

Either Johansen cointegration technique or dynamic cointegration analysis is not suitable for decomposing a time series into its permanent (trend) and transitory (cycle) parts in order to examine the co-movement of the cycle and trend components of the time series in question. This study, by looking at the objective, employs Multivariate Beveridge-Nelson decomposition technique in a cointegrating framework on equity indices and macroeconomic indicators of Malaysia in order to decompose the concerned time series into their permanent (trend) and transitory (cycle) components.

Beveridge & Nelson (1981) proposed that a time series can be decomposed into a stationary (temporary/transitory) and non-stationary (permanent) components. The permanent component always composed of a random walk with the same rate of drift as in the original data. In addition, the permanent component also comprised of a disturbance term proportional to that of the original data. The transitory component represents the predictable part of the data, and was expected to dissipate as the series tends to its permanent level as stated by Silva (2007). The derivation of Multivariate BN decomposition starts by stating the Wold decomposition for a vector of time series integrated of order one, which is:

$$\Delta y_t = \mu + C(L)\epsilon_t \qquad (8)$$

Where, $C(0) = I_N$and $\sum_{j=1}^{\infty} j\left|C_j\right| < \infty$. If we assume $\mu = 0$ for simplicen ity, equation (2) can be rewritten as follows:

$$\Delta y_t = C(1)\epsilon_t + \Delta C^* (L)\epsilon_t \qquad (9)$$

Where, $C_i^* = -\sum_{j>i}^{\infty} C_j$ for all $i$and $C_0^* = I_N - C(1)$. Integrating both sides of equation (10) provides the following:

$$y_t = C(1)\sum_{s=0}^{\infty} \epsilon_{t-s} + C^*(L)\epsilon_t \qquad (10)$$

Equation (10) represents the multivariate BN decomposition, where the first and the second terms denote the permanent (trend) and the temporary (cyclical) components of a time series respectively. In presence of a cointegrating relationship (means if a common trend exists), $C(1)$ will be of reduced rank. Specifically, the rank of $C(1)$ will equal k, where $k < N$ and $C(1)$ can be expressed in the following form:

$$C(1) = \gamma\delta' \qquad (11)$$

Where, γ and δ are both of rank k. The common trend Bevertidge-Nelson-Stock-Watson (BNSW) decomposition can be expressed as following:

$$y_t = \gamma\tau_t + C_t \qquad (12)$$

Where, τ_t and C_t represent the trend and cycle components at time t. The trend component τ_t can be expressed as follows:

$$\tau_t = b + \tau_{t-1} + \delta'\epsilon_t \qquad (13)$$

Repeated back substitution of equation (13) yields the following:

$$\tau_t = \delta' \sum_{s=0}^{\infty} \epsilon_t \qquad (14)$$

Substituting equation (14) into equation (12), we get the following expression:

$$y_t = \gamma\delta' \sum_{s=0}^{\infty} \epsilon_{t-s} + C^*(L)\epsilon_t \qquad (15)$$

Equation (15) is the common trend specification of the BN decomposition, which Watson (1994) refers to as the common trend representation of the cointegrated system.

Simultaneous plotting of the permanent and cycle components of the concerned time series reveals the convergence process of the equity indices and macro variables with respect to equity price in Malaysia.

4.6 Wavelet coherence approach

Wavelet analysis is a relatively new and powerful mathematical tool for signal processing in Electrical and Electronics engineering. This technique has recently been introduced in finance and economics research, allowing decomposing relationships between time series in the time-frequency domain. The main advantage of this technique is the ability to decompose financial time series into their time scale components and it resolves the issue of non-stationarity problem in the data given their translation and scale properties. This study would like to investigate the dynamic convergence and relationship between Malaysian stock market and other two foreign stock markets (Japan and USA) in different time frequencies. Besides, we apply the same approach to examine the time frequency dependent relationship between Malaysian stock price and three macroeconomic indicators (exchange rate, CPI, and IP). A few researchers have applied this method in analyzing correlation and cointgration of stock markets. Ramsey and Lampart (1998a and 1998b) and In and Kim (2006) are the pioneer in applying wavelet analysis in economics and finance. Wavelet theory for international co-movement of stock indices has been applied by Lee (2004), Sharkasi et al. (2005) and Rua and Nunes (2009). A few of the recent literatures on application of wavelet techniques in finance and economics include Vacha and Barunik (2012), Madaleno and Pinho (2012), Aguiar-Conraria and Soares (2011), Gallegati (2008), Crowley, and Aguiar-Conraria et al. (2008 and 2011a and 2011b).

The term wavelet stands for a small wave. It is small because the wavelet function is non-zero over a finite length of time and as the function oscillates, it is called a wave. Wavelet coherence is very useful in indicating how closely two time series X and Y are related by a linear transformation, which has a maximum value of 1. In time-series, the degree of coherence of two time series *x(t)* and *y(t)* with zero time-average values is the magnitude of their temporal correlation coefficient. Coherence is like a correlation measure that indicates how strongly the two variables are related at business cycle frequencies. It ranges from 0 (no correlation; completely incoherent) to 1 (perfect correlation; completely coherent). The caveat is that this correlation may not be contemporaneous, but may involve a lead or a lag, being the magnitude measured by the phase lead.

Dealing with discrete time series $\{x_n, n = 0, \ldots\ldots, N-1\}$ of N observation with a uniform time step δt, the continuous wavelet transform (CWT) of the time series $\{x_n\}$ becomes as follows:

$$W_m^x(s) = \frac{\delta t}{\sqrt{s}} \sum_{n=0}^{N-1} x_n \, \phi^* \left((n-m) \frac{\delta t}{s} \right), \;\; m = 0, 1 \ldots\ldots\ldots\ldots, N-1 \qquad (16)$$

It is possible to calculate the wavelet transform using the above formula for each value of *s* and *m* but it can be identified the computation for all the values of *m* simultaneously as a simple convolution of two series (Aguiar-Conraria et al., 2008; Torrence and Compo, 1998).

The wavelet power spectrum is just $|W_n^x|^2$ that characterizes the distribution of the energy (spectral density) of a time series across the two dimensional time scale plane, leading to a time scale (or time-frequency) representation. The theoretical distribution of the local wavelet power spectrum is presented in Torrence and Compo (1998) by the following:

$$D\left(\frac{|W_n^x|^2}{\sigma_x^2} < p \right) = \frac{1}{2} P_f \chi_v^2 \qquad (17)$$

At each time n and scale s, where the value of P_f is the mean spectrum at the Fourier frequency f that corresponds to the wavelet scale $s(\approx 1/f)$ and v is equal to 1 or 2, for real or complex wavelets respectively.

The phase for wavelets show any lag or lead relationships between components and defined as –

$$\phi_n(s) = \phi_{x,y} = tan^{-1}\frac{I\{W_n^{XY}\}}{\mathbb{R}\{W_n^{XY}\}},\ \phi_{x,y} \in [-\pi, \pi] \quad (18)$$

Where I(.) and $\mathbb{R}(.)$ represent imaginary and real parts respectively of the smooth power spectrum. Phase difference are useful to charecterize phase relationships between two time series. Phase is indicated by the direction of arrows (right, left, up, and down) on the wavelet coherence plots. A phase difference of zero indicates that both time series move together (similar to positive covariance) at the specified frequency. If $\phi_{x,y} \in [0,\ \pi/2]$, the two series move in-phase and time series *y* leading to *x*. In contrast, if $\phi_{x,y} \in [-\pi/2,\ 0]$, then two series x and y move in-phase and x is leading y. There is also an anti-phase relation between two time series (similar to negative covariance) if there is a phase difference of $\pi\ (or -\pi)$, meaning $\phi_{x,y} \in [-\pi/2,\ \pi] \cup [-\pi, \pi/2]$. If $\phi_{x,y} \in [\pi/2,\ \pi]$ then x time series is leading *y*. On the contrary, if $\phi_{x,y} \in [-\pi, -\pi/2]$ then time series *y* is leading time series *x*. In other words, positive (negative) co-movement between two time series can be indicated by the right (left) direction of arrows on the wavelet coherence plots. Arrow pointing up means that the first time series leads the second one by 90^0, arrow pointing down indicates that the second time series leads the first one by 90^0. This study finds mingled directions of arrows on wavelet plots to detect comovement between stock indices and macro indicators.

Another usefull measure is how coherent the cross wavelet transform is in time-frequency space. Cross wavelet power reavels areas with high common power. Following Torrence and Compo (1998), the wavelet coherence of two time series can be defined as follows:

$$R_n^2(s) = \frac{|S(s^{-1}W_n^{XY}(s)|^2}{S(s^{-1}|W_n^X(s)|^2).S(s^{-1}|W_n^Y(s)|^2)} \quad (19)$$

Where S is a smoothing operator in both time and scale, which can be written as a convolution in time and scale $S(W) = S_{Scale}(S_{Time}(W_n(S)))$ where S_{Scale} denotes smooting along the wavelet scale axis and S_{Time} smoothing in time (Torrence and Compo, 1998). The cross wavelet indicates the correlation between rotary components that are rotating in the same direction as a function of time and periodicity. It can be defined as the ratio of the cross-spectrum to the product of the spectrum of each series and can be thought of as the local correlation between two continuous wavelet transforms (CWTs).

5. Results and empirical analysis

5.1 Unit root tests

This study employed Augmented Dicky Fuller (ADF) and Phillips Perron (PP) unit root tests with intercept and intercept and linear trend to check the stationarity properties of the concerned equity indices and macroeconomic indicators. Table 2 summarizes the unit root test results.

Table 2: Summary of unit root tests

	P-values			
	Intercept		Intercept & Linear Trend	
Variables	ADF	PP	ADF	PP
LMY	0.4904	0.3846	0.4407	0.2894
LJP	0.0864	0.0780	0.1854	0.1721
LUS	0.3827	0.3882	0.8105	0.7668
LER	0.5612	0.5297	0.9244	0.9041

LIP	0.1366	0.2697	0.7501	0.0883
LCP	0.3953	0.2242	0.4970	0.4851
DLMY	0.0000	0.0000	0.0000	0.0000
DLJP	0.0000	0.0000	0.0000	0.0000
DLUS	0.0000	0.0000	0.0000	0.0000
DLER	0.0000	0.0000	0.0000	0.0000
DLIP	0.0021	0.0000	0.0044	0.0000
DLCP	0.0000	0.0000	0.0000	0.0000

Both tests assume the null hypothesis of non-stationary against the alternative hypothesis of stationary. The above test results conclude that all variables are non-stationary at level and stationary at first difference (at 5% and 10% significance level), implying that the variables are integrated of order one, that is, *I(1)*.

5.2 Johansen cointegration analysis

This study, upon checking stationarity properties of the variables, applied the standard Johansen Cointegration test in order to check the long run co-movement (convergence) of Malaysian equity market with respect to Japanese and United States equity markets, the Asian and global leader respectively. Apart from integration among equity markets, integration among equity market and macroeconomic indicators in Malaysia is also tested. We perform cointegration test with a VAR order of 2 as suggested by the appropriate lag length criteria of AIC and SC. Table 3 shows the cointegration test results.

Table 3: Johansen Maximum Likelihood results for cointegration

Cointegration LR Test Based on Maximum Eigenvalue				
H_0	**H_1**	**Statistic**	**95% critical**	**90% critical**
R = 0	R = 1	43.98	43.61	40.76
R <= 1	R = 2	29.19	37.86	35.04
R <= 2	R = 3	15.23	31.79	29.13
R <= 3	R = 4	14.81	25.42	23.10
Cointegration LR Test Based on Trace Stochastic Matrix				
R = 0	R >= 1	114.25	115.85	110.60
R <= 1	R >= 2	70.27	87.17	82.88
R <= 2	R >= 3	41.08	63.00	59.16
R <= 3	R = 4	25.86	42.34	39.34

The maximum Eigenvalue test indicates one cointegrating relationship at 5% significance level among the variables, as maximum Eigenvalue statistic H_0: r = 0 against H_1: r =1 is 43.98 > 43.61 (95% critical value). Similarly, Trace statistic also indicates existence of one cointegrating relationship at 10% significance level among the variables, as calculated Trace statistic H_0: r = 0 against H_1: r =1 is 114.25 > 110.60 (90% critical value). Based on the results of both tests, the study conclude that there exists one statistically significant cointegrating relationship among the *I(1)* variables (theoretically cointegration does exist if both Trace and Maximum Eigenvalue statistic or either of the two measures shows the presence of cointegration). Existence of one cointegrating relationship indicates incomplete process of integration among the equity markets and macroeconomic indicators as there should maximum of five cointegrating relationships.

The evidence of cointegrating relationship implies that there exists a common force that brings stock prices and other macro variables of Malaysia back to equilibrium in the long term. Relationship among the variables is not spurious when they are cointegrated. This implies that Malaysian equity market is theoretically (long run) related with Japanese equity market, the Asian leader, and the US equity market, the global leader. This result also indicates existence of long run relationship between equity price and macroeconomic indicators in Malaysia. An evidence of cointegrating relationship implies that there exists a common force that would bring these three equity markets to equilibrium and any alteration or shock in Malaysian exchange rate, industrial production, and consumer price index (proxy for inflation) would have impacts on Malaysian equity price in particular and the entire equity market in general.

Consequences of this integration of equity price and macroeconomic indicators of Malaysia are in line with theories. Analysis of results reveal that sharp drop in equity price during 1997 Asian financial crisis is concomitant with sudden increase in exchange rate, i.e. huge depreciation of Malaysian Ringgit, which follows the flow oriented model proposed by Dornbusch and Fisher (1980). Industrial production tends to grow steadily over the estimation period except a moderate drop during 1997 – 1998 and 2008 which suspects to be caused by the drop in equity price during these two major financial crises. This finding is line with the findings of the studies by Fama (1990), Geske and Roll (1983), Tainer (1993) and Chen, Roll and Ross (1986). Portfolio balance model would be suitable to explain the increase in Malaysian exchange rate during 2008 financial crisis when stock market was slumbered due to 2008 financial crisis spilled over from the US market. This crisis spill over could be explained by the presence of integration between the equity markets, even though it appears to be incomplete and weak. This issue has been evidenced by the findings of the empirical studies by Hung and Cheung (1995), Arshanapalli et al. (1995), Masih and Masih (1999), Daly (2003), Ibrahim (2005). Movement in inflation seems to hike very slowly as evidenced by slow increase in consumers' price index of Malaysia except in September 2008 when sudden hike in inflation may also suspects to contribute to decline in equity price in Malaysia.

This long run theoretical relationship also indicates to have insignificant gain from arbitrage activity among these three markets. In addition, possibility of abnormal gain from portfolio diversification would be minimum in these three markets. This theoretical relationship in general and integration between Malaysian equity price and macroeconomic indicators in particular, would convey worthy information for the multinational firms and foreign portfolio managers concerning their direct investment in the real sector and portfolio investment in Malaysia. They may require prudent vigilance while planning their future investment in Malaysia, especially, during the economic turbulence periods.

5.3 Error correction modeling and test of endogeneity(exogeneity)

Presence of cointegration, however, does not indicate the direction of Granger causality between the variables as to which variable is leading and which variable is lagging, i.e. which variable is exogenous and which variables is endogenous. This study applied vector error correction modeling technique in order to precisely identify the exogenous (independent) and endogenous (dependent) variables. Table 4 summarizes the results of vector error correction modeling.

Table 4: Vector Error Correction Estimates

Dependent Variable	Coefficient	T-ratio	P-value	Exogenous/Endogenous
DLMY	-0.1705 (0.0357)	4.7697	0.000*	Endogenous
D1	-0.0650	3.7712	0.000*	
D2	-0.0400	2.4434	0.015**	
DLJP	0.0028 (0.0358)	0.0789	0.937	Exogenous
D1	-0.0049	0.2856	0.775	
D2	-0.0074	0.4473	0.655	
DLUS	-0.0273 (0.0230)	1.1806	0.239	Exogenous
D1	0.0153	1.3715	0.171	
D2	-0.0214	2.0202	0.044**	
DLER	-0.0012 (0.0123)	0.0875	0.930	Exogenous
D1	0.0201	3.3975	0.001*	
D2	0.0026	0.4664	0.641	
DLIP	0.0781 (0.0211)	3.6929	0.000*	Endogenous
D1	0.0034	0.3363	0.737	
D2	0.9526E-4	0.0098	0.992	
DLCP	0.0020 (0.0019)	1.0382	0.300	Exogenous
D1	0.3756E-3	0.4116	0.681	
D2	0.5746E-3	0.6621	0.508	

Note: Values in the parenthesis are standard error of coefficients. One astric (*), two astrics (**), and three astrics (***) indicate 1%, 5%, and 10% level of significance respectively.

Results in the above table show that coefficient of error correction terms are significant for equity price and industrial production of Malaysia and insignificant for other equity prices and macroeconomic indicators of Malaysia. Theoretically, if the error correction coefficient in any equation is significant, the corresponding dependent variable is endogenous, i.e. it depends on the deviations of other variables. On the contrary, if the error correction coefficient is insignificant in any equation, the corresponding dependent variable refers to be exogenous variable, i.e. it does not depend on the deviations of other variables. These results indicate that movement in Malaysian equity price depends on the movement of Japanese and US stock prices, which also implies that Japanese and the US equity markets seem to be driver and Malaysian equity market seems to be follower market. Implications of this co-movement between Malaysian and other two leading equity markets would fortify the presence of contagion during the economic turbulence. Any shock or innovations in the US and Japanese equity markets would roll over the Malaysian equity market as evidenced by the possible contagion effect during 2008 global financial crisis originated in US market attributed to the default in the US mortgage market. Contagion effect of the 1997 Asian financial crisis is also prevalent in Malaysian market as indicated by the test results.

As for the macroeconomic indicators, the results reveal that exchange rate (MYR/USD) and consumer price index are independent and industrial production is dependent on changes of other macroeconomic indicators. This exogeneity of exchange rate and consumer price index suspect to contribute to equity price decline during 1997 – 1998 Asian financial crisis and 2008 global financial crisis. Also endogeneity of industrial production would be evidenced by the slight drop in industrial production during these two major crises period, which suspects to be caused by the equity market turbulence.

Therefore, based on the empirical evidence, it would be safer to claim that any shock in the exchange rate and consumer price index would spill over to the equity market in Malaysia. In addition, error correction model helps to distinguish between the short-term and long-term Granger causality. The coefficient of error correction term also indicates the speed of short-run adjustment to bring about the long-term equilibrium. The coefficient of the error correction term of Malaysia is 0.1705, which asserts the disequilibrium in equity price of Malaysia tends to be corrected by around 17 percent in each month, whereas, equity price in Japanese and the US markets seem to be corrected by 0.28 percent and 2.73 percent respectively. These results, moreover, indicate that if the equilibrium condition in Malaysian market is disturbed by any innovations or shocks, either internal or external, it would take around 6 (=1/0.1705) months to restore the equilibrium. However, surprisingly, equilibrium reinstating process would take longer time in Japanese and the US equity markets. We conjecture that this quick short term adjustment process in Malaysian equity market even though surprising but not unlikely, which could be credited to the market structure, careful vigilance, investors' confidence, foreign investment in general and incomplete process of integration in particular. This incomplete integration process claims to be beneficial for the Malaysian equity market as this could curb the intensity of contagion effect in Malaysian equity market, which believed to be evidenced by the relatively better growth and performance of the Malaysian equity market as compared to other developed markets amid the 2008 global financial crisis. It may happen on account of rapid growth of Islamic capital market in general and sukuk market in particular in Malaysia in the aftermath of 2008 Global financial crisis. However, results (significant dummy variables) imply that both 1997 Asian financial crisis and 2008 global financial crisis strike on Malaysian equity market but at varying degree. As a matter of fact, 1997 Asian crisis suspects to be more ruinous than 2008 Global financial crisis for Malaysian equity market, which is not unconvincing as Malaysia was one of the originating economies of 1997 Asian financial crisis. Contrary to this findings, US equity market undoubtedly significantly affected by the 2008 financial crisis as evidenced by the statistical significance of dummy variable D2 (proxy for 2008 financial crisis) variable. Meanwhile, dummy variable D1 (proxy for 1997 Asian financial crisis) is not statistically significant for the US, indicating possibly no impact of 1997 Asian financial crisis on US equity market, which is not surprising but convincing as generally, contagion dissipates from developed market to the developing markets, even though, it may flow in the reverse direction with less intensity. Surprisingly, none of the financial crisis has significant impact on Japanese equity market as suggested by the insignificant dummies. It may happen probably due to the presence of almost zero leverage in Japanese economy indicated by prevailing low interest rate. Empirically, it has been proved that debt ridden and more integrated economies experience more economic vulnerability due to financial turbulence. Dilapidated economic conditions of the US and major European economies after the 2008 financial crisis has strengthen this empirical evidence as most of these economies are burdened with massive volume of debt.

As for the macroeconomic indicators, exchange rate, consumers' price index, and industrial production, relatively smaller error correction coefficients suggest that it would take relatively longer time for restoring equilibrium followed by shocks in these macroeconomic variables. Among three macroeconomic indicators, only exchange rate of Malaysia (MYR/USD) seems to be affected by the 1997 Asian financial crisis as indicated by the statistical significance of dummy variable D1, however, insignificant dummy variable D2 implies that possibly 2008 Global financial crisis has no impact on Malaysian exchange rate. This finding though surprising but convincing in the sense that 1997 Asian financial crisis was caused by currency crisis in the major East Asian countries including Malaysia. This interesting finding demonstrated by insignificant D2 would confirm the validity of portfolio balance model which claims that shocks tend to spill over from equity market to foreign exchange market.

Error correction models, although tend to indicate the endogeneity/exogeneity, are unable to indicate the relative degree of endogeneity or exogeneity of the variables. This study applies variance decomposition technique in order to figure out the relative degree of endogeneity or exogeneity of the Islamic equity indices, the result of which is summarized in table 5.

Table 5: Generalized Variance Decomposition Analysis

		Percentage of Forecast Variance Explained by Innovations in:					
		ΔLMY	ΔLJP	ΔLUS	ΔLER	ΔLIP	ΔLCP
Month	ΔLMY						
24		43.63%	25.89%	9.76%	15.03%	2.49%	3.20%
36		**40.37%**	27.98%	9.05%	16.25%	2.96%	3.39%
Month	ΔLJP						
24		6.22%	76.09%	16.91%	0.60%	0.02%	0.15%
36		6.16%	**76.22%**	16.85%	0.60%	0.02%	0.16%
Month	ΔLUS						
24		7.54%	21.97%	64.58%	4.14%	1.21%	0.54%
36		7.16%	22.25%	**64.54%**	4.20%	1.29%	0.55%
Month	ΔLER						
24		9.65%	7.73%	3.20%	76.46%	2.67%	0.30%
36		9.75%	7.80%	3.21%	**76.24%**	2.69%	0.30%
Month	ΔLIP						
24		20.09%	0.20%	6.78%	0.24%	68.96%	3.73%
36		21.82%	0.19%	7.34%	0.17%	**66.78%**	3.70%
Month	ΔLCP						
24		3.63%	0.26%	4.97%	0.74%	2.22%	88.17%
36		3.76%	0.27%	5.09%	0.74%	2.24%	**87.90%**

The relative endogeneity or exogeneity of a variable can be recognized by the proportion of the variance explained by its own past. We recognize the most exogenous or endogenous variable by looking at the proportion of the variable explained by its own past. The variable that is explained mostly by its own past, as compared to other variables, is supposed to be the most exogenous or least endogenous variable.

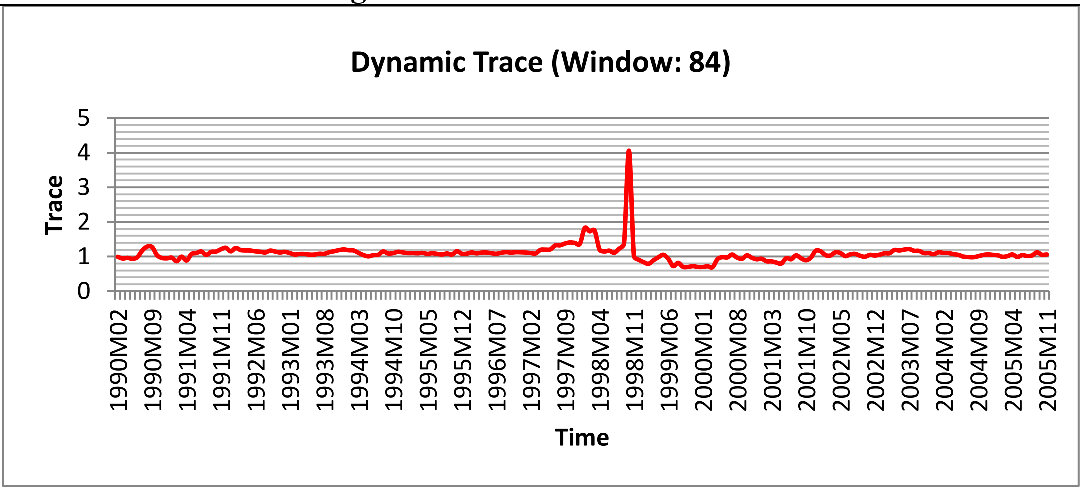
Variance decomposition results reveal that around 40 percent of the forecast error variance of Malaysian equity price is explained by its own shocks in 36 months or 3 years' time. However, as regards to the independent equity markets, Japanese equity market appears to be more independent (most leading) market as compared to the US equity market as suggested by the higher percentage of the forecast error variance of Japanese equity price explained by its own shocks in 36 months. Therefore, we conjecture that Japanese equity market may have relatively larger influence on Malaysian equity market as compared to the US equity market in the convergence process. Even though surprising but this interesting finding is in line with findings of the study by I.-W. Yu et al. (2010), where the authors by applying Haldane and Hall (1991) approach articulated that individual equity market indices are becoming more responsive to regional than global influences.

Looking at the macroeconomic indicators, results reveal that Malaysian consumers' price index appears to be more independent than exchange rate to exert impact on Malaysian stock price in the convergence process. It is indicated by the higher percentage of the forecast error variance of consumer's price index explained by its own shocks in 36 months. This result suggests that change in consumer price index seems to be more dominant in comparison with change in exchange rate to influence the change in stock price. As for the only endogenous macroeconomic variable industrial production, around 67 percent of the forecast error variance is explained by its own shocks in 36 months. This result indicates that industrial production is more dependent than stock prices on changes in other macro indicators in Malaysia.

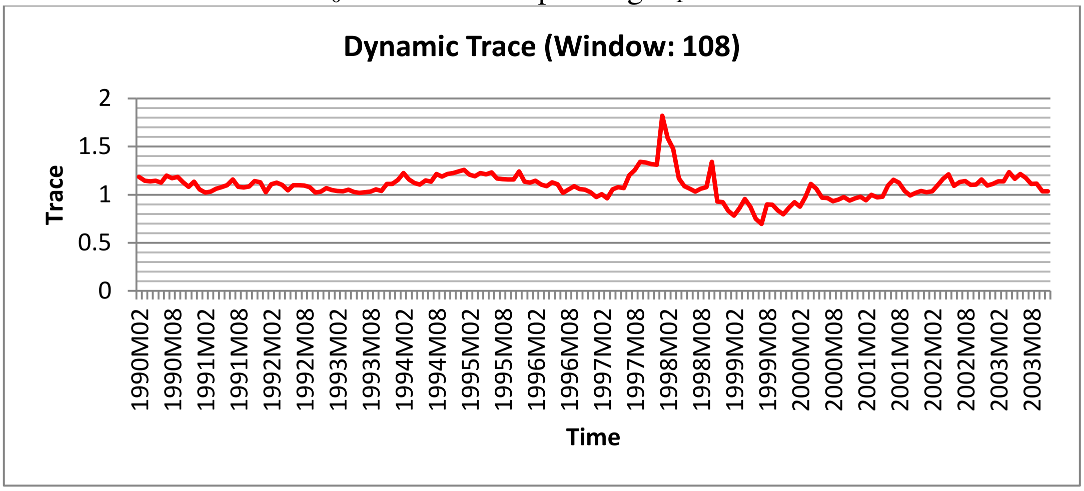
5.4 Dynamic cointegration analysis

Johansen cointegration test results already indicated presence of one cointegrating relationship among stock prices (of Malaysia, Japan, and the United States) and selected macro variables of Malaysia. However, presence of one cointegrating relationship out of six variables suggests that the process in integration is not yet completed. Moreover, plot of the variables clearly shows major swings at different time intervals, which motivated us to investigate the integration dynamics of the concerned variables. If variables are converging with change in time, the standardized trace statistics, which is the ratio between the trace statistics and the corresponding 95% critical values, should be consistently greater than one, suggesting that null hypothesis of no cointgration can be rejected. On the contrary, if variables are diverging or not cointegrated, the standardized trace statistics will be less than one. Following figure 2 presents the plot of dynamic trace statistics for window size of 84 and 108 observations. We choose 84 and 108 observations months as these periods are supposed to be long enough to establish meaningful integration relationship among the concerned variables.

Figure 2: Plot of Trace Statistics



H_0: r = 0 & corresponding H_1: r >= 1



H_0: r = 0 & corresponding H_1: r >= 1

The above plots of trace statistics, with respect to the issue of integration of six variables, show evidence of relatively weak convergence over the study period as the plots, in particular, indicate that these three equity indices and three macroeconomic indicators tend to have at most one cointegrating relationship for both windows of 84 and 108 observations. This weak convergence is revealed by rejection of H_0: r = 0 and acceptance of corresponding H_1: r >= 1. Significant surge in convergence is observed during the period of Asian financial crisis during 1997 – 1998 for both windows as addressed by the trace statistics consistently greater than one during that period. This finding is in line with the findings by of the study by I.-W. Yu et al (2010), where the authors intend to examine the dynamic integration process of Asian four dragon’s equity markets and Asian emerging markets. This increased convergence during 1997 financial crisis, however, should be carefully interpreted as it may lead to market contagion and transmitting volatility from one equity market to another very rapidly. Moreover, major macroeconomic policy changes to curb the propensity of financial crisis may exert immediate influence on equity markets. In addition, investors both in real sector and capital markets supposed to be in difficulty in diversifying their investments as contagion rolled over in the integrated markets. After the 1997 financial crisis, starting from last quarter of 1998 to first quarter of 2000, the plots of scaled trace statistics show evidence of no integration of these equity markets and macroeconomic indicators. It happens may be due to absence of a common force to bring Malaysian equity market along with Japanese and the US equity markets and Malaysian macro indicators back to equilibrium position. This could be a tranquil period when portfolio investors may gain from portfolio diversification in Malaysia, Japan and the US markets. However, macroeconomic policy changes may exert relatively lower influence on stock price in Malaysia during the tranquil period. These equity markets and macro variables, after the first quarter of 2000, again appear to be converged with one cointegrating relation till 2005. Status of convergence, unfortunately, could not be retrieved from the plots of scaled trace statistics in this study due to observation loss in the converging process. Apparently, we may assume that the convergence process would be continued and suspects to be increased amid 2008 Global financial crisis.

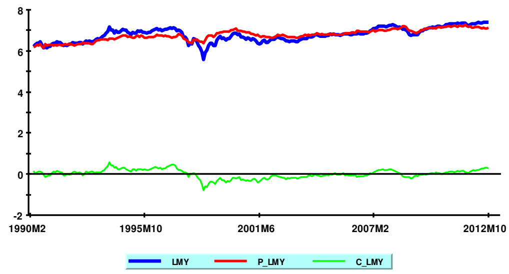
5.5 Beveridge-Nelson (BN) time series decomposition

In this study, we already applied Johansen cointegration and Dynamic cointegration analysis in order to investigate the nature of integration dynamics of equity markets of Malaysia, Japan, and US along with three major macroeconomic indicators of Malaysia: exchange rate, industrial production, and consumer's price index. Both of the approaches indicated the presence of one cointegration relationship. In other words, results addressed the existence of weak and incomplete convergence process among the variables. Moreover, dynamic cointegration failed to show integration dynamics in last 5 years of the study period due to observation loss because of window size. Besides, none of the approaches could decompose the time series in to their permanent and temporary components with a view to portray the co-movement of the permanent and temporary components over the study period.

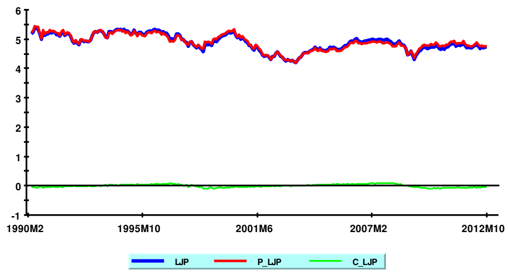
We apply the multivariate Beveridge-Nelson procedure that allows to extract a permanent component and a transitory component (cycle) from a non-stationary series. The permanent component is further partitioned into a trend or deterministic part and a stochastic component. The permanent component is the non-stationary part and the transitory (cycle) component is the stationary part of the time series. Permanent term contains a disturbance term proportional to that of the original data. On the contrary, the transitory component represents the predictable part of the time series, which would be the main concern for accurate forecast of a time series. Therefore, we should look for underlying stationary processes, in terms of identifiable economic fundamentals, ideally with clear basis in the theory. Then we need to identify the predictive power of such stationary processes for the underlying time series. The transitory components are then simply projections from current values of the underlying stationary processes, and the trends themselves effectively drop out as whatever is left over. The nature of both trends and transitory components must thus depend directly on nature, and predictive power, of the fundamental stationary processes.[3] The following figure 3(a) and 3 (b) portray the co-movement of all permanent and transitory components of the concerned time series.

[3]Page 3, Permanent vs Transitory Components and Economic Fundamentals.Garratt, Robertson, & Wright (2004).

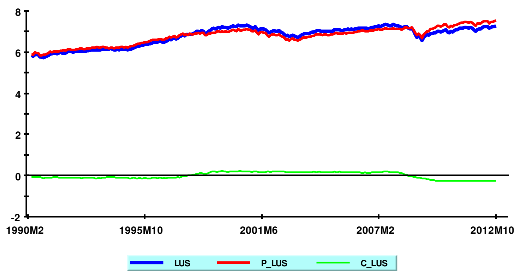
Figure 3 (a): Plot of decomposed time series: Permanent and Cycle Components



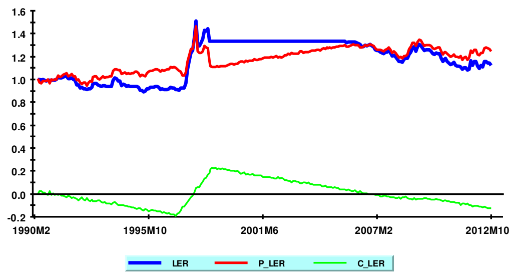
LMY with Permanent & Cycle components



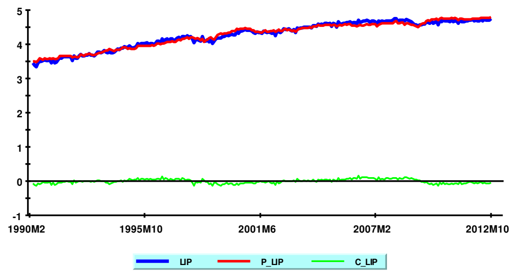
LJP with Permanent & Cycle components



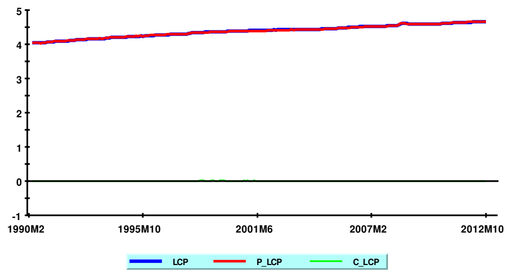
LUS with Permanent & Cycle components



LER with Permanent & Cycle components



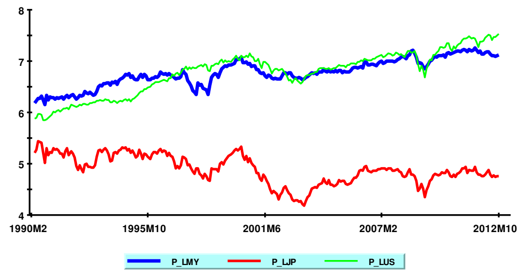
LIP with Permanent & Cycle components



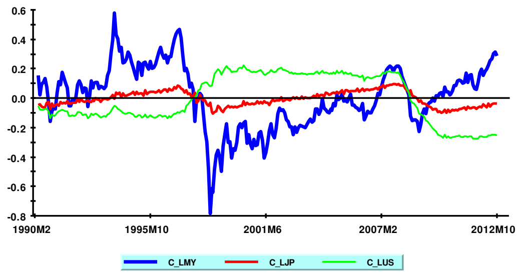
LCP with Permanent & Cycle components

Plots in figure 3(a) reveal that permanent components of all concerned time series appears to move simultaneously with the original (non-decomposed) time series except for Malaysian exchange rate as evidenced by sharp swings in the plot during 1997 – 1998 may be due to 1997 Asian financial crisis. During that period, Malaysian exchange rate dramatically increased against US dollar on account of notable depreciation of Malaysian Ringgit against US dollar. For example, data shows that MYR/USD exchange rate has been hiked by 18 percent in three months, from June 1997 to September 1997. Similarly, it has increased by around 18 percent from September 1997 to December 1997 and increased by 21 percent from December 1997 to September 1998, i.e. in 8 months. Therefore, we observe that Malaysian Ringgit depreciated abruptly at the inception of the 1997 Asian financial crisis. The highest exchange rate was recorded in September 1998, which was 4.22. This rate was around 68 percent more than the rate recorded in June 1997. Accordingly, transitory component of Malaysian exchange rate also shows sharp swings during the 1997 crisis period. This depreciation of Malaysian Ringgit appears to have adverse impacts on Malaysian equity market and on other pertinent economic indicators, which is line with theory.

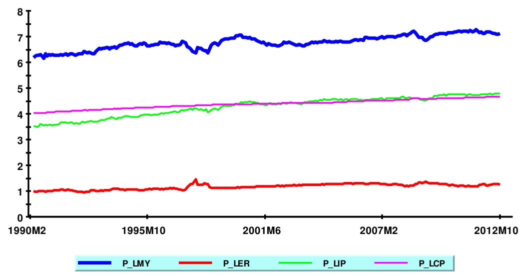
Figure 3 (b): Plot of Permanent and Cycle Components of the variables separately



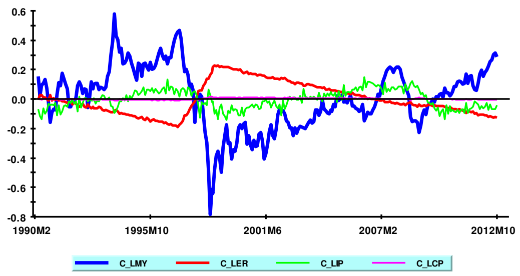
Permanent components of stock prices



Cycle components of stock prices



Permanent components of Malaysia Macro variables and stock prices



Permanent components of Malaysia Macro variables and stock prices

Upper plots in figure 3(b) depict the co-movement of decomposed permanent and cycle components of equity prices of Malaysia, Japan and United States. The plots in the above figure reveal that permanent components of equity prices in these three markets move almost symmetrically and impacts of both 1997 and 2008 financial crises are also apparent. However, cycle component (predictable part) of Malaysian equity price appears to move with larger swings as compared to the US and Japanese equity prices. These findings indicate, first, possible incomplete process of integration of these three equity markets, second, significant adverse impact of 1997 financial crisis on Malaysian equity market relative to Japanese and the US equity markets. Moreover, plots also reveal impacts of 2008 financial crisis in both US and Malaysian equity markets.

Bottom plots in figure 3(b) demonstrate the co-movement of decomposed permanent and cycle parts of macroeconomic indicators with respect to equity price in Malaysia. These plots indicate more or less simultaneous movement of the permanent components of the concerned indicators except for the equity price and exchange rate. Permanent component of equity prices tends to drop in 1997, the commencement of Asian financial crisis, when largest depreciation of exchange rate was recorded in Malaysia. However, predictable parts of consumer price index and industrial production seem to be less volatile than that of equity prices and exchange rate. These findings imply possible adverse impacts of 1997 financial crisis in equity and foreign exchange markets and 2008 financial crisis in equity market of Malaysia. Overall results provided by the BN decomposition approach apparently indicate the evidence of incomplete process of convergence among the concerned equity markets and macroeconomic indicators of Malaysia. Besides, results address the issues of adverse impact of 1997 and 2008 financial crises in Malaysian foreign exchange market and equity markets of Malaysia and the United States.

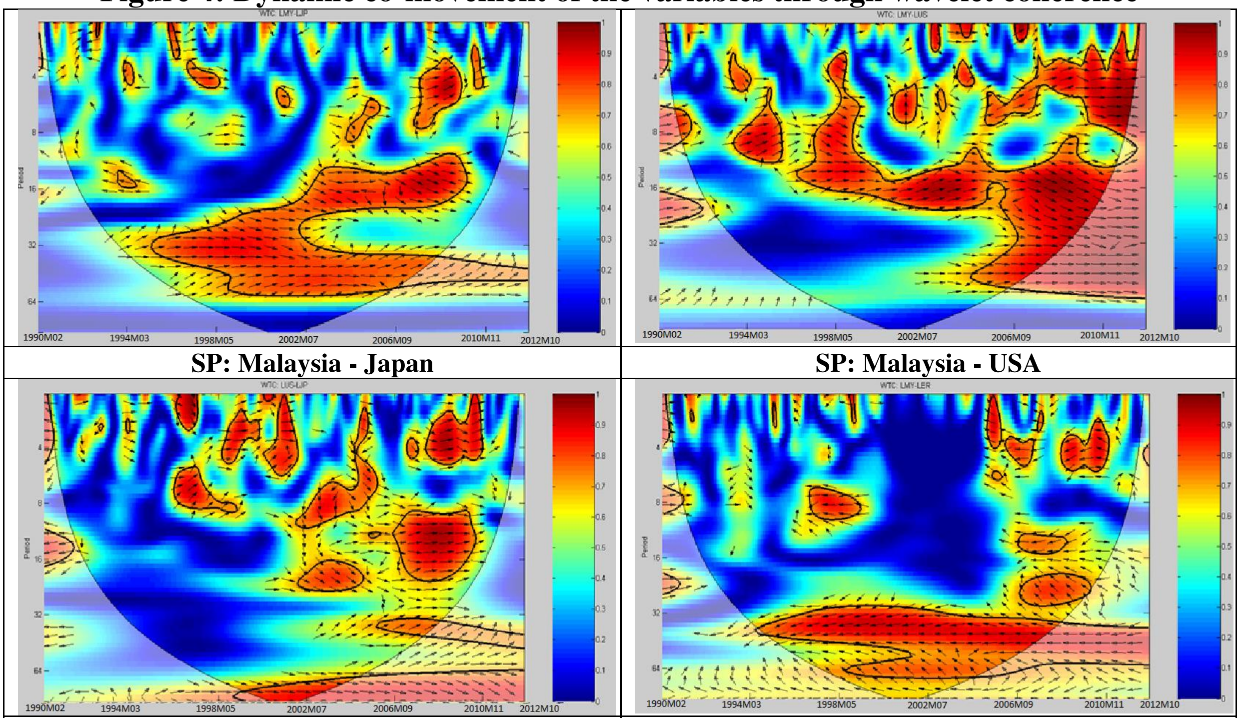
5.6 Wavelet coherence

Wavelet coherence indicates one to one co-movement of the equity markets and macroeconomic indicators of Malaysia over the study period. Moreover, co-movement of the time series is observable according to different time scales, which all other above approaches failed to perform. This approach also indicates the lead-lag relationship between the time series and presence of possible structural break over the estimation period. Presence of structural break can be identified by the correlation jump between two time series as indicated by the red contour in the coherence figure, which also indicates the issue of possible contagion effect between the two time series. On the contrary, blue contour indicates relatively tranquil period of low correlation between the time series. We follow the following yardsticks to establish lead-lag relationship according to various timescales between two time series, where X represents first and Y represents second time series:

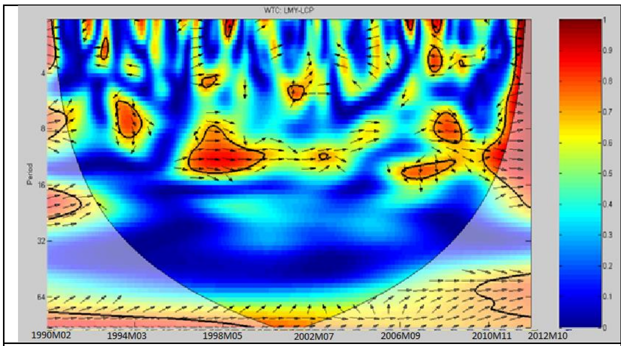
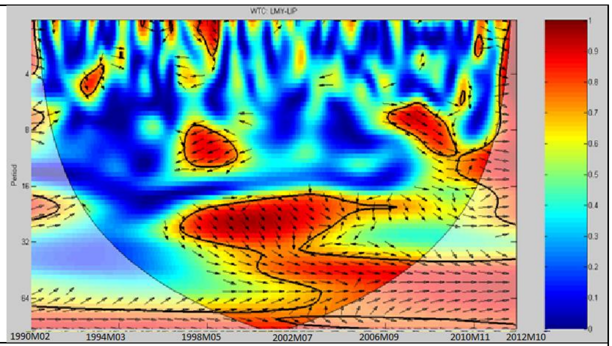
- When arrows direct towards left (and upward left), there exists negative correlation and time series X is leading time series Y.
- When arrows direct towards right (and upward right), there exists positive correlation and time series Y is leading time series X.
- When arrows direct towards left (and downward left), there exists negative correlation and time series Y is leading time series X**.**
- When arrows direct towards right (and downward right), there exists positive correlation and time series X is leading time series Y**.**

Following figure 4 depicts the co-movement and lead-lag relationship between the variables through wavelet coherence estimation:

Figure 4: Dynamic co-movement of the variables through wavelet coherence



SP: Malaysia - Japan | **SP: Malaysia - USA** | **SP: USA – Japan** | **SP and ER: Malaysia**

	
SP and CPI: Malaysia	**SP and IP: Malaysia**

Note: In figure 4 and table 6, SP = Equity price, ER = Exchange rate, CPI = Consumer's price index and IP = Industrial production

Summary of the wavelet coherence analysis in order to investigate dynamic co-movement of the concerned equity markets and macroeconomic indicators is presented in the following table 6.

Table 6: Summary of Wavelet Coherence results

	Time Scales				
Co-movement Relationship	0 – 4 Months	4 – 8 Months	8 – 16 Months	16 – 32 Months	32 – 64 Months
SP: Malaysia & Japan	Relatively tranquil except structural Break in 1997 – 1998. Japan leads Malaysia. Moderate positive correlation (+0.7 to +0.8)	Relatively tranquil except structural Break in 2008. Japan leads Malaysia. Moderate positive correlation (+0.7 to +0.8)	Presence of structural break leading to contagion during 2008 – 2009. Japan leads Malaysia. Moderate positive correlation (+0.7 to +0.8)	Presence of structural break leading to contagion during 2003 – 2009. Japan leads Malaysia. Moderate positive correlation (+0.7 to +0.8)	Presence of structural break leading to contagion during 1997 – 2009. Japan leads Malaysia. Moderate positive correlation (+0.7 to +0.8)
SP: Malaysia & USA	Relatively tranquil except structural Break in 2008. US leads Malaysia. High positive correlation. (+0.8 to +0.9)	Presence of structural break in 2008. US leads Malaysia. High positive correlation. (more than +0.9)	Presence of structural break in 1998. US leads Malaysia. High positive correlation. (+0.8 to +0.9)	Presence of structural break in 2008. US leads Malaysia. High positive correlation. (more than +0.9)	Presence of structural break in 2008. US leads Malaysia. Moderate positive correlation. (+0.7 to +0.8)
SP: USA & Japan	Mixed relationship at moderate level except in 2008. USA is leading Japan	Mixed relationship at moderate level. USA is leading Japan	Relatively tranquil except structural Break in 2008. USA is leading Japan	Relatively tranquil except structural Break in 2008. USA is leading Japan. Low positive correlation	Relatively tranquil except structural Break in 2008. USA is leading Japan. Low positive correlation
SP & ER: Malaysia	Relatively tranquil except structural Break in 2008.	Relatively tranquil except structural Break in 2008.	Relatively tranquil except structural Break in 1997	Relatively tranquil except structural Break in 2008. SP	Presence of structural break and contagion starting from 1997

	SP leads ER. Moderate negative correlation (-0.7 to -0.8)	SP leads ER Moderate negative correlation (-0.7 to -0.8)	and 2008. ER leads SP in 1997. SP leads ER in 2008 (-0.7 to -0.8)	leads ER Moderate negative correlation (-0.7 to -0.8)	to 2008. Moderate negative correlation (-0.7 to -0.8). ER leads SP in 1997 and SP leads ER in 2008
SP & CPI: Malaysia	Relatively tranquil	Relatively tranquil	Structural break during 1997 and 2008. Moderate positive correlation. CPI leads SP in 1997 and SP leads CPI in 2008	Relatively tranquil	Relatively tranquil
SP & IP: Malaysia	Relatively tranquil	Relatively tranquil	Structural break during 1997 and 2008. IP leads SP in 1997 and correlation is moderately positive. SP leads IP in 2008 and correlation is positive.	Structural break during 1997 and 2008. SP leads IP starting from 1997 to 2008. Correlation is positive.	Structural break starting from 2002 to 2008. SP leads IP during this period. Correlation is positive.

Table 6 demonstrate the status of dynamic co-movement and lead-lag relationship of equity prices of Malaysia & Japan, Malaysia & USA, USA & Japan, equity price & exchange rate of Malaysia, equity price & CPI of Malaysia and equity price & industrial production of Malaysia.

We observe relatively tranquil movement between equity prices of Japan and Malaysia except presence of possible structural break in 1997 in shortest timescale, 0 – 4 months, whereas, for 4 – 8 month time scale and 8 – 16 month time scale, possible structural break appears to be in 2008. Relatively longer period of market turbulence is observed for 16 – 32 and 32 – 64 month time scale. In all instances, Japanese equity market is leading Malaysian equity market with a moderate degree of positive correlation (+0.7 to +0.8). This result suggests close nexus between these two markets, which turns to be more dominant during periods of economic turbulence. Consequently, innovation and shocks in Japanese equity market spills over to the Malaysian equity market.

This positive relationship between these two markets may not generate portfolio diversification benefits for the portfolio investors and managers in general and during the financial crises in particular in all time scales. Therefore, portfolio managers and multinational firms should be prudent enough, particularly in timing, to execute their investment policies in these two neighboring markets. Investors may consider investing in sectors other than stock markets since these markets are positively correlated. Policy makers should be aware enough to control credit, which in turn may flow to these stock markets, particularly during financial crises. Otherwise, crises may aggravated by the possible failure of credit repayment due to ongoing crises. Existing portfolio investors in these two markets would be suggested to take position may be in derivative markets in order to hedge possible loss from their investments. Finally, these two markets in conjunction may not be better candidate for portfolio diversification particularly in longer investment horizon.

We notice relatively different status of co-movement between equity prices of Malaysia and the global leader United States. These two equity markets tends to be highly correlated during 2008 financial crisis, even though, empirical findings of a number of studies including this study suggest that Malaysian equity market tends to be more integrated with Japanese equity market than the US equity market in the long term. This higher degree of co-movements (+0.8 to +0.9) during 2008 financial crises would suspend the possible gain from portfolio diversification. Therefore, it would beneficial for the investors and portfolio managers to invest in these two markets with prudent planning avoiding economic turbulence periods.

Status of co-movement between equity prices of Japan and USA seems to be comingled in shorter time scales. Despite this fact, results imply the leadership of the US equity market with low positive correlation. Meanwhile, weak convergence between these two markets in longer time scales would be validated by their relatively low positive correlation, except for 2008 financial crisis period. This finding may convey good news for the portfolio investors and managers to select the stocks from these two markets as ideal instruments of portfolio construction, even though, not the entire market but stocks in particular sectors would be preferred by the investors.

Results show that equity price and exchange rate of Malaysia tend to move in reverse direction over the estimation period in general and during turbulence period in particular. During 1997 crisis period, shocks in exchange rate leads the stock price to change. Meanwhile, reverse mechanism works during 2008 financial crisis, when crisis, in fact, originated in US equity market at inception and then spilled over to the Malaysian market. Adverse effect of 2008 crisis is evident in all time scales but effect of 1997 crisis is dominant in 8 – 17 month and 32 – 64 month time scales. This result would convey positive signal for the portfolio managers, both domestic and foreign, to invest both in foreign exchange and equity markets as diversification benefit would be higher due to negative correlation.

With regards to consumer's price index (CPI), higher level of convergence with stock price is observed during 1997 and 2008 financial crises in 8 – 16 month time scale. Relationship seems to be placid in other time scales. Results indicate that CPI tends to lead stock price during 1997 crisis. However, equity price inclines to lead CPI during 2008 financial crisis. A moderate level of positive relation has been observed between these two indicators during the crises period. Apart from inherent negative relation, theory also advocate for a positive relation between equity price and CPI, when higher inflation leads to higher returns to equity holders as price of products may surge at a faster rate than wage rates. Similarly, change in equity price may lead to change in CPI, which may take place due to any shock or innovation in equity market, even though this relationship is uncommon. For example, equity market turmoil during 2008 financial crisis leads to drop in stock price and eventually CPI tends to drop. Therefore, we suggest the investors to be aware of medium time scale (8 – 16 month) for equity investment in Malaysia during the financial crisis period. Investment in other time scales would be relatively safer as suggested by the results. Contractionary monetary policy to curb inflation would be detrimental to equity market, particularly when equity prices tend to rise due to inflation hike. Policy makers may require careful vigilance in balancing money supply in the economy in order to pacify the possible anarchy in the equity market as a whole.

As for industrial production, co-movement with equity price seems to be serene in shorter time scales but relatively higher convergence may be observed in longer time scales. Adverse effect of both 1997 and 2008 financial crises on co-movement between equity price and industrial production is evident from the results. Results suggest that in most of the instances industrial production tends to lead equity price positively even during the period of economic turbulence. This issue has already been validated by the results of other analysis in this study. Industrial sector has been in continuing growth in Malaysia, which should be reflected in the growth of equity market as well. This inherent relation, sometime, may be distorted on account of unexpected events. Therefore, policy makers should formulate and execute policies in favor of industrial production growth in order to foster equity market growth in Malaysia.

As a whole, by applying wavelet coherence approach, this study intend to investigate the in depth picture of dynamic convergence of equity prices and macroeconomic variables in Malaysia. Unlike other approaches, the approach provides comingled experiences of convergence status in different time scales.

6. Concluding remarks

This study employed a few pertinent approaches, such as Johansen cointegration technique, vector error correction model (VECM), variance decompositions (VDCs), dynamic cointegration, Beveridge-Nelson (BN) time series decomposition and finally, wavelet coherence in order to investigate the dynamic integration of equity price and major macroeconomic indicators in Malaysia. In addition, this study attempts to examine how and what level Malaysian equity market is integrated with major foreign equity markets, such as Japanese and US equity markets. Following table 7 presents the summary of the findings from the empirical analysis by different approaches.

Table 7: Summary of integration status of equity markets and major macroeconomic indicators

Method	Objectives	Major Findings
Johansen cointegration	To investigate the presence and level of integration (long run relationship) among variables.	Suggests presence of one cointegrating relationship among equity markets of Malaysia, Japan, USA, exchange rate, CPI and industrial production of Malaysia. Also indicates that this integration seems to weak and incomplete.
VECM	To investigate the direction of co-movement and causality among the integrated variables. In other words, to test endogeneity and exogeneity of the integrated variables.	Addresses the endogeneity of Malaysian equity market, i.e. Malaysian equity market appears to be dependent on innovations in Japanese and US equity markets and changes in exchange rate and inflation of Malaysia. Also found that Malaysian industrial production seems to be dependent on equity prices and other variables. Moreover, indicates significant impact of Financial crises on Malaysian equity and

		foreign exchange markets.
VDCs	To assess relative degree of endogeneity/exogeneity, i.e. to find out leader-follower relationship.	Finds that Japanese equity market and Malaysian inflation rate appear to be leading equity market and macroeconomic indicator to influence Malaysian equity market.
Dynamic cointegration	To examine the time varying integration status of the integrated variables.	Suggests weak and incomplete process of integration over the estimation period. Also indicates increased level of integration during periods of financial crises.
BN decomposition	To investigate the co-movement of the permanent and transitory parts of the cointegrated variables.	Demonstrates almost simultaneous co-movement of permanent and transitory components of the concerned time series of equity prices and macroeconomic indicators. Co-movement appears to be closer during financial crises.
Wavelet coherence	To investigate the co-movement of the variables according to different time scales and to find out lead-lag relationship between the variables	Suggests closer co-movement of Malaysian equity market with Japanese equity market, which tends to vary according to time scales. Short term investment might be safer than long term investment, particularly during economic turbulence period. Better diversification benefit may be possible by investing in Japanese and US stocks. Finds that Malaysian equity price is highly responsive to changes in exchange rate in time scales. Equity price also finds to be responsive to changes in inflation and industrial production. Details of these findings is somewhat different from the findings of the VECM and VDCs.

The findings from results of different approaches regarding the status of integration are not uniform. The findings of the study have several implications for the investors and policy makers in general and portfolio managers in particular.

Evidence of one cointegration relationship indicates that there exists a common force to move these equity markets and macroeconomic indicators together in the long term. This implies that Malaysian equity market is theoretically (long run) related with Japanese equity market, the Asian leader, and the US equity market, the global leader. Portfolio diversification benefits would disappear in the long run due to theoretical connection of these equity markets. Results also indicate that Malaysian stock price maintains long run relationship with exchange rate, consumer's price index and industrial production of Malaysia. Consequences of this integration of equity price and macroeconomic indicators of Malaysia are in line with theories. This long run theoretical relationship also indicates to have insignificant gain from arbitrage activity among these three markets. This theoretical relationship in general and integration between Malaysian equity price and macroeconomic indicators in particular, would convey worthy information for the multinational firms and foreign portfolio managers concerning their direct investment in the real sector and portfolio investment in Malaysia. Prudent vigilance would be recommended by the policy makers to minimize the effect of financial contagion and should favor the growth and development of equity market while formulation and executing monetary policies of Malaysia. Higher convergence of Malaysian and Japanese equity markets as evident by the study would help investors and portfolio managers for their investment timing, setting and planning in Japanese market. They may find to form better portfolio by investing in Japanese and US equity markets. The results suggest the policy makers of Malaysia to observe the events and happenings in Japan carefully to predict the direction of Malaysian equity prices and markets. For example, adverse effect of natural disaster like earth quake and tsunami is inherent in Japanese equity markets, which may spill over to Malaysian market may be due to higher convergence and possible cross listing of equities in both markets.

Incomplete and weak convergence of equity markets and macroeconomic indicators as suggested by dynamic cointegration would convey slightly different message to the investors and portfolio managers. Still there remains possibility of abnormal gain from portfolio diversification in these three markets, which also indicates presence of information efficiency in the markets. Policy makers, for the long run benefit of the economy, should favor higher degree of integration as it supposed to generate a number of benefits for the economy. Higher integration enhances the capacity of competitiveness in the economy, reduces income and inequality gap when economic agents are competitive, encourages homogeneous development in the economy, induces technology transfer, raises cross border employment opportunities and so on. However, policy makers should be aware of the issues of contagion when economies as a whole and equity markets in particular are highly integrated. Besides, co-movement between two equity markets in different time scales as suggested by the wavelet coherence would be beneficial and conducive for the investors and portfolio managers in planning the timing of investment by avoiding turbulent periods in order to achieve maximum benefits from portfolio diversification. Co-movement based on different time scales also has implications for policy makers of Malaysia since it provides a detailed and in depth picture of co-movement of equity price, exchange rate, consumer's price index and industrial production index in Malaysia. Policy makers also get time scale based co-movement of Malaysian equity market with major foreign equity markets, which would help them to set bilateral economic policies in general and investment policies in particular.

While this study undertakes only two foreign markets and three major macroeconomic indicators, future research should look at more emerging markets where investors may find better diversification opportunities and consider more relevant macro indicators for Malaysia. Also, future research should look at long run relationship between contribution of foreign labor and growth of equity market in Malaysia as contribution of foreign work force (skilled and unskilled) in industry and services sectors has been increasing in Malaysia.

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