THE RELATIONSHIP BETWEEN DEVELOPED AND EMERGING MARKETS: AN EMPIRICAL APPROACH BETWEEN 1997 AND 2009

Theodoros Spyridis
Technological Education Institute (T.E.I.) of Kavala, Greece
jackie@vodafone.net.gr

Zeljko Sevic
University of Greenwich, London, Great Britain
z.sevic@greenwich.ac.uk

Nikolaos Theriou
Technological Education Institute (T.E.I.) of Kavala, Greece
ntheriou@teikav.edu.gr

ABSTRACT

The present paper is focused on the empirical examination of the relationship between a number of stock market indices between developed and emerging markets during the period between 1997 and (early) 2009. The relationship is examined with the employment of a variation of the Autoregressive Conditional Heteroscedasticity (ARCH) model, which is the exponential ARCH-in-Mean (EGARCH-M) model, with specific tests of stationarity (the Augmented Dickey-Fuller - ADF unit root test) between the indices, and, finally, with the employment of Johansen's (1988, 1991) multivariate cointegration test. Johansen's vector autoregressive (VAR) model examined the long-run relationship between the variables. Simultaneously, it shows if there is any opportunity for the investors to diversify their portfolio on a global level. After the presentation of the literature review based on cointegration analysis, we present the methodology that is followed so as examine the characteristics and the relationships between the markets. The results of the indices after the application of the EGARCH-M model on the ones that are characterised by heteroscedasticity present differences regarding the asymmetry effect. It is shown that for most markets negative shocks have more impact on volatility than positive shocks. Furthermore, the results showed that by testing two subperiods for all the variables long-run relationships were evident between the markets under examination. Specifically, as time passes, the relationships between the indices both for the developed and the emerging markets remain evident or even increasing. The VAR results undermine the benefits of portfolio diversification as the existence of cointegration between the markets shows that the indices are affected by their own past prices as well as by the past prices of other indices/variables.

Keywords: Cointegration, unit root, conditional volatility.

JEL: G12, G14.

1. Introduction

A dynamic and healthy stock exchange is considered a crucial factor of a country's economy. In a stock exchange stock brokers and traders trade stocks and other securities. Some of the roles that a stock exchange can play in an economy are the raising of capital for businesses or the creation of investment opportunities for small investors. The operations of a stock exchange can transform investor's money into investment. If this investment is profitable, it may give the opportunity to investors for further investments. Thus, besides the contribution of the stock exchange in a country's national economy, there is also a contribution to the investors individually (Elton *et al.*, 2003). During the last decades, an increasing number of emerging markets have developed substantially their financial structures, including their stock markets, but when they are compared to more developed markets, they are still characterised by lower levels of financial development and stock market transactions (Tsouma, 2009). In our study we try to explore the relationship between a number of stock market indices based on their economic situation as well as their geographical position. We study their individual characteristics, as well as the relationship between them. The study is organised as follows: Section 2 presents the literature review using cointegration analysis; section 3 presents methodology that is followed with the examination of the main models of the analysis. Furthermore, section 4 presents the data collection process with an introduction to the indices used in the tests. Section 5 and its sub-sections, present the empirical results and, finally, section 6 concludes the study.

2. Literature Review on Cointegration Analysis

In the present section we present a number of studies mainly based on cointegration analysis for the examination of the long-run relationship between financial or macroeconomic indices. Muradoglu and Metin (1996) investigated a semi-strong form of the efficient market hypothesis in Turkey. The long-run relationship between stock prices and inflation was investigated and the results presented the inefficiency of the Turkish stock market as stock prices can be forecasted. In our study the efficiency of the ASE index is one of the goals of our study using cointegration analysis. He (1997) investigated the relationship between four security sub-markets of Hong Kong. The results exhibited a stable, long-run, linear relationship among these sub-markets. Moreover, all four sub-markets played a major role to the process of price discovery and, more specifically, that price changes in one sub-market have a significant impact on the other sub-markets under examination. Kanas (1998) investigated for possible cointegration links between the US and six European equity markets during the period 1983-1996. The results exhibited evidence of the absence of cointegration between the US and the European markets, a result which contradicted previous findings. The main conclusion was that the absence of cointegration gives the opportunity to investors to diversify in the US and the European stock markets.

Knif and Pynnonen (1999) examined the impact of the leading markets, that is the US and Japan, on small markets, like Finland and Norway. The results of the tests showed that US price changes had an impact on all the other markets of the analysis. Finally, price changes on the Asian-Pacific markets had a direct effect on the price changes of European countries, but not on the price changes of the US market. Choi *et al.* (1999) examined the interactions between stock markets and macroeconomic variables, and their results suggested that stock markets help predict industrial production in the US, UK, Japan and Canada out of the G7. Nasseh and Strauss (2000) examined the same phenomena where not only domestic, but also international, macroeconomic variables enter the cointegration vectors to share long-run relationships with stock prices. Pan *et al.* (1999) applied the Johansen (1988) and the Johansen and Juselius (1990) cointegration test and a modified cointegration test with generalised autoregressive conditional heteroscedastic (GARCH) effects in order to investigate the relationship between the United States and five Asian-Pacific stock markets during the period between 1988 and 1994. The GARCH cointegration test examined the possible common time-varying volatilities between the series. While the results showed a strong integration between the six stock markets through their second moments (variances), the results were different through their first moments (means). The aim of their study was to investigate whether international stock markets have long-run, common time-varying volatility. The results of the study exhibited the presence of ARCH effects in most of the stock price series, which meant that, when testing for cointegration, one needs to account for time-varying volatility. The main conclusions suggest that volatility transmissions among international stock markets exist not only in the short-run, which refers to the volatility spillovers, but also in the long-run, something which is explained by the common time-varying volatility of the series under examination.

Moreover, Kwon and Shin (1999) investigated if the economic activities in Korea explained stock market returns using cointegration and causality tests. They found that cointegration is evident between stock market indices and macroeconomic variables, which are the production index, the exchange rate, the money supply and the trade balance. It should be noted here that, even though the stock market index and the production index affect each other, the stock market index is not a general leading indicator for economic variables.

Gilmore and McManus (2002) examined the relationship between the US market and three Central European markets, the markets of the Czech Republic, Poland and Hungary. The results showed that the markets are not strongly correlated and the (cointegration) tests for long-run relationship were weak. Finally, the causality tests were not significant from the European markets to the US one, suggesting possible benefits from international diversification. Hassan (2003) investigated for possible relationships between share prices in the gulf region and specifically, between weekly share price indices in the Kuwait, Bahrain and Oman stock market for the period 1994−2001. The results of the tests showed that there is one cointegrated vector that relates the Kuwait and the Bahrain stock market, which means that there exists a stable, long-run equilibrium relationship between the markets. This relationship between the two markets means that potential investors can benefit in the long-run from the information that exists in the Bahrain stock market and visa versa. Aggarwal and Kyaw (2005) examined for integration and cointegration links between three equity markets before and after the 1993 North American Free Trade Agreement (NAFTA), based on daily, weekly, and monthly data. The results of the unit root tests for the overall 1988-2001 period and for the two sub-periods (1988−1993 and 1994−2001) showed that, while stock prices were non-stationary, stock returns exhibited stationarity for all three markets and for all the periods of the analysis. The cointegration tests showed, for daily, weekly, and monthly data, that the prices of stocks are cointegrated only for the post-NAFTA period. The main conclusion of the analysis was that the increased integration and cointegration between the markets after the NAFTA presents less opportunity for international portfolio diversification. This is evidence for the need of new strategy developments among investors and managers.

Syriopoulos (2006) examined developed and emerging Central European stock markets for possible dynamic links and the effects of time-varying volatilities. He found that there was one cointegration vector between the variables, which presented long-run market co-movements. Specifically, the Central European markets presented strong links with the developed markets under examination. Moreover, the application of an asymmetric EGARCH model presented a time-varying volatility effect for these emerging stock markets. The main conclusions were that international portfolio diversification is not the best solution across these cointegrated markets, as risk is not so easy to be reduced and the returns present volatilities to international and domestic innovations. Furthermore, Tsouma (2009) examined the relationships between stock returns and economic activity in developed and emerging markets. The study employed cointegration and causality tests during the period between 1991 and 2006.

Specifically, the tests confirmed the existence of a strong relationship running from stock returns to future economic activity, while the relationship running from economic activity to future stock returns was not significant, confirming the forecasting ability of stock returns. The results were not the same between developed and emerging markets. Specifically, the relationship running from stock returns to economic activity was less strong for the emerging ones.

In the following section we present the methodology that is followed so as to examine the properties of each index and test their relationship.

3. Methodology

The steps that are followed so as to examine the relationship between the series start with the presentation of each index in its level, logarithmic level and logarithmic return. In this way we can observe that the range of the volatility of each series is reduced and that there are possible signs of volatility clustering. After the presentation of the series we present their respective descriptive statistics, so as to examine the characteristics of each index. Moreover, we present the correlation matrix between the returns of the series, so as to examine for possible correlation between them.

The study continues with the autocorrelation tests for each index and, in case there is dependence on the lags of a series, we construct a specific model for each index so as to run a linear regression test (OLS). Based on the regression model, we test the residuals of the series for possible heteroscedasticity (with the ARCH LM test). In case there are heteroscedastic effects we employ a specific GARCH model - the EGARCH-M model – so as to measure the conditional volatility of the series and examine if there are any asymmetry effects caused by positive and negative shocks.

Finally, we proceed to a series of unit root (stationarity) tests on the indices so as to achieve stationarity and continue with the cointegration analysis by employing Johansen's (1988; 1991) VAR model. In this way we can observe whether there is a long-run relationship between specific groups of variables/indices. Specifically, based on prior studies (Hondroyannis and Papapetrou, 2001; Maysami *et al.*, 2004; Tsouma, 2009): 1) We examine for the existence of a unit root in each one of the series that will be used in the analysis of cointegration. 2) If there is a unit root in the series, which means that the series is not stationary, based on the Augmented Dickey-Fuller - ADF (1979; 1981) procedure, we examine the first differences of the series. 3) Subsequently, we employ again the ADF (1979; 1981) test so as to examine the first differences of the series − if the series are integrated of order 1 ($I(1)$). 4) If the tests show that the series are $I(1)$ we proceed to cointegration analysis so as to examine if there is at least one linear combination between the series (the series are cointegrated). 5) If there is at least one linear combination between the series it means that there is at least one long-run relationship that connects the variables of the analysis. More specifically, after we see that the variables under examination are $I(1)$ we investigate whether there is any relationship in specific groups based on their economic and geographic position during the period between 1997 and (early) 2009.

The following sub-sections present the ARCH and the EGARCH-M model, the ADF unit root model and Johansen's VAR model.

3.1 The ARCH and the EGARCH-M Model

The ARCH model is employed in modelling the volatility of the time series (variables) under investigation. This means that the conditional variance of the series affects the conditional mean which gives rise to a regression model for the mean that includes some function of the conditional variance. That is, if an investor holds a financial asset and wants to model the respective returns of this asset, the conditional variance is likely not to remain constant over time. This might be due to small or even large shocks (change in government, stock market crash), which may affect the returns of the asset to a significant degree.

The problem of modelling volatility so that it can respond to time-varying shocks was solved with the development of the Autoregressive Conditional Heteroscedasticity (ARCH) model developed by Engle (1982).

In case there is a conditional mean equation of one variable:

$$y_{it} = \alpha_{\mathrm{it}} + b_{it} y_{t-1} + \varepsilon_{\mathrm{it}} \qquad \textbf{(1)}$$

then the ARCH model needed to capture the information from the time-varying volatility will have the following form:

$$\sigma_t^2 = a_0 + a_1 \varepsilon_{\mathrm{t-1}}^2 \qquad \textbf{(2)}$$

where σ_t^2 is the conditional variance of the residuals ε_{it} from equation (1) and ε_{t-1}^2 are the past values of ε_{it} at time $t-1$. As σ_t^2 is a variance it should not be negative and is mostly positive, otherwise the model is rejected according to Engle (1982). More specifically, the need for non-negativity leads to the following assumptions regarding the validity of ARCH model:

1) $a_0 \geq 0$. In case $a_1 = 0$, then the conditional variance σ_t^2 is $a_0 = 0$, which means that this coefficient must be non-negative. 2) $a_1 \geq 0$. Because ε_{t-1}^2 is always non-negative, a_1 should be equal or larger that zero so as $a_1 \varepsilon_{t-1}^2$ to be non-negative.
3) $a_1 < 1$. In case a_1 is larger that 1, then the process cannot be covariance stationary (nonstationarity of ARCH effects).

Based on the theory of ARCH model, Nelson (1991) developed the EGARCH model, with along with the measurement of the conditional volatility, examined for possible asymmetry phenomena in the time series. Furthermore, in order to examine, along with the modelling of conditional volatility, the influence of the volatility on the mean of the series, we employed the EGARCH-in-Mean (EGARCH-M) Model (Chortareas *et al.*, 20000):

$$R_t = \varphi_0 + \varphi_1 R_{t-1} + \gamma \sqrt{\mathrm{h_t}} + \varepsilon_t \qquad \textbf{(3)}$$

$$\log h_t = \alpha_0 + \alpha_1 \left[\left| \frac{\varepsilon_{\mathrm{t-1}}}{\mathrm{h_{t-1}^{1/2}}} \right| \right] + \beta \log(\mathrm{h_{t-1}}) + \frac{\delta \varepsilon_{\mathrm{t-1}}}{\mathrm{h_{t-1}^{1/2}}} \qquad \textbf{(4)}$$

According to the equations presented above, the a, β, γ, δ and φ are the parameters for estimation. Specifically, the parameter a_1 measures the impact of the innovation (shock) in equation (3) on the conditional volatility at time t. The parameter β is an autoregressive term on lagged conditional volatility, reflecting the weight given to the previous period’s volatility in the volatility at time t. The parameter γ expresses the influence of volatility on the mean of the series. Moreover, the parameter δ expresses the asymmetric response of the conditional volatility on shocks of different sign. Finally, φ_1 is a first-order autoregressive parameter (AR(1)) of the mean equation.

3.2 The Dickey-Fuller/Augmented Dickey-Fuller Test and Johansen’ s VAR model

The presence of a unit root can be presented using a first-order autoregressive process:

$$y_t = l + ky_{t-1} + e_t, e_t \sim N(0, \sigma_e^2) \quad \textbf{(5)}$$

where l is a constant of the equation, k is the coefficient of the first difference of y_t and e_t is the error term which has a mean of zero and variance σ_e^2. The Dickey-Fuller (DF) test (Dickey and Fuller, 1979; 1981) can be written as:

$$\Delta y_t = l + (k-1)y_{t-1} + e_t = l + py_{t-1} + e_t \quad \textbf{(6)}$$

after the subtraction of y_{t-1} from both sides of equation (5). In this test the null hypothesis says that there is a unit root in the time series, which means that $H_0 : p = 0$, while $H_1 : p < 0$, which is the alternative hypothesis and means that there is no unit root in the time series. Equation (6) gives the simplest case of a DF test where the residual is white noise. In fact, the residuals exhibit serial correlation most of the time and Δy_t can be rewritten as:

$$\Delta y_t = l + py_{t-1} + \sum_{i=1}^{k} f_i \Delta y_{t-i} + e_t \quad \textbf{(7)}$$

Equation (7) is the equation for the Augmented Dickey-Fuller (ADF) test. This is the improved version of the Dickey-Fuller test as it accommodates higher-order autoregressive processes in e_t (Greene, 2003).

Furthermore, in case there is a vector y_t of first-order integrated variables which can be expressed by an unrestricted vector autoregressive (VAR) model, based on the studies of Johansen (1988; 1991) and Johansen and Juselius (1990), unvolving up to k lags of y_t:

$$y_t = A_1 y_{t-1} + ... + A_k y_{t-k} + e_t \quad \textbf{(8)}$$

where $A_1,..., A_k =$ the matrices of the parameters of the model and $e_t =$ the vector of the residuals of the system that has a mean equal to zero, constant variance and its values are not serially correlated. The VAR model has been used so as to estimate dynamic relationships among jointly endogenous variables without imposing strong *a priori* restrictions - such as particular structural relationships. The VAR model comprised of a system of equations where each variable in y_t is regressed on the lagged values of itself and on the other variables of the system.

4. Data Collection

The study examines the monthly return series of a number of stock market indices during the period between 1997 and (early) 2009. The data was obtained from an international databank which is comprised of financial as well as macroeconomic indices. Specifically, the data set is comprised of 147 months. All the indices had a complete price history, which means that they had no missing values (with the exception of Russia for the first nine months) for this specific period of analysis because of missing data. The monthly returns of each stock index were calculated using the logarithmic approximation:

$$R_{i,t} = \log\left({P_{i,t}} \Big/ {P_{i,t-1}} \right) \quad \textbf{(9)}$$

where $P_{i,t}$ is the closing price of month t for index i (Coutts *et al*., 2000; Chortareas *et al.*, 2000).

4.1 The Selection of Variables

Based on prior studies (Tsouma, 2009; Gilmore and McManus, 2002) a number of financial indices were employed for the employment of unit root and cointegration tests. In this section we briefly present the variables/indices of the analysis. As in the case of prior studies using VAR or VECM models (Tsouma, 2009; Gilmore and McManus, 2002) or even financial models such as the CAPM and the APT model, we employ representative stock market indices of 16 countries so as to proceed to unit root and cointegration analysis and examine the long-run relationship between them.

Specifically, we employ for America: The market index of the United States (the Dow Jones Industrial Average) which is the second-oldest U.S. market index and computed from the stock prices of 30 of the largest and most widely held public companies in the United States, and the market index of Mexico, which is the second largest stock exchange in the Latin America, the stock index of Brazil, which is the fourth largest stock exchange in America in terms of market capitalization - behind NYSE, Nasdaq, and Toronto Stock exchange -, the stock index of Argentina, which is the most important index of the Buenos Aires Stock Exchange, the stock index of Venezuela, and the stock index of Chile, which is a market capitalization-weighted index that measures price variations of the majority of the exchange's listed stocks, classified by sectors according to its activity and revised annually.

Furthermore, we employ for Europe: The stock index of France (CAC 40), which is a stock market index that is comprised of the 40 largest French stocks based on market capitalization on the Paris Bourse (stock exchange) and it is the most commonly used index that represents the overall level and direction of the market in France, the index of Germany (DAX index), which is a blue chip stock market index consisting of the 30 major German companies trading on the Frankfurt Stock Exchange, the market index of Italy (Milan MIB30), which is a market capitalization-weighted index of the 30 top Italian companies trades on the Milan Stock Exchange, the index of the United Kingdom, which is an index made up of 100 largest (according to market capitalization) UK firms listed on London stock exchange, the stock index of Greece, which is comprised of the 60 largest companies of the Athens Stock Exchange, the index of Poland (Warsaw Stock Exchange - WSE) which lists 311 companies, the index of Hungary (from the Budapest Stock Exchange - BSE), the index of the Czech Republic, which is the second biggest stock exchange in Central and Eastern Europe, and the market index of Russia (from the The Moscow Interbank Currency Exchange - MICEX - which is one of the largest universal stock exchanges in the Russian Federation and East Europe.

Finally, for Asia: The stock index of Japan, which is an important stock market index of the Tokyo Stock Exchange and is comprised of stocks from different sectors of the Japanese economy, such as the food, construction and banking sector.

5. Empirical Results

5.1 Descriptive statistics and Correlation of the indices

Table 1 presents the descriptive statistics of the indices of the developed markets used in the analysis. The returns of the indices were calculated as presented in equation (9). It can be seen from the normality (Jarque-Bera) results and the respective probability statistics at the 5 per cent level of significance that none of the indices follow the normal distribution. This result will be helpful in the estimation of the conditional volatility using the EGARCH-M model later in the tests. Table 1 also shows that the index of Japan has the greatest kurtosis, which is a sign that the return volatility in this market is greater in comparison to other developed markets. Respectively, table 2 shows that none of the indices of the emerging markets follow the normal distribution and, in this case, the index of the Czech Republic presents the greatest kurtosis. The phenomenon of volatility clustering (heteroscedasticity) in the indices of Japan and Czech Republic is verified by the tests for ARCH effects presented in table 5. Generally, by taking into consideration the statistics examined above as well as the standard deviation of the indices (as in the case of Brazil), the results seem to be consistent with those of Huang *et al.* (2000) and Bekaert and Harvey (1995) that the volatility in emerging markets is greater than the volatility in developed ones.

Table 1: Descriptive statistics of the developed markets

Statistics	FRANCE	GERMANY	GREECE	ITALY	JAPAN	UK	US
Mean	0.000752	0.001727	0.002949	-0.000910	-0.006145	-0.000988	0.000111
Median	0.013731	0.012546	0.013023	0.011416	0.001749	0.006651	0.006646
Maximum	0.180349	0.174764	0.318831	0.183354	0.157153	0.155655	0.137384
Minimum	-0.253775	-0.309750	-0.497191	-0.357166	-0.452328	-0.223714	-0.237232
Std. Dev.	0.065782	0.074512	0.092412	0.071840	0.068275	0.053283	0.053884
Skewness	-1.015047	-1.209534	-0.831503	-1.397114	-1.959013	-1.114774	-1.132027
Kurtosis	5.498773	6.152712	8.810731	8.221479	14.23124	5.965229	6.565393
Jarque-Bera	63.05466	96.06488	222.2253	213.3520	860.7405	83.72779	108.5143
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Table 2: Descriptive statistics of the emerging markets

Statistics	ARGENTINA	BRAZIL	CHILE	CZECH	MEXICO	POLAND	RUSSIA	VENEZUELA	HUNGARY
Mean	0.001118	0.009251	0.005344	0.001237	0.009254	0.001985	0.013603	0.009770	0.001931
Median	0.010072	0.018859	0.011494	0.012534	0.023429	0.010930	0.037407	0.003574	0.018844
Maximum	0.424157	0.511616	0.116178	0.176503	0.212082	0.157665	0.581922	0.385424	0.360298
Minimum	-0.574471	-0.444477	-0.189358	-0.511968	-0.349800	-0.365473	-0.521297	-0.469486	-0.485143
Std. Dev.	0.120311	0.113386	0.049633	0.084982	0.081456	0.076881	0.144431	0.094918	0.095898

Skewness	-1.016949	-0.490085	-1.104492	-1.902289	-1.256523	-1.460871	-0.640177	-0.383836	-1.415194
Kurtosis	8.098395	7.881878	5.538802	11.80480	6.766590	7.490097	7.383902	8.922551	10.04238
Jarque-Bera	173.2497	142.5624	65.11947	528.9960	117.8899	165.0109	119.9330	205.0791	331.2357
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Moreover, table 3 and 4 present the correlation using the Pearson correlation statistic between the two groups of variables. Specifically, it can be observed that both for the developed markets and the emerging ones there is significant correlation at the 1 per cent level of significance. The fact that the time series of the variables are strongly correlated may be due to their common characteristics as developed or emerging markets respectively. Prior studies such as the one by Pan *et al.* (1999) showed that the correlation was not so strong between the stock markets. The strong correlation between the indices may be based on the increased integration of the markets. Swanson (1987) suggested that as time passes financial markets are becoming more integrated than before. This suggestion is verified by the cointegration results between the indices presented in table 9 to 14.

Table 3: Correlation matrix of the developed markets

	ITALY	GERMANY	FRANCE	UK	US	JAPAN	GREECE
ITALY	1.000	0.848**	0.904**	0.853**	0.729**	0.592**	0.605**
GERMANY	0.848**	1.000	0.921**	.833**	0.809**	0.652**	0.650**
FRANCE	0.904**	0.921**	1.000	0.898**	0.823**	0.639**	0.666**
UK	0.853**	.833**	0.898**	1.000	0.824**	0.632**	0.607**
US	0.729**	0.809**	0.823**	0.824**	1.000	0.620**	0.539**
JAPAN	0.592**	0.652**	0.639**	0.632**	0.620**	1.000	0.520**
GREECE	0.605**	0.650**	0.666**	0.607**	0.539**	0.520**	1.000

**Correlation is significant at the 1 per cent level.

Table 4: Correlation matrix of the emerging markets

	BRAZIL	ARGENTINA	VENEZUELA	MEXICO	CHILE	CZECH	RUSSIA	HUNGARY	POLAND
BRAZIL	1.000	0.694**	0.303**	0.778**	0.701**	0.491**	0.518**	0.662**	0.606**
ARGENTINA	0.694**	1.000	0.367**	0.698**	0.586**	0.535**	0.520**	0.590**	0.555**
VENEZUELA	0.303**	0.367**	1.000	0.400**	0.362**	0.181*	0.336**	0.251**	0.294**
MEXICO	0.778**	0.698**	0.400**	1.000	0.684**	0.579**	0.596**	0.656**	0.686**
CHILE	0.701**	0.586**	0.362**	0.684**	1.000	0.527**	0.591**	0.561**	0.625**
CZECH	0.491**	0.535**	0.181*	0.579**	0.527**	1.000	0.572**	0.743**	0.748**
RUSSIA	0.518**	0.520**	0.336**	0.596**	0.591**	0.572**	1.000	0.591**	0.583**

HUNGARY	0.662**	0.590**	0.251**	0.656**	0.561**	0.743**	0.591**	1.000	0.741**
POLAND	0.606**	0.555**	0.294**	0.686**	0.625**	0.748**	0.583**	0.741**	1.000

**Correlation is significant at the 1 per cent level.

*Correlation is significant at the 5 per cent level.

5.2 ARCH and EGARCH-M Results

Table 5 and 6 below present the results from the tests for ARCH effects on each of the indices. The first column of each table shows if there in an ARCH effect at the residuals of each time series while the second and third column show a) if the asymmetry effect can be explained by the application of the EGARCH-M model and b) whether the conditional volatility has any direct influence on the mean of the series. The results show that the ARCH effect is verified in the six out of the sixteen indices. Moreover, for the four of the indices the coefficients of the asymmetry effect is significant (except for the case of Japan and the Czech Republic), which means that there is a difference in the impact of negative and positive shocks on the time series of the indices. More specifically, the coefficients of the four indices are also negative, a sign that negative shocks generate more volatility than do positive shocks on the time series under examination (table 5 and 6). In the case where the coefficients are insignificant might mean that the shocks are either of the same magnitude (no asymmetry effect found), or the model is only partially capable of capturing the asymmetry effect. As far as the “in-mean factor” is concerned, as explained in equation (3), we can observe from both tables that it was statistically insignificant for all the indices, which might mean that there are different variables which influence the mean of the series except from volatility.

Table 5: ARCH and EGARCH-M on the indices of developed markets

INDEX	ARCH EFFECT	ASYMMETRY EFFECT	IN-MEAN EFFECT
ITALY	NO (up to 10 lags)	-	-
GERMANY	NO (up to 10 lags)	-	-
FRANCE	NO (up to 10 lags)	-	-
UK	YES (up to 10 lags)	-0.3898 0.0183*	0.6492
US	NO (up to 10 lags)	-	-
JAPAN	YES (up to 10 lags)	-0.0204 0.8662	0.2522
GREECE	NO (up to 10 lags)	-	-

*Correlation is significant at the 5 per cent level.

Table 6: ARCH and EGARCH-M on the indices of emerging markets

INDEX	ARCH EFFECT	ASYMMETRY EFFECT (Probability value)	IN-MEAN EFFECT
BRAZIL	YES (up to 10 lags)	-0.3887 0.0112*	0.5825
ARGENTINA	NO (up to 10 lags)	-	-
VENEZUELA	NO (up to 10 lags)	-	-
MEXICO	NO (up to 10 lags)	-	-
CHILE	YES (up to 10 lags)	-0.2113 0.0120*	0.1232
CZECH	YES (up to 10 lags)	0.1218 0.4140	0.3488
RUSSIA	YES (up to 10 lags)	-0.4570 0.0014*	0.8470
HUNGARY	NO (up to 10 lags)	-	-
POLAND	NO (up to 10 lags)	-	-

*Correlation is significant at the 5 per cent level.

The following section presents the results of unit root and cointegration analysis.

5.3 Unit Root and Cointegration Analysis Results

Tables 7 and 8 present the unit root (stationarity) results for all the indices. By employing a number of specific unit root tests, based on the studies of Dickey and Fuller - ADF (1979; 1981) we can see that the variables are stationary (do not have a unit root) in their first differences. Specifically, in tables 7 and 8 present only the indices in their first differences (the results in their levels are available upon request) and it can be verified that all the indices have become stationary - are integrated of order 1 $(I(1))$ at a 5 per cent level of significance. Next to the name of each variable the respective ADF test statistics are presented by applying the models without a constant and a trend, then only with a constant and, finally, both with a constant and a trend. If we recall, based on the Augmented Dickey-Fuller (ADF) test, the acceptance of the null hypothesis means that there is a unit root in the series. These results can lead us to a series of cointegration tests for both groups of variables.

Table 7: The ADF unit root results of the indices in their first differences (developed markets)

	ADF		
Variables	None	Const	const/trend
ΔITALY	-10.3979*	-10.3633*	-10.8528*
ΔGERMANY	-10.0817*	-10.0475*	-10.1245

ΔFRANCE	-10.0710*	-10.0336*	-10.2641*
ΔUK	-11.6555*	-11.6206*	-11.7670*
ΔUS	-10.9896*	-10.9500*	-11.2143*
ΔJAPAN	-11.1599*	-11.1983*	-11.2135*
ΔGREECE	-11.0862*	-11.0487*	-11.3956*

*Correlation is significant at the 5 per cent level.

Table 8: The ADF unit root results of the indices in their first differences (emerging markets)

	ADF		
Variables	None	Const	const/trend
ΔBRAZIL	-9.5620*	-9.6337*	-9.5997*
ΔARGENTINA	-10.0237*	-9.9899*	-9.9554*
ΔVENEZUELA	-9.6216*	-9.7180*	-9.7013*
ΔMEXICO	-10.5706*	-10.5382*	-10.5094*
ΔCHILE	-10.1975*	-10.2646*	-10.2689*
ΔCZECH	-10.5286*	-10.4935*	-10.4707*
ΔRUSSIA	-8.4724*	-8.5214*	-8.5295*
ΔHUNGARY	-9.5579*	-9.5619*	-96870*
ΔPOLAND	-10.5706*	-10.5382*	-10.5094*

*Correlation is significant at the 5 per cent level.

Furthermore, tables 9 to 14 present the results of cointegration analysis. We separated the whole period in two equal sub-periods based on economic and geographical reasons so as to see the differences in the level of cointegration between the variables. The best form of Johansen's model was selected based on the Schwarz (1978) criterion (its value for the selected model should be algebraically the smallest compared to the values of all the other models). Specifically, the first sub-periods extends from January 1997 to December 2002 and the second one from January 2003 to March 2009. As markets are becoming more integrated, it is interesting to mention that Bernard (1991) suggested that if there are a number of k variables, a complete integration would exist if there were $k-1$ cointegrated vectors between the indices. We should mention that in case that the p-value (last column) is less than 0.05 the null hypothesis of no cointegration is rejected. Moreover, as there are small differences between the results of the maximum eigenvalue and the trace statistic which are both statistics-indicators of the existence of cointegration or not, we select the trace statistic as it shows more robustness to skewness and kurtosis in the residuals (Cheung and Lai, 1993; Maysami *et al.*, 2004), and this is the main reason that it is the only statistic that is depicted in the tables below. We have employed a number of cointegration tests so as to see any difference in the behaviour of specific markets between the two time periods. More specifically, in tables 9 to 12 we took into consideration as the dependent variable of the tests the general index of the Greek stock exchange. The main conclusion was that Greece, as it can be regarded nowadays as a developed market, is becoming more integrated as a market and this can be verified by the fact that a) when it is compared with other developed markets, the cointegration vectors are increasing from the first to the second sub-period (from table 9 to 10) and b) when it is compared to a number of emerging markets the vectors are non-existent (from table 11 to 12). The same procedure was followed having as dependent variable the US stock index. The results, presented in tables 13 and 14, show that as the countries of Latin America are developing through the years, their relationship with developed markets such as the US increases (from table 13 to 14). Generally, the existence of cointegration presented in tables 9 to 14 are similar to those of prior studies such as the one by Bruner *et al.* (2008) a fact that verifies the common trend of financial indices.

Table 9: Johansen's cointegration test between Greece, Italy, Germany, France, UK and US (1997−2002)

Trace Statistic			
Null	Trace Statistic	Critical Values (at 5%)	Prob.
$R = 0$*	109.7192	103.8473	0.0193
$R \leq 1$	72.2692	76.9727	0.1081
$R \leq 2$	45.2269	54.0790	0.2414
$R \leq 3$	29.6163	35.1927	0.1763

*Indicates significance at the 5 per cent level.

Table 10: Johansen's cointegration test between Greece, Italy, Germany, France, UK and US (2003−2009)

Trace Statistic			
Null	Trace Statistic	Critical Values (at 5%)	Prob.
$R = 0$*	145.4904	103.8473	0.0000
$R \leq 1$*	86.8846	76.9727	0.0072
$R \leq 2$	45.8761	54.0790	0.2190
$R \leq 3$	17.0464	35.1927	0.8843

*Indicates significance at the 5 per cent level.

Table 11: Johansen's cointegration test between Greece, Czech Republic, Russia, Hungary and Poland (1997−2002)

Trace Statistic			
Null	Trace Statistic	Critical Values (at 5%)	Prob.
$R = 0$*	96.7803	76.9727	0.0007
$R \leq 1$*	64.1012	54.0790	0.0050
$R \leq 2$*	35.4881	35.1927	0.0465
$R \leq 3$	16.4599	20.2618	0.1540

*Indicates significance at the 5 per cent level.

Table 12: Johansen's cointegration test between Greece, Czech Republic, Russia, Hungary, and Poland (2003−2009)

Trace Statistic			
Null	Trace Statistic	Critical Values (at 5%)	Prob.
$R = 0$*	92.2621	76.9727	0.0022

$R \leq 1$*	59.0280	54.0790	0.0170
$R \leq 2$	32.0962	35.1927	0.1040
$R \leq 3$	11.6558	20.2618	0.4801

*Indicates significance at the 5 per cent level.

Table 13: Johansen's cointegration test between US, Mexico, Argentina, Brazil, Chile, Venezuela and Japan (1997−2002)

Trace Statistic			
Null	Trace Statistic	Critical Values (at 5%)	Prob.
$R = 0$	91.2295	111.7805	0.4721
$R \leq 1$	64.1186	83.9371	0.5507
$R \leq 2$	38.4007	60.0614	0.7753
$R \leq 3$	24.4359	40.1749	0.6806

*Indicates significance at the 5 per cent level.

Table 14: Johansen's cointegration test US, Mexico, Argentina, Brazil, Chile, Venezuela and Japan (2003−2009)

Trace Statistic			
Null	Trace Statistic	Critical Values (at 5%)	Prob.
$R = 0$*	160.8088	125.6154	0.0001
$R \leq 1$*	109.5869	95.7536	0.0040
$R \leq 2$	68.6905	69.8188	0.0613
$R \leq 3$	40.6521	47.8561	0.2000

*Indicates significance at the 5 per cent level.

6. Conclusions

The results of the relationship between a number of developed and emerging markets presented in this study show that current situations exist that might lead to strong relationships between the markets. These are the phenomenon of globalisation which leads to the increase in the freedom of transactions between the markets and their direct cooperation in economic issues. These phenomena lead to even more increasing common trends between their indices. The indices seem to be influenced by their past prices as well as the past prices of other indices, as it can be seen by the cointegration tests, which is a sign that contradicts the (weak-form) efficient market hypothesis - EMH. The investors expect to be informed appropriately so as to be able to make the right choice and invest wisely. Other reasons that might justify the (partial) inefficiency of markets are the lack of a proper technical organization in several countries which could lead to a spread of information reflected in stock prices (Dockery and Kavussanos, 1996). Other reasons are possible delays of news on stock market prices as well as psychological factors that influence the decision of investors (Niarchos and Alexakis, 2000).

Furthermore, although a sufficient sample period has been used, an even larger sample with the examination of more sub-periods would lead to a more complete examination of the markets with their respective changes through the years. Additionally, the examination of the indices for possible diagnostic problems such as stationarity, normality, autocorrelation (available upon request) and heteroscedasticity, could lead to a more clear view regarding the data that is used in the tests and the characteristics of each index, which can help to avoid any potential spurious regressions during the analysis (Phillips, 1986). Furthermore, the results regarding ARCH effects showed that some time series are characterised by conditional volatility which necessitates the use of specific tools so as to measure this volatility such as the EGARCH-M model. The existence of cointegration between the markets undermines the benefits from international diversification. As more markets are transitioned to developed ones the benefits will be even less evident. However, the actions and motivations of each investor depend on the risk that he/she is willing to take with their individual preferences and choices. The financial institutions should develop their own models with their respective parameters to aid their investment decision-making process. Generally, the findings of the tests have important applications for investors' portfolio formation and performance evaluation, as most of the investors care about long-term security returns and this is the main reason that cointegration analysis was employed in the study. By adding the fact that there is not a solid theoretical background on these relationships, as most of them are results of statistical analysis, we tried to employ an adequate number of variables/indices so as to come to some inferences regarding the way that the markets are related.

References

Aggarwal, R. and N. A. Kyaw (2005), "Equity Market Integration in the NAFTA Region: Evidence from Unit Root and Cointegration Tests", *International Review of Financial Analysis*, **14**(4), pp. 393-406.

Bekaert G. and C. R. Harvey (1995), "Time-Varying World Market Integration", *The Journal of Finance*, **50**, pp. 403-444.

Bernard, A. (1991), *Empirical Implications of the Convergence Hypothesis*, CEPR Working Papers, Stanford: Stanford University.

Bruner, R. F., W. Li, M. Kritzman, S. Myrgren and S. Page (2008), „"Market Integration in Developed and Emerging Markets", *Emerging Markets Review*, **9**, pp. 89-103.

Cheung, Y.-W. and K. S. Lai (1993), "Finite Sample Sizes of Johansen's Likelihood Ratio Tests for Cointegration", *Oxford Bulletin of Economics and Statistics*, **55**(3), pp. 313-328.

Choi, J. J., S. Hauser and K. J. Kopecky (1999), "Does the Stock Market Predict Real Activity? Time Series Evidence from the G-7 Countries", *Journal of Banking and Finance*, **23**(12), pp. 1771-1792.

Chortareas, E. G., B. J. McDermott and T. E. Ritsatos (2000), "Stock Market Volatility in an Emerging Market: Further Evidence from the Athens Stock Exchange", *Journal of Business Finance and Accounting*, **27**(7&8), pp. 983-1002.

Coutts, A, C. Kaplanidis and J. Roberts (2000), "Security Price Anomalies in the Emerging Market: The Case of the Athens Stock Exchange", *Applied Financial Economics*, **10**(5), pp. 561-571.

Dickey, D. A. and W. A. Fuller (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, **74**(366), pp. 427-431.

Dickey, D. A. and W. A. Fuller (1981), "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", *Econometrica*, **49**(4), pp. 1057-1072.

Dockery, E. and M. G. Kavussanos (1996), "Testing the Efficient Market Hypothesis using Panel Data with Application to the Athens Stock Market", *Applied Economics Letters*, **3**(2), pp. 121-123.

Elton, J. E., J. M. Gruber, J. S. Brown and N. W. Goetzmann (2003), *Modern Portfolio Theory and Investment Analysis*, Hoboken, New Jersey: John Wiley and Sons.

Engle, R. F. (1982), "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation", *Econometrica*, **50**(4), pp. 987-1007.

Gilmore, C. G. and G. M. McManus (2002), "International Portfolio Diversification: US and Central European Equity Markets", *Emerging Markets Review*, **3**, pp. 69-83.

Greene, W. H. (2003), *Econometric Analysis*, New York: Pearson Education International.

Hassan, A. M. H. (2003), "Financial Integration of Stock Markets in the Gulf: A Multi-variate Cointegration Analysis", *International Journal of Business*, **8**(3), pp. 335-346.

He, L. T. (1997), "Price Discovery in the Hong Kong Security Markets: Evidence from Cointegration Tests", *Journal of International Financial Markets, Institutions and Money*, **7**(2), pp. 157-169.

Hondroyannis, G. and E. Papapetrou (2001), "Macroeconomic Influences on the Stock Market", *Journal of Economics and Finance*, **25**(1), pp. 33-49.

Huang, B., C. Yang and J. Hu (2000), "Causality and Cointegration of Stock Markets among the United States, Japan and the South China Growth Triangle", *International Review of Financial Analysis*, **9**(3), pp. 281-297.

Johansen, S. (1988), "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, **12**(2&3), pp. 231-254.

Johansen, S. (1991), "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models", *Econometrica*, **59**(6), pp. 1551-1580.

Johansen, S. and K. Juselius (1990), "Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money", *Oxford Bulletin of Economics and Statistics*, **52**(2), pp. 169-210.

Kanas, A. (1998), "Linkages between the US and European Equity Markets: Further Evidence from Cointegration Tests", *Applied Financial Economics*, **8**(6), pp. 607-614.

Knif, J. and S. Pynnonen (1999), "Local and Global Price Memory of International Stock Markets", *Journal of International Financial Markets, Institutions and Money*, **9**(2) pp. 129-147.

Kwon, C. S. and T. S. Shin (1999), "Cointegration and Causality between Macroeconomic Variables and Stock Market Returns", *Global Finance Journal*, **10**(1), pp. 71-81.

Maysami, R. C., L. C. Howe and M. A. Hamzah (2004), "Relationship between Macroeconomic Variables and Stock Market Indices: Cointegration Evidence from Stock Exchange of Singapore's All Sector Indices", *Jurnal Pengurusan*, **24**, pp. 47-77.

Muradoglu, Y. G. and K. Metin (1996), "Efficiency of the Turkish Stock Exchange with Respect to Monetary Variables: A Cointegration Analysis", *European Journal of Operational Research*, **90**(3), pp. 566-576.

Nasseh, A. and J. Strauss (2000), "Stock Prices and Domestic and International Macroeconomic Activity: A Cointegration Approach", *The Quarterly Review of Economics and Finance*, **40**(2), pp. 229-245.

Nelson, D. B. (1991), "Conditional Heteroscedasticity in Asset Returns: A New Approach", *Econometrica*, **59**(2), pp. 347-370.

Niarchos, N. A. and C. A. Alexakis (2000), "The Predictive Power of Macroeconomic Variables on Stock Market Returns: The Case of the Athens Stock Exchange", *Spoudai*, **50**(2), pp. 74-86.

Pan, M., Y. A. Liu and H. J. Roth (1999), "Common Stochastic Trends and Volatility in Asian-Pacific Equity Markets", *Global Finance Journal*, **10**(2), pp. 161-172.

Phillips, P. C. B. (1986), "Understanding Spurious Regressions in Econometrics", *Journal of Econometrics*, **33**, pp. 311-340.

Schwarz, G. (1978), Estimating the Dimension of a Model, *Annals of Statistics*, **6**(2), pp. 461-464.

Syriopoulos, T. (2006), "Risk and Return Implications from investing in Emerging European Stock Markets", *Journal of International Financial Markets, Institutions and Money*, **16**(3), pp. 283-299.

Swanson, P. E. (1987), "Capital Market Integration over the Past Decade: The Case of the US Dollar", *Journal of International Money and Finance*, **6**, pp. 215-225.

Tsouma, E. (2009), "Stock Returns and Economic Activity in Mature and Emerging Markets", *The Quarterly Review of Economics and Finance*, **49**, pp. 668-685.