A test of Integration between Emerging and Developed Nation's Stock Markets

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ABSTRACT

This paper makes an attempt to examine the financial integration between emerging countries and developed countries. Stock market data for six countries USA, CANADA, UK, India, Malaysia and Singapore have been used for the purpose of the study. Cointegration was tested on the basis of various alternative techniques. Results contradict existing literatures and suggest that although developments at international level significantly influence national stock markets, but they are driven mainly by the developments at domestic level. Study also indicates that world equity market is segmented; where developed nations and emerging markets have made separate grouping. In case of India we find that it is positively correlated with all the markets, but this relationship is not highly positive.

KEY WORDS

Financial markets Integration, Johansen test, VAR-ECM, Engle-Granger Two stage method, Developed nations, Developing Nations.

OBJECTIVE

The objective of this paper is to test the cointegration of stock markets of emerging and developed nations. In the past various studies has been done on this issue, but most of these studies were focused mainly on integration between developed country's stock markets. Very few studies have been done to check whether the stock markets of developed and emerging markets are cointegrated in the long run. Again there is a clear dearth of studies including India also as one of the sample country. So in this paper we are trying to analyze the cointegration between developed and emerging nations' stock markets including India using various alternative methodologies.

INTRODUCTION

Financial market integration can be understood as a situation where there are no quantitative and qualitative barriers like tariffs, taxes, restriction on trading in foreign assets or information costs which hampers the free flow of capital from one market to another. Financial market integration is a buzzword now a day. Financial markets can be considered integrated if there is no barrier on free capital mobility and same risk assets command the same return across the different markets. In the last decade significant improvement have been made in terms of financial reforms to achieve market integration especially in developing countries like India. The reforms helped considerably in removing the institutional bottlenecks on free flow of capital across different markets.

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Liberalization of Financial Markets is a major force behind Financial Market integration. An open and well-integrated financial market helps to maximize the benefits of an increasing globalised economy. A financial market that is well integrated with the rest of the world allows country to smooth its consumption pattern and attract investment from abroad to enhance its productivity. Integration of Financial markets helps developing nations in achieving high economic growth and improve living standard by opening international pool of resources. It also adds depth and liquidity to the domestic capital markets and permits it to perform its intermediation and risk diversification roles more efficiently. Highly integrated financial markets also help individuals and investors to diversify their portfolio risk by investing in different countries worldwide.

Although this integration has some attached cost with it especially for developing nations. It makes domestic economy vulnerable to international shocks. It also increases the volatility of the markets, as large amount of freely flowing money makes it very difficult to have a balanced and planned economic development approach. If the Financial markets are integrated to a high degree then the economy of the country is influenced by foreign policies especially in case of developing nations. Another cost associated with the capital flows is misallocation of capital inflows in domestic financial system. It may be due to weak banking system and poor regulation of the financial system.

Increasing integration of world markets should have an obvious impact on the behaviour of stock market prices. Several studies done in the past show that linkage among countries has increased after 90s, but increasing linkage need not mean increasing integration also. Historical evidences also show the international capital flow has been limited to small number of large and medium income countries to reeve the benefits of high return .The small developing nations do not enjoy the benefits of the integrated world capital market. The extent of financial integration among different countries is still a debated issue, and there is evidence that some countries have made relatively slow progress along this path. In this paper an attempt is made to study the integration between different developing countries and developed countries[2].

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[2]Countries with a high degree of industrialization, high standards of living and high per capita GDP come into the gamete of Developed Nations. Developing country is a country with low average income compared to the world average. In the United Nations system there is no established convention for the designation of "developed" and "developing" countries or areas. In common practice, Japan in Asia, Canada and the United States in northern America, Australia and New Zealand in Oceania and Europe are considered "developed" regions or areas. In international trade statistics, the Southern African Customs Union is also treated as a developed region and Israel as a developed country; and countries of Eastern Europe and the former USSR, countries in Europe are not included under either developed or developing regions.

There are mainly two different approaches to study the financial markets integration. First, testing the sensitivity of Capital flow from one market to another based on Interest rate differentials and Second, testing of real interest rate prevalent in different countries or return on capital (net of risk).

BACKDROP OF THE PAPER

Studying the integration of different markets is not a new area of research. Hordick (1972), Argy and Hodreja (1973) and Salant and Sweeny (1976) tested the degree of integration in different markets using different techniques. Fase (1976) found evidence of substantial degree of market integration in eleven European countries, base on monthly short-term interest rate data for the period of 1961-1972 and using Principle Component analysis technique. The wave of globalization accompanied by financial sector reforms in many emerging countries during 1990s (or 1980s more specifically) motivated many empirical studies in this area.

Mishkin (1982) studied the equality of real interest rates and other parity conditions for countries UK, West Germany, Netherlands and Switzerland and found evidences that real interest rates are not equal in these countries, although he acknowledged that there is a tendency for real interest rates across these countries are equalizing over time.

Mark (1983), Cumby and Mishkin (1984) investigated the movement of real interest rates in developed countries and found a strong positive correlation between interest rate movements in US and these countries. Kasa (1992) examined number of common stochastic trends in the equity market of US, Japan, England, Germany and Canada and found a strong common trend driving stock prices of these countries

Cheun and Mark (1992) using weekly return series for the period of 1977 and 1988 Investigated the relationship between the two developed markets US and Japan and eight Asian-Pacific markets; Australia, HK, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand and found that US market leads the stock market of most of these countries with the exception of Korea, Taiwan and Thailand. While Japanese market found to have a less important influence in this region. Malliaris and Urrutia (1992) analyzed lead-lag relationship for six major stock market indexes[3] for before and after 1987 market crash. Although they did not find any causality for pre-crash and post-crash period but they found important feedback relationship and unidirectional causality for the month of causality.

Chung and Liu (1994) conducted a study to examine the common stochastic trend among national stock prices of the US and five East Asian countries Japan, HK, Singapore, Taiwan and Korea. Their study suggests that except Taiwan, all other countries in the

[3] New York S&P 500, Tokyo Nikkei, London FT-30, Hong Kong Hang Seng, Singapore Straits Times and Australia All Ordinaries.

sample has a strong linkage with US market and holds same speed of adjustments from short term disequilibrium.

Corhay et al (1995) conducted a study to investigate long-run relationship among five major European markets France, Germany, Italy, Netherlands and UK and found evidences of strong integration among these countries. Korajczyk (1996) and Harvey (1995) found asymmetric integration relationship; stock markets of developed notions are more integrated than those of emerging nations.

Choudhary (1994) test the stochastic structure of individual stock markets of US, UK, Japan, Italy, France, Canada and Germany. Their study supports the efficient market hypothesis. All stock indices contain a long-term permanent stochastic trend (unit root) that makes long run predictions impossible. Using Johansen method of cointegration, they found no evidence of the presence of common stochastic trend among these stock markets (for the period of 1953-1989). In a different paper, same author (Choudhary 1997) used a bivariate framework for the period of 1985-1993 for six Latin-American markets and found support for the existence of long-run relationship.

Solnik et al (1996) examined the correlation of volatility in stock prices in different markets and found that this correlation increases during the period of high market volatility. They also found that in the last 37 years (1959-1995) correlation of individual foreign markets with the US stock market has increased slightly, but in the last 10 yrs (1985-1995) there is no significant increase in this correlation.

Ghosh et. al. (1998) checked the individual integration of nine Asia pacific markets with either the US or Japanese stock markets, but they did not find any evidence that US or Japanese stock market movements dominates these markets. Phylaktis (1999) also examined Asia Pacific Basin countries to investigate whether the Japan has play a more influencing role in this region than USA. Using Impulse-response analysis for speed of adjustments and long-run comovements of real interest rates, they found that these countries are closely linked with world financial markets. Their relationship is stronger with Japan than with USA. Haung et al (2000) explored the causality and cointegration relationship among the US, Japan and several South East Asian countries including recently established markets in China; Shenzhen and Shanghai exchanges. They found no cointegration among these markets except between Shanghai and Shenzhen.

A recent study of Robert P. Flood and Andrew K. Rose (2003) tests the assets integration within and between American stock markets. Using inter-temporal asset-pricing model, they compared the expected risk free rates across assets. According to the study expected risk-free rates vary dramatically over time, unlike short interest rates. They found that the S&P 500 market seems to be well integrated, and the NASDAQ is generally (but not always) integrated. However, the NASDAQ is poorly integrated with the S&P 500.

Lamba (2003) studied the dynamic relationship between South Asian Market India, Sri Lanka and Pakistan and with major developed markets US, UK and Japan. He found that the large developed equity markets influence Indian market and this relationship has strengthened in recent time. India does not influence the stock markets of Sri Lanka and Pakistan; rather Pakistan and Sri Lanka stock markets are relatively isolated.

DATA AND METHODOLOGY

DATA

The paper uses the daily stock index data for a period of 11 years (1994 to 2005) for three developing and three developed countries; US, Canada, UK, India, Singapore and Malaysia. Most popular indexes of respective countries are selected for study like S&P/TSX Composite Index for Canada, S&P 500 Index for United States, BSE Sensex for India, Straits Times Index for Singapore, FTSE 100 Index for UK and Composite Index for Malaysia. There are total 2760 observations. The data has been collected from www.finance.yahoo.com and the validity of the data was checked from the respective stock exchange websites. Since the objective of this study is to check whether the cointegration of the movement of these indexes, so natural logarithm of the data has been used for further analysis.

METHODOLOGY

There are a number of test used in the literature to test the long-run relationship of two variables. Some of the most widely used techniques are Engle-Granger two-step technique of cointegration, Johansen cointegration analysis, VAR-ECM model, Principle-Component Analysis and Impulse-Response Analysis.

- ***Test of Stationarity***

Two series are considered to be cointegrated if a linear combination of these series is stationary, even though individual series may be non-stationary. Non-stationary time series has a trend and do not return to their mean, so it is always advised to convert these series into stationary after doing some transformation. Generally stock price data shows non-stationarity. So our analysis of data starts with a test of stationarity.

Literature contains many test of Stationarity, but some of the widely used tests are Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) test.

Augmented Dickey-Fuller test consist of estimating the following equation;

$$\ln Y_t = a + b\, t + \delta \ln Y_{t-1} + d \sum_{i=1}^{n} \Delta \ln Y_{t-i} + e_t$$

Here we test under the null hypothesis if $\delta = 0$. if $\delta = 0$ then series contains a unit root and thus non-stationary. But while testing null hypothesis, one should be aware of not using normal t-statistics. Dickey Fuller itself developed a test statistics known as τ (Tau) statistics. So if computed value of tau-statistics in absolute terms is more than critical value, then one should reject the null hypothesis. In other words, if computed value is more than critical value (in absolute terms) at a given level of significance then underlying series is stationary. Phillip Perron test is similar to ADF test with only difference that in ADF we add lagged difference term to take care of possible serial correlations, while Phillip-Perron test uses nonparametric statistical methods to take care of serial correlation in the error terms. Test statistics of both the tests are similar.

- ***Test of cointegration***

EG Two Stage test of Cointegration

Engle and Granger test of Cointegration is normally a bivariate test of cointegration. In this test, first prerequisite is that all the series should be integrated of same order. So this test formally begins with the identification of integration order of the series. Then in the first stage of the test, one should estimate the normal OLS regression and obtain the residuals. In our model, we run the following equation in the first stage:

$$\ln Y_t = a + b \ln X_{t-1} + e_t$$

$$\ln X_t = a + b \ln Y_{t-1} + e_t$$

In the second stage, we test these residuals (individually for each series) for stationarity using Augmented Dickey Fuller test or Phillip-Perron test. If residuals are stationary, then underlying time series are co-integrated.

Here two points are important to note; first, this test should be performed if both the series (X and Y in this equation) are integrated of same order and second, one should use the critical values calculated by Engle and Granger[4].

Johansen test

Johansen (1991) test is an alternative and more powerful test of multivariate cointegration test. This test is based on the rationale that although series are integrated of the same order, but can a linear combination of them becomes stationarity. This test is based on Maximum Likelihood approach and can be seen as a multivariate version of ADF test, which provides a likelihood ratio (LR) for the null hypothesis of at most r cointegrated vectors (r can range between zero to the number of variables I the model).

Johansen test is based on eigenvalues of a stochastic matrix and in fact reduce to a canonical correlation problem similar to that of principal components. They are based on the Error Correction form of the multivariate system (VEC):

$$\Delta Y_t = {}^{k-1}\sum_{I=1} \Gamma_I \Delta Y_{t-i} + \Pi Y_{t-k} + \mu + e_t$$

When there exist only r linearly independent cointegrated vectors, Π can be written as $-\alpha\beta$, where α and β are $N \times r$ metrics with rank r. β contains the co-integrating vectors

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[4] Although we are using ADF or PP test in the second stage but here residuals are based on estimated parameters of ‘b’ ‘so tau statistics would not be applied here.

and α is the matrix of weights with which each cointegrating vector enters into the VAR model. Johansen procedure allows testing on coefficients α and β using several likelihood ratio tests. A bivariate cointegration analysis is performed for each couple of variables in log level. Some groups of three or four variables are also studied with the Johansen test to check the coherence of the bivariate results. In the above equation if rank of Π is zero, then it becomes the usual VAR model in first difference.

Johansen test provides two different test statistics that can be used to test the hypothesis of the existence of r cointegrating vectors. First, the trace test and second maximum eigenvalue test. The trace test statistics test the null hypothesis that the number of distinct cointegrating relationship is less than or equal to *r* against the alternative hypothesis of more than *r* cointegrating relationships, and is defined as:

$$\lambda_{trace}\ (r) = -T\ {}^{p}\sum_{j=r+1} \ln (1-\lambda_j)$$

Where *T* is the number of observations and the λs are the eigenvalues of Π in the above equation. The maximum eigenvalue test statistic tests the null hypothesis that the number of cointegrating relationships is less than or equal to *r* against the alternative of *r+1* cointegrating relationships, and is defined as:

$$\lambda_{max}\ (r, r+1) = -T\ (\ln (1-\lambda_j))$$

VAR-ECM

The rationale behind VAR-ECM is that if two variables are cointegrated then there exists a long run relationship between them, although in short-run they can be in disequilibrium. Therefore one can treat error term in the regression of these two variables as 'equilibrium error' and by incorporating it in the model, one can see how speedily two variables adjust towards long run equilibrium. In case of two variable (X and Y) ECM[5] can be written as:

$$\Delta Y_t = a_0 + a_1\ \Delta X_t + a_2\ (Y_{t-1} - b_0 - b_1\ X_{t-1}) + \sum \gamma_i\ \Delta Y_{t-i} + e_t$$

Where 'a' are the parameters of the equation, $(Y_{t-1} - b_0 - b_1\ X_{t-1})$ represents one period lagged value of error term. This model exhibits that ΔY_t depends on ΔX_t and also equilibrium error term. Now suppose ΔX_t is zero and $(Y_{t-1} - b_0 - b_1\ X_{t-1})$ is positive. This simply means that Y_{t-1} is too high from equilibrium and it will restore to equilibrium if a_2 is negative. In this equation a_2 shows the speed of adjustment and long-term equilibrium is attain when $Y_{t-1} = b_0 - b_1\ X_{t-1}$. This model can be extended easily to include more than two variables also.

[5] Error Correction Model

RESULTS

Descriptive Statistics

Table one provides the brief description of the six countries' stock data (in logarithms form). Table one suggests low variability of stock market indices during the period of our study. Table also shows that distribution of stock return for USA, UK, CANADA and INDIA has thicker tail, while Singapore and Malasiya has slim tail[6]. Similarly distribution of stock return for USA, UK, CANADA, Singapore and Malasiya is right-skewed, but in case of India it is left skewed[7]. JB statistics for all the distributions shows that none of them are normally distributed[8].

Table One: Summary statistics of Various Stock Market Indices

Country	USA	UK	CANADA	INDIA	Singapore	Malasiya
Mean	6.8400	8.4438	8.8048	8.2606	7.5073	6.6872
S.D.	0.3245	0.2319	0.2529	0.2067	0.2108	0.2661
Kurtosis	-0.5234	-1.0323	-0.6786	-0.1751	0.8005	0.4211
Skew ness	-0.7596	-0.1942	-0.3846	0.7520	-1.0375	-0.6084
Minimum	6.0901	7.9643	8.2839	7.8633	6.6908	5.5710
Maximum	7.3313	8.8436	9.3403	8.8414	7.8566	7.1811
JB	297.01	140.08	121.78	263.64	568.12	190.33
Observation	2762	2762	2762	2762	2762	2762

Note: (i) Figure for Kurtosis reflects difference from mean Normal value i.e. 3
(ii) No JB statistic is significant even at 10% level of significance

As we just discussed in the methodology section, there are a number of test to check the cointegration between different variables. Highly cointegrated markets should provide highly correlated rate of return. Table two shows the Karl Pearson coefficient of correlation between all possible pairs of two countries. Table 2 contains very interesting results. All developed nations' stock markets are highly positive correlated. India is positively correlated with all other but degree of correlation is very low. Singapore and Malaysia both markets are negatively correlated with all the three developed nations markets, but positively correlated with emerging markets.

All the coefficients are highly significant even at 1% level of significance, which shows higher degree of market linkage. But one should be cautious that higher correlation is neither a necessary nor a sufficient condition for higher cointegration between the

[6] As per a general rule a normal distribution should have a Kurtosis of 3. If it is less than 3, then distribution has thicker tail and vice-versa.
[7] Skewness for a normal distribution has a value '0'. If a distribution has positive 'S' then it is left-skewed and vice-versa.
[8] JB statistics is a joint test for S=0 and K=3. If p value for the test statistics is sufficiently low, then one reject the hypothesis that distribution is normal.

markets. Markets are considered cointegrated if value of same asset is equal across the markets and there is no arbitrage opportunity.

Table Two: Karl Pearson Coefficient of correlation

Variables	Canada	US	India	Singapore	UK	Malaysia
Canada	1					
US	0.927	1				
India	0.478	0.309	1			
Singapore	-0.217	-0.329	0.372	1		
UK	0.780	0.920	0.186	-0.251	1	
Malaysia	-0.356	-0.554	0.261	0.782	-0.581	1

Note: All values are highly significant at 1%.

Test of Stationarity

Figure one, two and three in the Appendix contains plot of observed stock price indices in original form and natural log form (level series and first difference). Figure suggests that all natural log series of indices value can be stationary at first difference. To validate our result we carried out both ADF test as well as P-P test. Results of these two tests are summarized in Table Three. Results of both ADF test and PP test shows that all the series are integrated of same order and is I (1).

Table Three: Unit root test results

	ADF test Statistic	PP test Statistic	Critical Value	Conclusion
USA	-2.214	-2.114	**For ADF test**	
	-9.398*	-53.307*		I (1)
UK	-1.876	-1.790	-3.435 at 1%	
	-8.905*	-52.646*	-2.863 at 5%	I (1)
Canada	-1.476	-1.351	-2.567 at 10%	
	-7.952*	-47.434*		I (1)
India	-1.140	-1.554	**For PP Test**	
	-9.083*	-47.515*		I (1)
Singapore	-2.335	-1.896	-3.435 at 1%	
	-7.786*	-45.553*	-2.863 at 5%	I (1)
Malasiya	-2.534	-2.248	-2.567 at 10%	
	-7.076*	-49.236*		I (1)

Note: (i) First figure shows test statistics at level form, while second figure is for first difference.
(ii) All test statistics are significant at 1% level, showing that series are I (1)

Engle Granger Test for Cointegration

Since all the series are integrated of the same order, so we use Engle-Granger test and Johansen test both to check the long run equilibrium relationship of the variables. First we use the Engle granger test to check the cointegration. Here we use the following regression equations as explained in the methodology section.

$$\ln Y_t = a + b \ln X_{t-1} + e_t$$

$$\ln X_t = a + b \ln Y_{t-1} + e_t$$

Only thing one needs to take care of is that although all the series are I (1), but these equations should be estimated at level form only. Since it is a bivariate test of cointegration, so we need to run the above regression for all possible pairs of six countries under study. Results of this test are summarized in table four; these results are really very interesting and eye opening. I found significant long run relationship in case of only two pairs of countries. Singapore and Malasiya stock market shows a long run significant relationship at 1% level of significance, while USA and UK exhibits this long run relationship at 5% level of significance. In case of other countries I found no long run equilibrium relationship. Surprisingly, I found that Indian stock market is not cointegrated with any of the market in the study and in the long run USA market has no influence on other markets except UK. Contrary to existing literature, results of this test indicate that world equity markets are still segmented and developed and emerging countries markets has some influence on other markets in their region only.

Table Four: Engle-Granger Test for Cointegration

	ADF Test Statistics	PP Test Statistics	Conclusion
USA/UK	-6.510*	-6.884*	Cointegtrated
USA/CANADA	-1.779	-2.009	No-cointegration
USA/INDIA	-2.016	-1.972	No-cointegration
USA/SINGAPORE	-1.937	-1.896	No-cointegration
USA/MALASIYA	-1.758	-1.678	No-cointegration
UK/CANADA	-1.937	-1.927	No-cointegration
UK/INDIA	-1.751	-1.742	No-cointegration
UK/SINGAPORE	-1.776	-1.810	No-cointegration
UK/MALASIYA	-1.777	-1.791	No-cointegration
CANADA/INDIA	-2.036	-1.985	No-cointegration
CANADA/SINGAPORE	-1.288	-1.296	No-cointegration
CANADA/MALASIYA	-1.156	-1.142	No-cointegration
INDIA/SINGAPORE	-2.135	-2.004	No-cointegration
INDIA/MALASIYA	-1.867	-1.794	No-cointegration
SINGAPORE/MALASIYA	-3.682*	-3.852*	Cointegrated

Note: * show results significant at 1% level of significance.

EG two-stage test although very simple, but suffers from some drawbacks. First, being the bivariate test one cannot identify more than one cointegrated vectors among k variables, where k > 2. Second, second stage of this test is estimated on the basis of residuals obtained in first stage, so any error that may occurred in stage first will simply carried over to second stage also. So to further strengthen our results we move to Error Correction Model.

Error Correction Model

The rationale behind VAR-ECM is that if two variables are cointegrated then there exists a long run relationship between them, although in short-run they can be in disequilibrium. Therefore one can treat error term in the regression of these two variables as 'equilibrium error' and by incorporating it in the model, one can calculate the speed with which two variables adjust towards long run equilibrium. As per the Johansen, whenever two variables are cointegrated and showing short-run adjustments to bridge the long-run disequilibrium, there is causality between them.

Table Five: Results of Error Correction Model

Dependant Variable	Independent Variable	λ_{trace} Statistics	Slope Coefficient	Adjustment Parameter
USA	UK	28.25*	0.022 (1.624)***	-1.013 (-53.116)[a]
	Canada	18.100	0.013 (0.817)	1.032 (54.518)[a]
	India	8.750	0.0006(0.068)	-1.013 (-53.142)[a]
	Singapore	9.049	0.0019 (0.163)	-1.018 (-53.458)[a]
	Malaysia	11.007	0.020 (1.801)***	-1.014 (-53.188)[a]
UK	Canada	22.878	0.0354 (2.176)**	-0.997 (-52.254)[a]
	India	8.321	0.0124 (1.273)	-0.995 (-52.205)[a]
	Singapore	7.829	0.038 (3.280)*	-0.995 (-52.168)[a]
	Malaysia	9.728	-0.031 (-2.812)*	-0.995 (-52.189)[a]
Canada	India	10.072	0.021 (2.540)*	-0.900 (-47.444)[a]
	Singapore	20.099	-0.404 (-3.959)*	-0.900 (-47.506)[a]
	Malaysia	9.714	0.0371 (3.870)*	-0.903 (-47.567)[a]
India	Singapore	20.365	-0.055 (-0.327)	-0.907*(-47.802)[a]
	Malaysia	14.300	0.029 (1.845)	-0.947 (-47.799)[a]
Singapore	Malaysia	59.351*	0.0123 (0.913)	-0.861 (-45.610)[a]

Note: *, ** AND *** shows statistics significant at 1%, 5% and 10% level of significance. Superscript 'a' shows highly significant statistic (p almost zero). λ_{trace} statistics rejects the null hypothesis for r = 0 against the alternative hypothesis that there is one cointegrating vector.

Result of Error Correction Model is shown in table Five. Result of ECM is on the similar line what we obtained from EG two-stage test. We found only two cointegrated vectors; one for USA and UK and another for Singapore and Malaysia. We found a number of significant slope coefficients, which shows that in the short run changes in one country's stock market prices influences another country's stock market prices. All the adjustment parameters are statistically significant, which shows that entire adjustment does not take place in the same period, rather it is carried over to other periods also. Considering these adjustment coefficients along with correlation coefficients suggests that although developments at international levels affects the national stock markets, but entire impact is not resulting in the same period. It can also be interpreted as that equilibrium error term is not zero.

Johansen Test

So far we are checking the one on one integration relationship between different countries stock markets. Now we move to more powerful test of cointegration. As we seen all the stock market indices are integrated of the same order. So now using Johansen test we check whether a linear combination of these indices becomes stationary.

Johansen's test indicates the number of cointegrated vectors using the Maximum Likelihood approach. It provides two test statistics to test the existence of r cointegrating vectors; Maximum eigenvalue test and trace test. Trace test statistics test the null hypothesis that the number of distinct cointegrating relationship is less than or equal to *r* against the alternative hypothesis of more than *r* cointegrating relationships. While maximum eigenvalue test statistic tests the null hypothesis that the number of cointegrating relationships is less than or equal to *r* against the alternative of *r+1* cointegrating relationships. Table Six shows the result of Johansen test.

Table Six: Johansen test for multivariate Cointeration

Part A: All Six Countries

Cointegrating Vectors	λ_{trace} Statistics	Critical value 5%	Critical Value 1%
r = 0	169.534*	94.15	103.81
r = 1	91.750*	68.52	76.07
r = 2	44.335	47.21	54.46
r = 3	20.674	29.68	35.56
r = 4	7.713	15.41	20.04
r = 5	3.288	3.76	6.65

Part B: Only Developed Countries (USA, UK and CANADA)

Cointegrating Vectors	λ_{trace} Statistics	Critical value 5%	Critical Value 1%
r = 0	48.659*	29.68	35.65
r = 1	14.321	15.41	20.04
r = 2	3.701	3.76	6.65

Part C: Only Developing Countries (India, Singapore and Malaysia)

Cointegrating Vectors	λ_{trace} Statistics	Critical value 5%	Critical Value 1%
r = 0	67.217*	29.68	35.65
r = 1	10965	15.41	20.04
r = 2	3.510	3.76	6.65

Johansen test indicates the existence of two cointegrated vectors for all the six countries. In case of Developing and developed countries are considered separately, there exists only one cointegrated vector. Looking closely on these results further strengthen previously obtained results. The two equations obtained from including all the six countries shows strong and a very closer relationship between USA and UK.

These cointegrated equations are as shown next;

For all Six Countries

$$u_{t-1} = \ln USA - 1.032745 \ln CANADA + 0.279627 \ln INDIA - 2.051784 \ln SINGAPORE + 1.881458 \ln MALAYSIA + 2.764934$$

$$u_{t-1} = \ln UK - 0.582288 \ln CANADA + 0.484337 \ln INDIA - 2.996610 \ln SINGAPORE + 2.408389 \ln MALAYSIA - 0.926634$$

For Developed Countries

$$u_{t-1} = \ln USA - 0.889193 \ln UK - 0.572393 \ln CANADA + 5.707971$$

For Developing Countries

$$u_{t-1} = \ln INDIA - 7.117073 \ln SINGAPORE + 5.352259 \ln MALAYSIA + 9.378300$$

VAR-ECM Model Building

In this section we developed a long run relationship model for Indian stock index in terms of other five countries' stock indices. This VECM for India will be in the following form:

$\Delta \mathbf{lnINDIA_t}$ = 0.000202 + 0.102469ΔlnINDIA$_{t-1}$ -0.045978ΔlnINDIA$_{t-2}$ +0.027809 ΔlnINDIA$_{t-3}$ +0.040414ΔlnINDIA$_{t-4}$ – 0.046841ΔlnUSA$_{t-1}$ + 0.039662ΔlnUSA$_{t-2}$ +0.025652ΔlnUSA$_{t-3}$ +0.045324ΔlnUSA$_{t-4}$ –0.017930ΔlnUK$_{t-1}$+0.007023ΔlnUK$_{t-2}$ +0.026823ΔlnUK$_{t-3}$ –0.002970ΔlnUK$_{t-4}$ –0.061032ΔlnCANADA$_{t-1}$ – 0.021641 ΔlnCANADA$_{t-2}$ + 0.013648ΔlnCANADA$_{t-3}$ +0.016734 ΔlnCANADA$_{t-4}$ + 0.022803ΔlnSINGAPORE$_{t-1}$ + 0.035819ΔlnSINGAPORE$_{t-2}$ – 0.035052ΔlnSINGAPORE$_{t-3}$ + 0.040911ΔlnSINGAPORE$_{t-4}$ – 0.030108ΔlnMALAYSIA$_{t-1}$ + 0.011999 ΔlnMALAYSIA$_{t-2}$ – 0.012082 ΔlnMALAYSIA$_{t-3}$ + 0.019673 ΔlnMALAYSIA$_{t-4}$ -0.002213 ECT(1) **OR** 0.011903 ECT (2)

Where ECT (1) and ECT (2) is given by following equations;

ECT (1) = lnIndia$_{t-1}$ + 2.325145 lnUK$_{t-1}$ + 1.480082 lnCanada$_{t-1}$ – 6.323651 lnSingapore$_{t-1}$ + 5.225786 lnMalaysia$_{t-1}$ – 2.332974

ECT (1) = lnUSA$_{t-1}$ – 0.483393 lnUK$_{t-1}$ – 0.679121 lnCanada$_{t-1}$ – 0.690126 lnSingapore$_{t-1}$ + 0.854920 lnMalaysia$_{t-1}$ +2.685201

CONCLUSION

This paper provides evidences that although there exists two cointegrated vectors among six countries under study means these six countries markets are moving more or less in the same direction, but while checking on one-on-one basis, we found no statistically significant cointegration relationship among most of the market pairs. It indicates that despite the increasing linkage after globalization, national stock markets are driven more by the developments at national level than at international levels. Study also indicates that world equity market is segmented; where developed nations and emerging markets have made separate grouping. In case of India we find that it is positively correlated with all the markets, but this relationship is not highly positive.

FURTHER SCOPE

This paper has tremendous potential to work further on various lines. One can work further on this paper using other techniques like Principle-Component Analysis, Impulse-Response Function and ARDL methodology. Another dimension is that this paper checks for only contemporaneous relationship, one can check for whether different markets have a lead-lag sort of relationship. One can also test for structural breaks in this relationship dividing the entire sample period in different sub-periods.

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EXHIBITS

Figure One: Daily Value of Stock Indices (original form)-April 1994 to March 2005

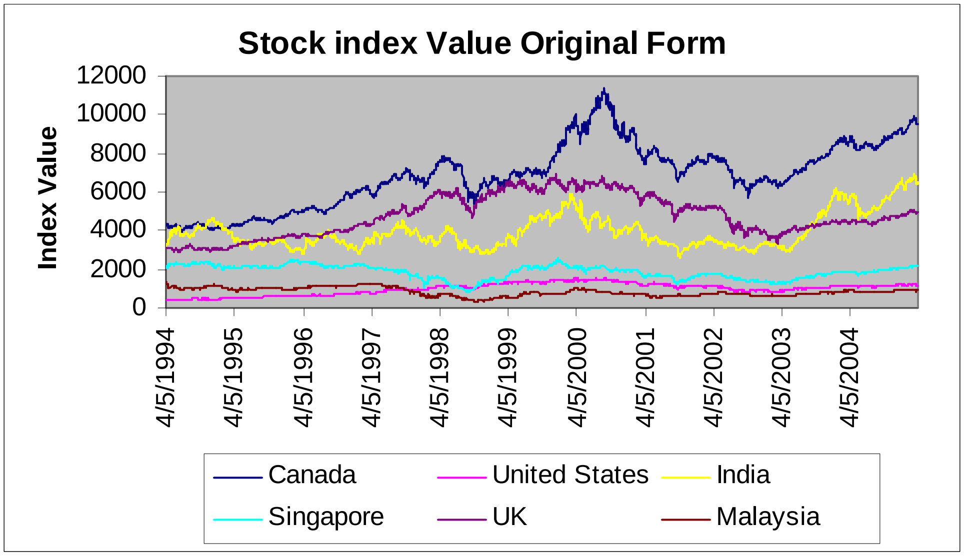

Figure Two: Daily Value of Stock Indices (log level form)-April 1994 to March'05

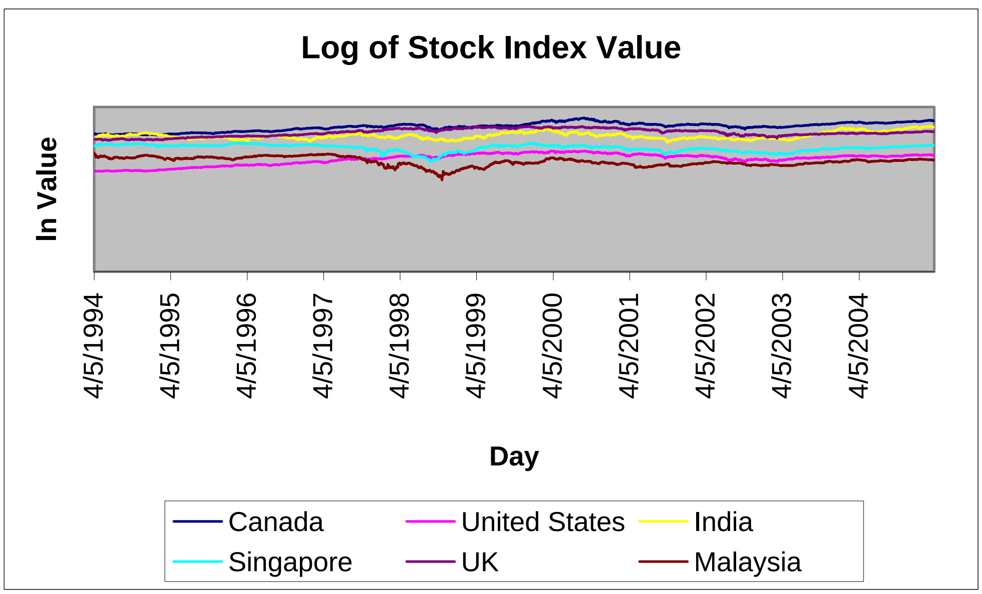

Figure Three: Daily Value of Stock Indices (log First difference form)
April '94 to March'05