Dynamic Bilateral Integration of Stock Markets and Its Driving Factors

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Abstract:

This study aims to assess the degree of dynamic integration in developed and emerging stock markets and to investigate various factors fostering the integration of those markets. Dynamic conditional correlation (DCC) technique was used to identify the degree of dynamic correlation between two stock markets returns and henceforth it was applied as a measure for assessing the degree of integration. We employed panel data regression and GARCH (1,1) techniques to investigate its determinants using data observed during the period January 2000 to May 2016 on a monthly basis from four countries selected. Result obtained from the assessment indicated that different pairs of international stock markets displayed differing degree of integration. The investigation on the effects of its determinants suggested that interest rate and exchange rate volatility had negative effect on the degree of market integration. Furthermore, inflation rate had no effect, while crisis condition and return volatility increased the degree of market integration. Specifically, significant role of those factors in explaining dynamic integration was only found in emerging stock markets.

Keywords: dynamic integration; DCC; GARCH; panel data.

JEL Classification: F36; G15; C10

Introduction

The removal of various explicit barriers gradually to international trade and investment exhibits to have lasted since last three decades. Financial liberalization generally refers to the removal of direct or institutional barriers that include legal restrictions on cross-border securities trade, foreign exchange regulation, repatriation limits, taxes, and transactions costs. Liberalization and open financial markets should allow global investors to enter the market, buy domestic stocks and apply international portfolio diversification. This will eventually lead to the demands and the urgent need for firms' management to increase transparency and accountability that will generate a growing resources allocation, reduce the risk of holding stocks and reduce cost of capital, which in turn leads to increased real assets investment and higher economic welfare (Arouri, Nguyen, and Pukthuanthong 2012, Diamandis 2008, Kim and Singal 2000).

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Financial liberalization implemented by developed countries have a series of major objectives such as the strengthening of financial integration in order to obtain a number of benefits including risk diversification, volatility stabilization, cost of capital reduction, informational efficiency improvement, and capital inflows movement in providing funding for many domestic investment projects in developing stock markets. The benefits may ultimately increase economic growth (Bekaert and Harvey 1997, 2003). Therefore, integration of stock markets is a central concept in the field of international finance and investment.

Consequences of financial liberalization and integrated financial markets, on the one hand, have a positive impact as stated above. However, large-scale capital inflows contain certain risks in the recipient country, especially when their financial systems are not sufficiently advanced, and domestic macroeconomic and financial policies are weak or inconsistent (Alper and Yilmaz 2004). Furthermore, Bekaert and Harvey (1995) and Phylaktis and Ravazzolo (2002) argue that financial liberalization makes financial markets to be more integrated to the global international financial movements so that is more sensitive to external shocks. Economic events show that the financial turmoil does not occur alone on a country or a region. In addition, volatility spill over is a consequence of financial interdependence between stock markets. Many stock markets have received systemic impact and volatility spill over caused by the delivery of information spill over from other markets (Fleming, Kirby, and Ostdiek 1998).

The integration among the world's stock markets is of importance for both international investors and policy-makers. For international investors, the integration determines the opportunities for international portfolio diversification. They need to understand the forces behind the interdependence of stock markets in order to realize the potential risks and rewards of global diversification. For policy-makers, it can result in contagion effects due to which the price changes and potential errors are transmitted across markets. Contagion effects have been magnified by the major events affecting stock markets such as the global financial crisis. They need to understand the driving forces behind the integration since contagion means irrational capital flows, especially capital outflows when capital is needed the most (Lean and Smyth 2014, Pretorius 2002).

From the perspective of analytic techniques, they are increasingly sophisticated in examining topic of markets integration so as to enrich the expansion of analysis and reduce the weaknesses of previous techniques. Considering that risk premium on equities and financial integration processes appear to vary over time caused by the degree of economic integration varies over time for a given pair of countries (Bekaert and Harvey 1995, Guesmi and Teulon 2014, Harvey 1991, Kearney and Lucey 2004) and dynamic development of economic and business factors, the previous studies among others Karolyi and Stulz (1996), Karim and Ning (2013), Dorodnykh (2014) require expansion of analysis.

Zonouzi, Mansourfar, and Azar (2014) reveal that in most previous studies, Pearson correlation test was used to analyze the short-term relationship between market prices. Recent empirical studies, however, show that the correlation between equity returns varies over time. Therefore, they use DCC model to review the conditional correlation varying over time. Other studies using the DCC technique were conducted by Kuper and Lestano (2007), Chiang, Jeon, and Li (2007), Diamandis (2008), Arouri and Nguyen (2010), Christoffersen, Errunza, Jacobs, and Jin (2014), Majdoub and Mansour (2014).

Our study differs from the previous studies on factors influencing degree of market integration in term of the analytic technique. Our study accommodates integration process varying over time by applying dynamic conditional correlation (DCC) as a measure of integration and it becomes dependent variable in our model. DCC technique was proposed by Engle (2002) and has been adopted in several studies to examine the degree of integration between stock markets. In addition, from the scope of discussion, literature on how stock markets are integrated has been widely studied in various countries. However, it still can be counted as the study investigating on forces affecting the degree of stock market integration (Karim and Ning 2013, Mobarek and Mollah 2016, Pretorius 2002). Because it was still scarce and less complete and to take advantage of increasingly sophisticated analytic technique, our research attempts to fill the gap.

According to three categories of literature on stock markets interdependence stated by Pretorius (2002), we examine the first and the third categories. We investigate stock markets interdependence to determine how specific pairs of stock markets are integrated and attempt to explain why the stock markets are integrated. Section 2 provides a literature review on stock market integration covering theory and definition; several previous studies that examine the presence of integration and its determinants in various countries. The data and methods are explained in Section 3. The results and discussion are given in Section 4, and Section 5 presents the conclusions generated from this study.

1. Literature review

The law of one price (LOOP) is a fundamental principle underlying the integration of financial markets. This law stipulates that two markets are integrated when identical goods or assets are priced equally across borders (Yeyati, Schmukler, and Horen 2009). According to Marashdeh and Shrestha (2010), the law states that when transaction costs and taxes are not taken into account, identical securities should carry the same price across all stock markets where such securities are traded. Kearney and Lucey (2004) state that if two or more stock markets are integrated, then assets with identical cash flows should command the same return within both markets. In the case of stock market integration, all assets with similar risk characteristics and maturity have the potential to attract the same return across different markets.

Stock market integration can be defined as a union of a number of separate stock markets both informational and operational in term of trading mechanisms and activities, instruments characteristics, and interaction among market participants. Arouri *et al.* (2012) state specifically that markets where the assets require the same expected return regardless of their trading location are said to be integrated, while markets where the expected return of an asset depends on their location are said to be segmented.

The earlier studies of stock markets interdependence and portfolio diversification have performed using static correlation technique to test the short-term linkages, among others Grubel (1968) and Levy and Sarnat (1970). Most of the studies found a low correlation between stock markets which suggest the potential benefits for international portfolio diversification. Grubel (1968) explores potential benefits for the US investors who hold long-term international assets. He finds that between 1959 and 1966, the US investors could have achieved superior risk and return opportunities by investing part of their portfolio in foreign equity markets. Furthermore, Levy and Sarnat (1970) analyze international correlations for the period 1951-1967, and show the diversification benefits from investing in developed and emerging equity markets. Investors are conscious of the fact that international stocks have different characteristics so that by applying diversification among different countries can increase their portfolio performance.

Following earlier studies, benefits of international portfolio diversification (IPD) have been examined by Solnik (1974) and Lessard (1976). Unlike the above-mentioned studies which investigate only for the US stock market, however, Solnik (1974) finds the first evidence relating to international diversification. Solnik's theory states that the benefits can be achieved through the IPD if returns in the different markets are not perfectly correlated. Furthermore, Lessard (1976) explains that equity investing in international markets differs from equity investing in domestic market in three important respects.

First, the co-variances among securities within national markets are much higher than the co-variances among securities in different markets. National factors have a strong impact on returns of security relative to any common world factor. This contrasts with the more familiar covariance structure of single market, like that the US, where there is well defined national market factor and few stable relationships among returns on individual securities beyond this factor.

Second, barriers imposed by taxation, currency controls, or even investor tradition may segment financial national markets sufficiently that securities are priced in a domestic, rather than an international context. Third, exchange rates between different currencies may fluctuate, increasing the possibility of exchange risk in international investment. He uses two sets of data. The first set is percentage changes in market-value weighted price indexes monthly for 16 countries and 30 industries covering the period January 1959 to October 1973. The second set is monthly price changes for 205 individual securities from 14 countries and 14 industries over the period January 1969 to October 1973.

Studies investigating the existence of stock market integration are scattered in empirical literature and the results are highly varied. The review from Lean and Smyth (2014) suggests that many previous studies have examined the linkages among world major stock markets or between world major stock markets and stock markets in emerging regions. One conclusion shows that linkages among the major markets have increased over time. Their second conclusion shows that emerging stock markets are becoming more integrated with markets in the major financial centres.

Guidi and Ugur (2014) find that the South-Eastern European stock markets of Bulgaria, Croatia, Romania, Slovenia and Turkey are integrated with developed markets (US, Germany, UK). The implication of this finding is of international portfolio diversification opportunities decline over time. This conclusion is different from the finding of Naranjo and Porter (2007), which reports that assets in emerging stock markets exhibit very low correlation of returns with assets in developed markets and due to this, complementing characteristics of emerging markets in an international portfolio provides greater diversification benefits than adding only the developed markets. Christoffersen *et al.* (2014) investigate patterns and trends in correlations over time for developed markets (DMs) and emerging markets (EMs). Empirically, they find that correlations have trended upward significantly for both DMs and EMs. Based on a time-varying measure of diversification benefits, they find that adding EMs to a DM-only portfolio increases diversification benefits.

A set of other empirical literature apply co-integration techniques to assess level of long-term co-movements among international stock markets, but the results are varied and uncertain. Kasa (1992) finds that only one vector of integration in world's major stock markets, namely the US, Japan, Britain, Germany, and Canada during the period 1974-1990, which indicates lower level of convergence. Choudhry (1994) finds no evidence of long-term linkages among countries G-7 (the US, Britain, Canada, France, Japan, Italy, and Germany) for the period 1953-1989. Kanas (1998) suggests that the US equity market is not co-integrated with any of the major European equity markets during the period from 3 January 1983 to 29 November 1996. Some studies have found that stock markets were not co-integrated during the Asian financial crisis (Goh, Yoke-Chenwong, and Kok 2005).

There are many studies using co-integration techniques to determine whether Asian markets are integrated, but in general they obtain inconsistent results. For example, Majid, Meera, and Omar (2008) reveal that the ASEAN stock markets are going towards a greater integration either among themselves or with the US and Japan, particularly in the post-1997 financial turmoil. Their study discovers that Indonesia was relatively independent of both the US and Japan. In the other regions, Arouri and Nguyen (2010) explore the time-varying characteristics of stock market linkages within the Gulf region and find the weak linkages between the stock markets of this region. Marashdeh and Shrestha (2010) sampled Gulf Cooperation Council (GCC) countries to investigate the long-run relationship and linkages among these countries by applying the ARDL approach. Their results show that the GCC stock markets are not fully integrated among themselves. Zonouzi *et al.* (2014) find that market returns of the sampled Middle Eastern oil-producing countries are not definitely correlated in the short- and long-term.

From the different perspective, Arouri *et al*. (2012) divides stock markets in terms of the reasons why they are segmented. Market segmentation is generally the result from three different factor groups: direct capital flow barriers, indirect barriers, and world economic conditions. Direct barriers affect the ability of global investors to invest in the assets of a particular country, whereas indirect barriers and general global economic variables affect their willingness to invest in these assets. Direct barriers are institutional barriers that differentiate between domestic and foreign investors. In the last decade, the institutional barriers have been lower significantly, and in some cases, especially in the major developed countries, completely eliminated. However, indirect barriers can still discourage foreign investors and prevent world stock markets integration. Examples of indirect barriers include risk perception based on ignorance, expectations of expropriation by the government or majority of shareholder and less developed markets and institutions. They can also arise from asymmetric information between potential foreign entrants and domestic incumbents, differences in accounting standards and investor protection, and some specific risk such as economic instability, exchange rate risk and liquidity risk. The global economic conditions could potentially affect the degree of stock market integration. Low returns in domestic markets during recessions drive investors to invest abroad in search of higher returns that could lead to higher integration, while high domestic returns tend to keep at home. Similarly, low interest rates and low economic growth in a domestic market could lead higher market integration by increasing capital mobility across-borders. Lastly, exchange rate volatility could drive to high market segmentation.

Based on the literature, Pretorius (2002) also notes that in general, there are three categories for explaining why different stock markets are co-movement. The categories are contagion effect, economic integration, and stock market characteristics. Economic integration is divided into two categories, namely bilateral trade and cash flow model. For the first, the stronger the bilateral trade relations between two countries, the higher the degree of co-movement between their stock markets. Second, based on cash flow model, a number of macroeconomic variables, such as interest rates and inflation, affect the performance of stock market. Because these variables influence market returns, correlation between these variables will affect correlation between stock markets returns. In other words, if macroeconomic variables in two countries convergent (divergent), then performance of stock markets should also convergent (divergent). Furthermore, cash flow model mathematically is described referring to initial formation of the intrinsic stock price as follows. Stock price (P) can be written as the expected discounted stream of dividends:

$$P = ((1 + g)\, D_0) / (k-g) \quad (1)$$

where: D_0 is the last dividend paid, g is the (constant) growth rate in dividends and k is the discount rate.

In simple terms it can be stated that the systematic forces affecting stock prices, and hence returns, are those affecting the discount factor (k) or growth rate in dividends (g). Any factor affecting the stream of cash flows or the discount rate will systematically affect stock prices. From this model, Chen, Roll, and Ross (1986) state in their article that the effects of interest rates and inflation on the discount rate, and industrial production growth on the expected cash flow, and hence on stock prices, have been well established.

These macroeconomic variables affect stock market performance of an individual country, which means that in two countries where these variables are similar, then stock market performance will be similar. For example, if the interest rates of two countries show the same trend over time, perhaps due to similar monetary policies, the impact of interest rates on stock prices will result a co-movement in the two markets. Therefore, greater differences in interest rates, growth, and inflation will cause smaller amount of co-movement. It is predicted that increasing deviations will lead to less stock markets co-movement over time. It can be said that if the economic variables that affect stock markets in two countries diverge (converge), their stock prices are estimated to diverge (converge).

The empirical evidence on determinants of stock markets co-movement has been described by several authors. Bracker, Docking, and Koch (1999) observe on nine national stock indices, including Japan and the US during 1972-1993, and investigate how and why the correlation structure varies over time. They conclude that level of international integration as measured by magnitude of correlation structure is positively related to world market volatility and trend. In addition, level of international integration is negatively related to exchange rate volatility, term structure differential across markets, real interest rate differentials, and the returns on a world market index. Not much different, Johnson and Soenen (2002) also investigate how and why different pairs of international stock markets display differing in degrees of co-movement over time. They use daily returns from 1988 to 1998 in twelve Asian equity markets to investigate level of integration with the Japanese equity market and examine factors influencing level of economic integration. They find two main empirical results showing that Australia, China, Hong Kong, Malaysia, New Zealand, and Singapore equity markets are strong integrated with stock market in Japan, and several macroeconomic factors are significantly associated with degree of stock market integration over time. A higher import share and a greater differential in inflation rates, real interest rates, and GDP growth rate have negative impact on stock market co-movement. In contrast, increased export share by Asian countries to Japan and greater foreign direct investment from Japan contribute to greater co-movement.

Pretorius (2002) examines ten emerging stock markets during the period 1995-2000 by using a cross-sectional and a time-series model. The main finding shows that only the extent of bilateral trade and the industrial production growth differential are significant in explaining the correlation of returns between two countries on a cross-sectional basis. In addition, countries in the same region are more correlated than countries in different regions. The results of the time-series regression show that only the extent of bilateral trade, industrial production growth differentials, a dummy to reflect the 1998 emerging market crisis and regional dummy variables are significant in explaining the pair correlation coefficients.

Lin and Cheng (2008) apply nonlinear multinomial logit model (MNLM). By using daily data covering the period from 1994 to 2004, their empirical analysis suggests that economic determinants affecting stock markets co-movement between Taiwan and its four major trading partners (Mainland China, the US, Japan, and Hong Kong) are market return volatility, rate of change in exchange rate, and interest rate differentials. A similar study examined by Tavares (2009) analyzes how bilateral indicators of economic integration impact on stock returns co-movements among countries, in developed and emerging stock markets. The sample used covers 40 developed and emerging markets from 1970 to 1990. The results show that bilateral trade intensity increases stock returns correlation, while real exchange rate volatility, asymmetry of output growth, and dissimilarity of export structure decrease stock returns correlation.

Karim and Ning (2013) examine determinants of level of integration among five ASEAN emerging stock markets, namely Indonesia, Malaysia, Thailand, Philippines, and Singapore during the period 2001-2010. They measure level of integration using a constant correlation between daily returns of two countries and find that trade and stock market volatility, measured by variances of returns ratio in country p and q, significantly influence the level of market integration. Guesmi and Teulon (2014) investigate intra-regional integration in the Middle East region during the period 1996-2008. They employ international version of CAPM that allows for dynamic changes in level of regional markets integration, global risk premiums, currency risk and currency risk premiums. Their finding suggests that inflation, exchange rate volatility, variations in interest rate spreads, and dividend yield of global market are key intra-regional integration variables in the Middle East region context. Furthermore, despite the complex economic and political situation that characterizes this area, the results indicate that stock markets are well integrated in the regional market.

Using broader coverage of markets sample, Dorodnykh (2014) observes many geographical regions including North America, Latin America, Africa and Middle East, Asia and Oceania with the sample period from 1995 to 2010. In this study, multivariable logit regression is used to examine two twenty-eight variables classified into seven types, namely: macroeconomic variables, development variables, regulation variables, structural variables, stock exchange regulation variables, operating variables, and control variables. The results show that financial harmonization, cross membership agreement, for-profit corporate structure, trading engine, and regional integration are important drivers of stock market integration. By contrast, high size of stock market has negative effect on the likelihood of successful mergers.

A recent study by Mobarek and Mollah (2016) assesses international integration and the co-movement between country pairs distinguishing between developed and emerging markets during 1995–2010. The data sample covers 20 countries, ten developed countries and ten emerging countries. They implement a pooled cross-country time series regression models to test significance of independent variables on the degree of integration. The statistically significant variables include, on a global level, import dependence, stock markets' size differential and their relative size, difference in annual GDP growth rate, and time trend. The differences in empirical results among prior studies above may occur because stock markets selected, conditions and periods (such as normal or crisis), frequency of data used (such as daily, weekly or monthly), and method used are different in each study.

2. Data and methods

Data for this study are collected from the websites of international financial statistics (IFS)-International Monetary Fund (IMF), yahoo.finance.com, and other relevant publications. The first data set is monthly market price indexes on the US, Indonesia, Pakistan, and Japan stock markets, including S&P 500, IDX or Jakarta Composite (JKSE), Karachi Stock Exchange (KSE), and NIKKEI225 indexes. These data are used to calculate rate of returns on their respective stock markets and then to find value of DCC between two stock markets returns. Rate of returns at month *t* for stock market price index *i* ($R_{t,i}$) represents the difference between natural logarithm of price index at current period and natural logarithm of price index at previous period on monthly basis. It can be written as $R_{t,i} = \text{Ln } P_{t,i} - \text{Ln } P_{t-1,i}$. The second data set is inflation rate and interest rate in each country as well as exchange rate between two countries. Data provided for inflation rate and interest rates have highest frequency on monthly basis, so for the other data should be adjusted in the same frequency. All data have the same time period spanning from January 2000 to May 2016.

The first part of our two analyses includes the estimation of conditional correlations among the four stock markets. For this purpose, we use the DCC (Dynamic Conditional Correlation) model to estimate short-term conditional relationships among the United States, Indonesia, Pakistan, and Japan stock markets. The principal advantage of this model is that while it retains the main features of standard GARCH models, it allows us to model explicitly time variation in the conditional covariance and correlation matrix.

DCC model introduced by Engle (2002) can be described briefly as follows. In the DCC-GARCH(1,1) model, the conditional variance–covariance matrix is defined by $H_t = D_t R_t D_t$, where H_t takes the following formulation:

$$H_t = \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \begin{bmatrix} 1 & \rho_{12,t} \\ \rho_{21,t} & 1 \end{bmatrix} \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \tag{1}$$

D_t is a (n x n) diagonal matrix of time-varying standard deviations from univariate GARCH models with $(h_{ii,t})^{1/2}$ on the *i*th diagonal, i = 1, 2, …, n; R_t is the (n x n) time-varying correlation matrix and R_t is conditional correlation matrix:

$$R_t = (diag(Q_t)^{-1/2}\, Q_t\, (diag(Q_t))^{-1/2} \tag{2}$$

The evolution of the correlation in DCC model is given by:

$$Q_t = \bar{Q}(1 - \alpha - \beta) + \alpha\, \varepsilon_{t-1}\, \varepsilon'_{t-1} + \beta Q_{t-1} \tag{3}$$

where: $\bar{Q}$ is the unconditional correlation matrix of the epsilons; $Q_t = (q_{ii,t})$ is the (n x n) time-varying covariance matrix of ε_t; α and β are non-negative scalar parameters satisfying $(\alpha + \beta) < 1$.

In the empirical methodology, Arouri and Nguyen (2010) convey that conditional correlation coefficient ρ_{ij} between two markets i and j at time t is then expressed by the following equation:

$$\rho_{ijt} = \frac{(1-\alpha-\beta)\bar{q}_{ij} + \alpha\mu_{i,t-1}\mu_{j,t-1} + \beta q_{i,t-1}}{\left((1-\alpha-\beta)\bar{q}_{ii} + \alpha\mu^2_{i,t-1} + \beta q_{ii,t-1}\right)^{1/2}\left((1-\alpha-\beta)\bar{q}_{jj} + \alpha\mu^2_{j,t-1} + \beta q_{jj,t-1}\right)^{1/2}} \tag{4}$$

where: q_{ij} refers to the element located in the i^{th} row and j^{th} column of the matrix Q_t.

DCC-GARCH model as described above is estimated using a two-stage procedure. In the first stage, a univariate GARCH(1,1) model is estimated for each return series included in the multivariate system. During the second stage, the transformed residuals from the first stage (*i.e.* the estimated residuals standardized by their conditional standard deviations) are used to infer the conditional correlation estimators.

The Log likelihood for this estimator can be expressed as:

$$L = -\frac{1}{2}\sum(n\log(2\pi) + 2\log|D_t| + \log|R_t| + \varepsilon_t' R_t^{-1}\varepsilon_t) \tag{5}$$

The second part of the analysis involves the statistical testing of all observations using panel data regression technique to prove the significance of each independent variable as a potential determinant of the degree of stock market integration. Some benefits of using a panel data include the following: (1) Controlling for individual heterogeneity. Panel data suggests that individuals, firms, states or countries are heterogeneous; (2) Time-series and cross-section studies not controlling this heterogeneity run the risk of obtaining biased results; (3) Panel data give more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency; (3) Panel data are better able to study the dynamics of adjustment; (4) Panel data are better able to identify and measure effects that are simply not detectable in pure cross-section or pure time-series data; (5) Panel data models allow us to construct and test more complicated behavioral models than purely cross-section or time-series data; (6) Micro panel data gathered on individuals, firms and households may be more accurately measured than similar variables measured at the macro level; and (7) Macro panel data on the other hand have a longer time series and unlike the problem of nonstandard distributions typical of unit roots tests in time-series analysis (Baltagi 2005).

Table 1. List of potential determinants

Variables	Description	Expected Direction
Inflation rate (Inf_{ij})	Absolute value of inflation differential between country *i* and *j* $Inf_{ij} = \mid inf\ i - inf\ j \mid$	Negative
Interest rate (Int_{ij})	Absolute value of interest rate differential between country *i* and *j* $Int_{ij} = \mid int\ i - int\ j \mid$	Negative
Exchange rate Volatility ($Forx_{ij}$)	Conditional variance of exchange rate between country *i* and *j* $\sigma^2_{it} = \alpha_0 + \alpha_1 \varepsilon^2_{it-1} + \lambda_1 \sigma^2_{it-1}$	Negative
Crisis period (DCr)	Dummy variable of crisis period with 1 for crisis condition and 0 for other	Positive
Market volatility ($Volt_{ij}$)	Conditional variance of DCC between country *i* and *j* $\sigma^2_{it} = \alpha_0 + \alpha_1 \varepsilon^2_{it-1} + \lambda_1 \sigma^2_{it-1}$	Positive

At this stage, independent variables as displayed in Table 1 are tested using panel data regression technique to dynamic correlation of returns. The model specification is expressed as follows:

$$DCC_{ij,t} = \alpha + \beta_1 Inf_{ij,t} + \beta_2 Int_{ij,t} + \beta_3 Forx_{ij,t} + \beta_4 DCr_{c,t} + \beta_5 Volt_{ij,t} + \mu_t \quad (6)$$

where: $DCC_{ij,t}$ is Dynamic Conditional Correlation of returns between stock markets of country *i* and stock market of country *j* at time *t*; $Inf_{ij,t}$ is difference in absolute value of inflation between country *i* and *j* at time *t*; $Int_{ij,t}$ is difference in absolute value of interest rates between country *i* and *j* at time *t*; $Forx_{ij,t}$ is exchange rate volatility between country *i* and *j* at time *t*; $DCr_{c,t}$ is dummy variable for crisis period at time *t*; the value for crisis period = 1 and for others = 0; $Volt_{ij,t}$ is stock market volatility, obtained from conditional variance of DCC between country *i* and *j* at time *t*; μ_t is error term at time *t*.

We employ DCC model generating degree of dynamic correlation between two stock markets returns to obtain a proxy for the degree of integration. Meanwhile, to obtain values of stock market volatility and exchange rate volatility, we conduct steps of volatility modeling following procedure of GARCH (1,1) model.

We also perform additional analysis to compare the different result possibilities between developed and emerging stock markets. For this analysis, we use a GARCH (p,q) model. Engle (1982) introduced ARCH (Autoregressive Conditional Heteroscedasticity) methodology for calculating volatility of stock returns. He assumed that the conditional variance depends on squared residual in the previous periods or ARCH.

The equation for conditional variance is expressed as follows:

$$\text{ARCH (p)}: \sigma^2_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \dots + \alpha_p \varepsilon^2_{t-p} \quad (7)$$

$$\text{ARCH (1)}: \sigma^2_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} \quad (8)$$

Furthermore, Bollerslev (1986) enhanced ARCH into GARCH methodology. GARCH is the evaluation methodology to measure volatility of asset price movements such as indexes, stocks, and bonds. He extended the ARCH process, in which the conditional variance is a function of lagged σ^2_t and lagged ε^2_t, called GARCH (Generalized Autoregressive Conditional Heteroscedasticity). GARCH(1,1) model expresses conditional variance of the error term at time *t* as a function of not only squared error term in the previous time period, but also its conditional variance in the previous period (Mobarek and Li 2014).

The specifications are expressed as follows:

$$y_t = c + \varepsilon_t,\ \varepsilon^2_t \mid I_{t-1} \sim N(0, \sigma^2_t) \quad (9)$$

$$\text{GARCH(1,1)}: \sigma^2_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \lambda_1 \sigma^2_{t-1} \quad (10)$$

where: y_t represents the dynamic correlation of returns between two stock markets at time *t*; *c* is a specific dynamic correlation mean; ε_t is the error term; I_t denotes the information available at time *t*; σ^2_t is the conditional variance of the error term at time *t* and a function of both ε^2_{t-1} (the squared error term in the previous time period) and σ^2_{t-1} (conditional variance in the previous period). The parameters α_0, α_1, and λ_1 are constrained to be positive; the likelihood is also penalized to ensure that $\alpha_1 + \lambda_1 \leq 1$, a constraint that never binds in estimation ($\alpha_0 > 0$; $\alpha_1 \geq 0$; $\lambda_1 \geq 0$; and $\alpha_1 + \lambda_1 < 1$).

3. Results and discussion

Table 2 presents a summary of descriptive statistics of the static correlation between two stock market index returns. Based on Pearson correlation, it indicates that the highest correlation of returns was found in pair of the US and Japan (USA-JPN) stock markets amounted to 63.84%. Meanwhile, the lowest was found in pair of Indonesia and Pakistan (INA-PKS) stock markets amounted to 14.63%. The correlation coefficients are entirely significant at the level of 1 percent. When these results are compared with the dynamic conditional correlation coefficients as shown in Table 3, they are not much different.

Table 2. Pearson static correlation among stock market index returns

Stock Market	United State of America (S&P500)	Indonesia (JKSE)	Pakistan (KSE)
Indonesia (JKSE)	0.4953		
Pakistan (KSE)	0.2251	0.1463	
Japan (N225)	0.6384	0.4778	0.1983

Note: All correlation coefficients are significant at the 1% level.

Table 3 presents a summary of the dynamic conditional correlation between two stock market index returns. It is interesting to note that the highest mean of dynamic correlation of returns was found in pair of USA and JPN stock markets amounted to 61.01% and it has lower standard deviation of 6.55%. This result is similar to finding of Karolyi and Stulz (1996). They explored the co-movement between Japanese and the US stock markets from 1988 to 1992 showing that their correlation and covariance are high when the markets move a lot.

The lowest mean value of dynamic correlation was found in pair of INA and PKS stock markets at 13.12%. It has a standard deviation of 10.39% which is the highest among the other stock markets pairs. This result indicates that a pair of stock markets between two developed countries has higher degree of integration; otherwise a pair of stock markets between two emerging countries has lower degree of integration. In addition, the degree of integration in pairs between developed stock market and emerging stock market (USA-INA, USA-PKS, INA-JPN, PKS-JPN) appears in moderate level and lies in between two previous pairs of stock markets. This level is indicated by the mean of conditional correlations ranged from 22.96% (PKS-JPN) to 44.70% (USA-INA).

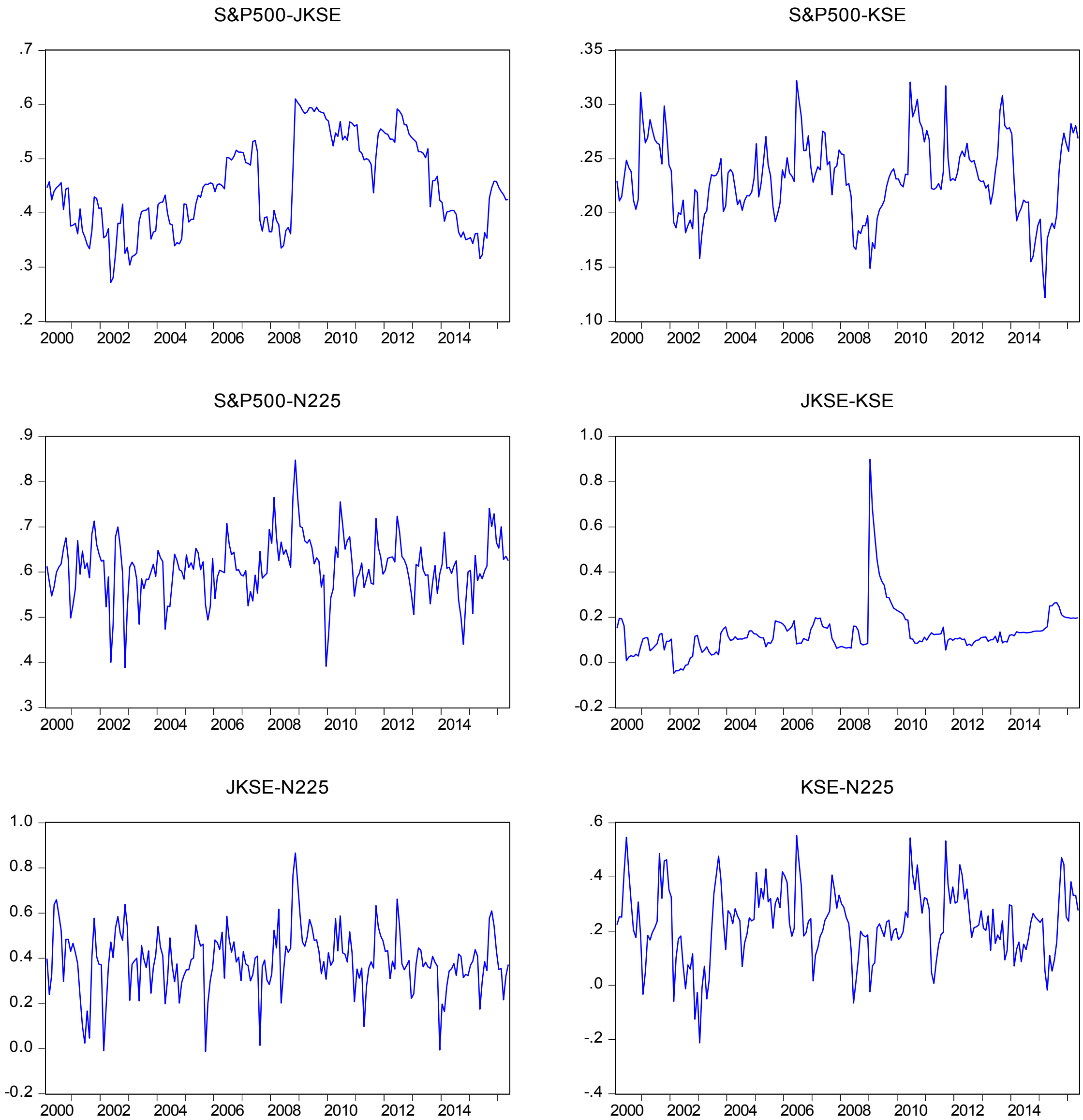
Table 3. Dynamic conditional correlation among stock market index returns

	USA-INA	USA-PKS	USA-JPN	INA-PKS	INA-JPN	PKS-JPN
Mean	0.4470	0.2320	0.6101	0.1312	0.3907	0.2296
Max	0.6106	0.3220	0.8480	0.8993	0.8656	0.5533
Min	0.2718	0.1217	0.3880	-0.0485	-0.0127	-0.2128
St Dev	0.0825	0.0361	0.0655	0.1039	0.1358	0.1328

Results of correlation analysis above are generally consistent with finding of Naranjo and Porter (2007) which states that the assets among developed stock markets showed relatively higher return correlation, while assets between emerging stock market and developed stock market demonstrate relatively lower return correlation. Therefore, in order to provide greater benefits from an international portfolio diversification, then the portfolio should be complemented with assets in emerging stock markets.

The dynamic correlations graphically are shown more clearly in Figure 1. The graphs strengthen the quantitative data presented in Table 3 and appear that lower average dynamic correlations (below 50%) are found in almost all stock markets pairs, except between two developed markets (S&P500-N225). This finding indicates the presence of substantial opportunities for international risk diversification because of returns among stock markets generally showed no high co-movement. In addition, international investors should involve the emerging markets as an element in their portfolios diversification. The high degree of correlation constitutes impressive evidence of a high degree of economic integration among the stock market so that little gain can be realized from combining them in the portfolio (Levy and Sarnat 1970).

Figure 1. Multiple graphs: DCC of returns among indices



The conditional correlations on the global financial crisis period in general appear different compared to the previous period. They increased in year 2009, except the correlation between USA-JPN stock markets. Then after that period, they backed to the normal position. The highest degree of correlation between USA-JPN stock markets amounted to 84.80% occurred in November 2008 and then it declined gradually. The highest degree of correlation between INA-PKS stock markets occurred in January 2009 of 89.93%.

Table 4. Results of regression on dynamic correlation of returns using 3 models of panel data regression: PLS, FEM, REM

Models / Variables	PLS	FEM	REM	PLS	FEM	REM
C	***0.422	***0.358	***0.361	***0.423	***0.354	***0.403
Inf	***-0.035	-0.003	-0.004	***-0.033	-0.001	***-0.021
Int	***-0,010	***-0.003	***-0.003	***-0.010	***-0.003	***-0.009
Forx	***5.43E-09	*-1.98E-09	*-1.77E-09	***5.43E-09	*-1.98E-09	***2.81E-09
DCr	***0.062	***0.046	***0.046			
Volt				*0.186	***0.497	***0.302
Adjusted R^2	0.085	0.729	0.025	0.079	0.743	0.059
F *p-value*	0.000	0.000	0.000	0.000	0.000	0.000
Akaike IC	-0.582	-1.796		-0.575	-1.849	
Schwarz IC	-0.560	-1.752		-0.553	-1.806	
N	1176	1176	1176	1176	1176	1176

Note: The asterisks denote that the corresponding coefficient is significant at, respectively, the 1% level (***), the 5% level (**), and the 10% level (*).

The estimation using Pooled Ordinary Least Squares (PLS) models is reported in Table 4. The results indicate that all variables (inflation rate, interest rate, exchange rate volatility, and stock markets volatility) are significant in affecting market integration. The Chow test, used to choose the appropriate model between PLS and FEM (fixed effect model), suggests that FEM estimation is more appropriate and the specification of fixed effect is better. This decision is supported by the test results showing that the values of F-test and chi-square are significant with p-value of 0.000 and 0.000 which are less than 5%, respectively.

We also run the panel data to make the findings to be valid as reported in the same table, using two types of panel estimator technique: fixed effect model (FEM) and random effects model (REM). From the Hausman test, the results indicate that panel estimation of REM is inappropriate and specification of fixed effect is better with probability value of Hausman test of 0.000. The results of panel estimator based on FEM show that from five independent variables in the equation, inflation rates is the only insignificant variable, all other variables are significant. This result can be written in equation below:

$$DCC_{ij,t} = ***0.358 - 0.003\ Inf_{ij,t} - ***0.003\ Int_{ij,t} - *1.98E\text{-}09\ Forx_{ij,t} + ***0.046\ DCr_{c,t} \quad (11)$$

$$DCC_{ij,t} = ***0.354 - 0.001\ Inf_{ij,t} - ***0.003\ Int_{ij,t} - *1.98E\text{-}09\ Forx_{ij,t} + ***0.497\ Volt_{i,t} \quad (12)$$

Statistical test shows that interest rate negatively affects the degree of stock market integration indicated by the p-value is less than 1%. Similarly, exchange rate volatility negatively affects the degree of integration by the p-value below 10%. The global financial crisis and stock market volatility positively affect the degree of integration with each coefficient value of 0.046 and 0.497 at the level of significance below 1%. In addition, inflation rate does not affect the up and down of integration among stock markets.

Coefficient of interest rate that has negative direction is in accordance with the theory that the smaller the difference in interest rates between two countries, the higher the degree of their stock markets integration. This evidence corroborates the result delivered by Bracker *et al.* (1999) conducted a study on nine national stock indices during 1972-1993. They tested the correlation structure determinant and one of their conclusions is that degree of international integration as measured by magnitude of correlation structure is negatively related to difference in real interest rate.

Similarly, there is negative causality of exchange rate volatility on the degree of stock markets integration. It means that the higher the exchange rate volatility movement between two countries, the lower the degree of their stock markets integration. This result is consistent with finding of Tavares (2009) who examined the impact of bilateral economic integration indicators to market return correlation. He concluded that real exchange rate volatility has a negative impact on correlation of stock returns. These results corroborate the evidence found by Bracker *et al.* (1999).

The degree of integration appears to be higher during the crisis period indicated by positive direction of regression coefficient. This is consistent with almost previous empirical results. A number of studies have found that the market is becoming more integrated after the financial crisis (Arshanapalli and Doukas 1993; Francis, Kim, and Yoon 2002; Yang, Kolari, and Min 2003). The result of time-series model regression by Pretorius (2002) showed that the dummy variable of emerging market crisis in 1998 affect the constant correlation between two stock markets. While in the study of Chiang *et al.* (2007) noted evidence of significant co-movement among the various stock markets during the Asian financial turmoil. Furthermore, Majid and Kassim (2009) found that stock market tends to exhibit higher degree of integration during the US subprime crisis.

It was also found positive direction of the causality from stock market volatility to dynamic correlation of two stock markets. This is in line with the statement by Pretorius (2002) that if the volatilities of two stock markets converge (diverge), then the price of assets should also converge (diverge). Therefore, if volatility of one stock market increases relative to volatility of other stock market, then the first stock market return should also increase relative to the second stock market return. It reflects the higher the risk of an asset, the higher should its return. Longin and Solnik (1995) examined correlation in seven major European countries during the period 1960-1990 and showed that the international covariance and correlation matrices are unstable over time and the correlation rises in periods of high volatility. Forbes and Rigobon (2002) concluded that stock markets are often interdependent in periods of high volatility. This result is almost consistent with the finding of Karim and Ning (2013) stated that stock market volatility affects the degree of stock market integration.

To test statement that the influence of economic factors on stock markets integration more appears in emerging stock markets than in developed markets, we apply two alternative models: OLS and GARCH(1,1) models. Table 5 displays the magnitude of regression coefficients accompanied with the level of significance. Based on OLS regression model on developed stock markets, it generates the equation expressed as follows:

$$DCC_{ij,t} = {}^{***}0.604 + 0.024\, Inf_{ij,t} - 0.002\, Int_{ij,t} + 1.18E\text{-}05\, Forx_{ij,t} + {}^{***}0.082\, DCr_{c,t} - 2.405\, Volt_{i,t} \quad (13)$$

Meanwhile the equation from regression using OLS model on emerging stock markets can be written as follows:

$$DCC_{ij,t} = {}^{***}0.153 - 0.002\, Inf_{ij,t} - {}^{***}0.010\, Int_{ij,t} + 5.43E\text{-}06\, Forx_{ij,t} + 0.037\, DCr_{c,t} - {}^{***}0.459\, Volt_{i,t} \quad (14)$$

The first equation above suggests that in developed stock markets only the crisis period which is significant (at the 1% level) to the degree of their stock markets integration, while the entire fundamental economic variables are insignificant. This evidence is inconsistent result with the panel data regressions using full observation presented in Table 4. In emerging stock markets, the second equation above suggests that interest rate and stock markets volatility significantly affect the degree of integration, while the three other variables are insignificant. Jarque-bera Test shows that the error distribution is normal (p-value = 0.460); the classic assumption of autocorrelation required for OLS model has been fulfilled, none of error on the correlogram of residual is significant; and White Heteroskedasticity Test shows that F-statistic is not significant with probability of 0.463.

The equation generated from regression using GARCH(1,1) model in developed stock markets is expressed as follows:

$$DCC_{ij,t} = {}^{***}0.595 + 0.017\, Inf_{ij,t} - 0.001\, Int_{ij,t} - 1.33E\text{-}05\, Forx_{ij,t} + {}^{***}0.074\, DCr_{c,t} + 0.325\, Volt_{i,t} \quad (15)$$

$$\sigma^2_t = 0.003 + 0.149\, \varepsilon^2_{t-1} + 0.105\, \sigma^2_{t-1} \quad (16)$$

Meanwhile the equation from regression using GARCH(1,1) model in emerging stock markets is expressed as follows:

$$DCC_{ij,t} = {}^{***}0.153 - 0.0005\, Inf_{ij,t} - {}^{***}0.009\, Int_{ij,t} - {}^{**}4.17E\text{-}06\, Forx_{ij,t} + {}^{***}0.119\, DCr_{c,t} + {}^{***}0.339\, Volt_{i,t} \quad (17)$$

$$\sigma^2_t = {}^{***}0.0003 + {}^{***}1.104\, \varepsilon^2_{t-1} - 0.001\, \sigma^2_{t-1} \quad (18)$$

Table 5 - Results from regression on dynamic correlation of returns using OLS and GARCH(1,1) models

	Developed market		Emerging market	
Models / Variables	OLS	GARCH	OLS	GARCH
Dependent Variable (Y_t)				
C	***0.604	***0.595	***0.153	***0.153
Inf	0.024	0.017	-0.002	-0.0005
Int	-0.002	-0.001	***-0.010	***-0.009
Forx	1.18E-05	1.33E-05	5.43E-06	**-4.17E-06
DCr	***0.082	***0.074	0.037	***0.119
Volt	-2.405	0.325	***0.459	***0.339
Conditional Variance (σ^2_t)				
C		0.003		***0.0003
ARCH(1)		0.149		***1.104
GARCH(1)		0.105		-0.001
Adjusted R^2	0.136	0.127	0.395	0.334
F *p-value*	0.000		0.000	
Akaike IC	-2.729	-2.725	-2.163	-3.205
Schwarz IC	-2.629	-2.575	-2.063	-3.055
N	196	196	196	196

Note: The asterisks (***, **, *) indicate that *p-value* is significant respectively at the 1%, 5%, 10% level.

Based on the application of GARCH(1,1) model for stock markets of developed countries, the result shows that only the crisis period significantly influences the degree of their integration, while all other variables are insignificant. This result is similar with previous OLS model presented at the same table. The amount of coefficient values in GARCH equation with the constant are less than one (0.254) and both ARCH(1) and GARCH(1) are positive and insignificant. This result indicates the absence of volatility. In the emerging stock market, GARCH(1,1) model produces inferential statistics as follows. Interest rate and exchange rate volatility negatively affect the degree of integration. The financial crisis period and stock markets volatility positively affect the degree of integration, while only inflation rate does not affect the degree of integration. These results are relatively consistent with panel data regressions using full observation presented in Table 4. The regression coefficients in GARCH equation with constant show that only ARCH(1) coefficient has a positive effect on volatility.

Table 5 shows also that in developed stock markets, the highest adjusted R^2 of 0.136 and the lowest values of AIC and SIC of -2.729 and -2.629, respectively are in OLS model. If the results of OLS model are compared with GARCH(1,1) model at each level of dynamic correlation using model selection criteria of AIC and SIC, it can be determined that the best fit model is OLS model. In emerging stock markets, the highest adjusted R^2 value is in the OLS model of 0.395. The lowest values of AIC and SIC are in GARCH(1,1) model of -3.205 and -3.055, respectively. These results are in contrast to developed stock markets. After comparing the tentative models at each level of dynamic correlation using model selection criteria of AIC and SIC, it can be determined that the best fit model for emerging stock markets is GARCH(1,1).

Conclusion

Based on the analysis and discussion in previous section, one can be concluded that the degrees of integration among the stock markets are relatively low as a whole. The pair of stock markets between two developed countries has a higher degree of integration than the pair of emerging stock markets. While the pair of stock markets having different class (between developed and emerging stock market) shows that its degree of integration lies in between pairs of stock markets having the same class. By adding the assets of emerging markets into assets portfolio of developed markets potentially increases benefits of international portfolio diversification that depends on degree of correlation between stock market returns. Therefore, it is necessary to analyze combination among stock markets of developed and emerging countries.

Based on the analysis of factors driving the dynamic integrations among stock markets, the results empirically demonstrate that interest rate and exchange rate volatility have a negative effect on the degree of stock market integration. This means that the lower the interest rate difference between a country with other country, and the lower the volatility of exchange rates, the higher the degree of the stock market integration. The global financial crisis and stock markets volatility have a positive effect on the degree of stock market integration. This means that the degree of integration among stock markets appears to be higher during the crisis period and high volatility. Meanwhile, the inflation rate has no effect on the degree of integration.

This research can be one of the important considerations for stock market participants, especially international investors to understand the magnitude of the degree of integration and factors driving the degree of integration, which are interest rate, exchange rate volatility, market and macroeconomic conditions, and market volatility. Thus, they can make decisions on selected stock markets that should be included in the portfolio diversification. In addition, they can determine their position accurately and quickly in the trade, reduce uncertainty, and maximize their capital gains.

In the analysis of this research, the model used is relatively simple, only OLS, pooled data, and GARCH(1,1) techniques. For subsequent studies, it needs to be extended with lagged conditional variance of error term and squared error term in several periods by employing an iterative process and a variety of other GARCH models to obtain the best model. In addition, there are many other potential determinants that have not been explored by considering the type of data that have pursued higher frequencies.

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