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AN EMPIRICAL ANALYSIS OF DYNAMIC LINKAGES: A CASE OF INDIA, JAPAN, SINGAPORE AND US STOCK MARKETS

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Abstract

In this study, we conducted a detailed large sample analysis of the dynamic relationship between India, U.S., Japanese, and Singapore stock markets on the time series data from April 2000 to March 2008 using Unit Root Tests, Cross – Correlation Test , EG ADF and Higher – Order Cointegration Test. The unit root test result suggests that these markets are weak form efficient. But the EG –ADF test result reveals that the Indian stock market is co- integrated with Singapore. But India is isolated from USA and Japan markets.

Introduction

There has been increasing interest in international linkages as stock markets world-wide have become more open. The issue of stock market integration and co -movements of stock prices across economies have received considerable attention in economic literature. The interest in studying the dynamic relationships among the world's equity markets gathered considerable momentum following the October 1987 global stock market crash, and even more so, following the Asian financial crisis in 1997. With an integrated regional stock market, investors from all member countries will be able to allocate capital to the locations in the region where it is the most productive. With more cross-border flows of funds, additional trading in individual securities will improve the liquidity of the stock markets, which will in turn lower the cost of capital for firms seeking capital and lower the transaction costs investors incur.

An accurate assessment of the degree of co-movement among international financial markets is important for several reasons. For investors, the design of a well-diversified portfolio crucially depends on a correct understanding of how closely equity returns are correlated across countries. Changes in international correlation patterns will in general call for an adjustment of portfolios. Supervisory authorities are interested in correlations among financial markets because of their implications for the stability of the global financial system. International stock market developments affect monetary policy. This paper specifically considers whether the stock markets of India are currently co -integrated with USA, Japan, and Singapore.

Statement of the Problem

Securities market in India has grown in terms of amount raised from the market, the number of listed stocks, market capitalisation, trading volume and turnover on stock exchanges and other intermediaries. Globalisation is increasing at a fast pace and capital markets across the globe are getting integrated. Deregulation and market liberalisation measures, rapid development in the communication technology and computerised trading systems have accelerated the growth of Indian capital markets. India is one of the countries with expanding stock markets, increasingly attracting funds from FIIs. The October 1987 global stock market crash, the Asian financial crisis during 1997–98 and the terrorist attacks on the US on 11th September 2001, affected the international markets. If markets move together, then

investing in various markets nullifies much of the gain arising out of diversification across the borders. The NSE has also attracted the attention of the global community as it has emerged as the third largest stock exchange of the world in terms of the number of transactions per day, next only to that of the NYSE and the NASDAQ. The average daily transactions that NSE logs today are in the range of 1.9 to 2.1 million trades. Therefore, it is important, for both investors and academicians to know whether stock markets are interrelated.

Hence this study has been undertaken to analyse whether India is co- integrated with USA, Japan and Singapore.

Objectives of the Study

The specific objectives of the study are:

- To scrutinize the returns and volatility of the various stock indices.
- To examine the non- stationarity of the various stock indices
- To examine the co- integration between India and USA, Japan and Singapore

Overview of the Literature

The academic literature on co- movement among international equity markets is large.

Rao and Naik (1990) ,Kam C. Chan, Benton E. Gup and Ming-Shiun Pan (1992) Kasa (1992), Kwan Sim, Cotsomitis (1995), Mohammad Najand (1996), Kam C. Chan, Benton E. Gup and Ming-Shiun Pan (1997), Kate Phylakktis and Fabiola Ravazzolo(1998), Roca (1999), Asim Gosh (1999) examined the dynamic relationship among various stock markets and recorded mixed results.

Kiran Kumar (2002) investigated the short run dynamic inter linkages between the US and Indian stock market. The study showed that the US stock markets significantly influenced Indian stock markets and not vice versa. Golaka C. Nath and Sunil Verma (2003) analysed the dynamic inter linkages among the three important emerging equity markets in Asia namely, India, Taiwan and Singapore and concluded that the returns of these countries were not interrelated and there was no long-term equilibrium. Ali F. Darrat and Omar M. Benkato (2003) investigated relations between the Istanbul Stock Exchange (ISE) and the major matured markets of the United States, Japan, and Europe. He documented that there was a significant co-integration between ISE and the four matured markets. Jian Yang et. al, (2003) investigated market integration among European stock markets. They concluded that the EMU had significantly strengthened stock market integration among its member countries but lessened linkages with a non-member country (UK) in the same region. Khan Masood Ahmad (2005) attempted to detect the causal relationship and dynamic linkages between the NASDAQ Composite Index in the US and the NSE S&P CNX Nifty in India .The main findings of the study were that Granger Causality Results indicated unidirectional causality running from the USA to Indian markets. However, the causal relationship was stronger during 1999–2001 and weakened in the period during 2002–2004. Although there are voluminous literature on equity market integration internationally, there has been no in-depth analysis of the interdependence structure of the Indian Capital Markets with other stock markets. The literature review shows that there is conflicting evidence on the issue of international stock market linkages and hence the issue needs further investigation. In this paper, we examine the linkages among India, US, Japan and Singapore.

Data

The data used in this study consist of time series of daily stock market indices at closing time. All data utilized in this study were obtained from Yahoo finance.Com. It covers a total of 2010 observations. The four stock markets

included in our study are NASDAQ of USA, Nikkei of Japan, Straight Time Index of Singapore and National Stock Exchange of India. The analysis focuses on the dynamic relationships between India, USA, Japan and Singapore markets from April 2000 to March 2008.

Hypotheses

Following null hypotheses were formulated for testing.

- All the stock indices are nonstationary
- India is not co- integrated with USA, UK and Singapore.

Research Design

In order to test whether the two market indices are co-integrated, it is necessary to first determine that each index series is stationary. If they are non- stationary, the index series are then examined to determine whether they are co-integrated.

Augmented Dickey–Fuller Test

Augmented Dickey–Fuller test was used on the market index levels and their first differences to test for unit root in the data. To perform the ADF test for each market index series, the following regression is estimated.

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \mu_t \quad (1)$$

Where μ_t is a white noise error term and $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$. $Y_t = \text{Ln}\ (Y_t)$. ADF still tests whether $\delta = 0$

The null and alternative hypotheses are

$H_0 : \delta = 0$
$H_1 : \delta \neq 0$

The acceptance of the null hypothesis implies non-stationarity. The critical value of ADF test at five per cent level of significance is –3.41. The ADF test values are given in Table 3.

Co-integrating Regression Durbin–Watson (CRDW) Test

To find out whether X_t and Y_t are co- integrated, the CRDW test serves as an alternative and quicker method. Durbin–Watson d is obtained from the residuals of the co-integrating regression. Null hypothesis is d = 0. The five per cent level of critical value to test the hypothesis that the true d = 0, is 0.386. If the computed d value is smaller than the critical value, the null hypothesis of no co -integration is accepted. Tables 4 presents the results of Engle–Granger DF test along with Durbin–Watson (CRDW) test.

Engle Granger–Augmented Dickey Fuller Test

The concept of co- integration was introduced by Granger (1981, 1986) and further developed by Engle and Granger (1987) to examine whether long-run equilibrium exists between the two variables.

If the market index series of the same order are integrated. Co- integration analysis is used to determine whether the index series become stationary in a linear combination. There are many methods for testing co- integration. Engle and Granger Dickey–Fuller Test for co- integration is used in the study.

In the first step, the co-integrating coefficient δ is estimated by ordinary least squares with the following formula:

$$X_t = \beta_1 + \Delta Y_t + \mu_t \quad (2)$$

This regression is called co-integrating regression. Then the Engle-Granger ADF Test is conducted on 'co-integrating residuals', obtained from the co- integrating regression by using the following equation.

$$\Delta \mu_t = -\delta \mu_{t-1} + a_i \sum_{i=1}^{m} \Delta \mu_{t-1} + \mu_t \quad (3)$$

Where ? μ_t represents the first difference of the error term,

The specific hypotheses are :

H_0 : $\delta = 0$

H_1 : $\delta \neq 0$

Null hypothesis is that there is no co-integration among the stock indices. The value of a calculated absolute tau (ô) value is greater than the tabulated critical (ô) value; the null hypothesis of no co-integration is rejected. Engle and Granger have provided the critical values of ADF statistics. The results of EG–ADF test are given in Table 4.

Where μ_t is the residuals obtained from the equation (2), $\Delta \mu_t$ is the first difference of the residuals.

This two step procedure is called the Engle–Granger ADF Test for co- integration or EG–ADF (Engle–Granger 1987)

Higher Order Co- integration

Next, to test for higher – order system of co -integration, we follow Coleman by estimating the following co- integrating regression as

$$S^i_t = a + b_j S^i_t + b_k S^k_t + b_l S^l_t + \ldots + e_t, \quad (4)$$

Where i,j,k,l ….. are countries.

Equation (4) is again estimated by ordinary least squares, and the co- integrating residuals are tested by ADF tests as indicated in equation (3). The critical values of the higher –order ADF tests are from Coleman's co -integrating simulations.

Empirical Results and Discussions

The summary statistics of daily price changes (returns) are provided in **Table -1**. The returns are exceptionally high in India, followed by USA. But Japan recorded negative returns. The volatility was very high in USA (2.138) but it was low in Singapore (1.173). The returns are negatively skewed for USA, Japan and Singapore but not for India. If returns are normally distributed, then the kurtosis should be three. However, it is found to be very high in Singapore (6.056). It indicates that there are more extreme values present in the STI index. The results of descriptive statistics show that these markets have distinctly different characteristics.

Table- 2 contains cross correlation coefficients of Indian stock market returns (first difference in the log level) with those of the other three countries examined. Under cross correlation test, only few lags are significant at 1% level, indicating that there is less degree of correlation among these markets. In respect of Nifty on STI, 4 lags are significant, and its magnitudes are 0.122, -0.254, 0.584 and -0.306. In the case of Nifty on Nikkei and Nifty on NASDAQ, 3 lags are significant and their magnitudes are 0.091, 0.244, 0.076 and 0.069, 0.259 and -0.086 respectively. The values of cross – correlation coefficients are high in Nifty on STI than Nifty on Nikkei and Nifty on NASDAQ. Overall, the correlations are not very high and the low correlation coefficients highlight the fact that international diversifications among these markets are effective.

The results of unit root tests are presented in table 3. The calculated tau (τ) values for India, Singapore, Japan and USA are – 2.790, -2.310, -2.884 and -2.654 respectively. The calculated tau (τ) values of ä for all the stock market indices are less than the tabulated tau (τ) value. These values are insignificant at 5 per cent level. The ADF test results prove that all the stock market indices are nonstationary at market index levels but stationary at first differences. For the stock market indices, the null hypothesis of a unit root was rejected at 5% level. For stock market returns, however, the null hypothesis is strongly rejected with significance levels much less than 1%. The uniqueness of unit root in the stock price level is thus confirmed. These findings

suggest that changes in stock prices are stationary in all the countries tested.

Table 4 gives the results of EG - ADF tests and Durbin Watson test of co- integration among the stock markets. If we have larger negative ADF statistics, the null hypothesis of no co- integration is rejected. The calculated d values are smaller than the crtitical value. But the calculated tau (τ) value for India on Singapore is greater than the critical table value. The null hypothesis that there is no co- integration between India and Singapore is rejected. This indicates that India and Singapore are co-integrated and there are no significant pairwise co-movements between India and USA and Japan. The higher order co- integration tests improve on the pairwise study of co- movements among the countries. The stock price of India was tested to determine if it can be predicted by using a combination of stock prices from other countries. Similar to pairwise results, **Table-5** exhibits no co- integration between India, Japan and USA but India is co-integrated with Singapore. The ADF statistics for India, Japan and USA are smaller (in absolute values) than the 5 percent critical value listed in the last column of **Table-5**. Thus the Indian, Japan and USA stock markets are collectively efficient in the long run.

Findings and Suggestions

The findings imply that international diversification among India, USA and Japan is effective because the markets are long-run efficient. That is, we cannot predict the stock price movements in India, for example, by using any combination of stock prices in the USA and Japan. The past price series of USA and Japan market can in no way be used for predicting the Indian stock prices. Thus, stock prices in each of these markets are independent of one another. International diversification is justified and desirable because unsystematic risk across countries can be reduced. Investing in India is beneficial to Indian as well as foreign investors since India records highest returns among other countries and it is independent.

Additional research can be done by investigating the possibility of co- integration of other international stock markets by integrating all stock prices into the analysis. Thus, international market efficiency and diversification effectiveness can be examined in a global context. Further, the level of co-integration before and after the structural changes can also be tested.

Conclusion

In this paper, we have applied econometric techniques on the co- integration of time series to examine issues of short- and long- run stock market integration. Daily stock prices in the United States, Japan, Singapore and India pass the unit root tests, suggesting that the individual stock markets are weak-form efficient. Pairwise and higher - order co-integration tests are performed for these markets. No evidence of co- integration is found between India and USA and Japan but India is co -integrated with Singapore. The co-integration of two sets of stock market returns suggests that in the long run, these returns are highly correlated with the implication that the reduction in long run portfolio risk from international diversification will be slight. In summary, the stock markets in USA, Japan, Singapore and India are weak –form efficient individually and India, USA and Japan are weak –form efficient collectively in the long run.

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Table 1 : Descriptive Statistics of Daily Returns (2000-2008)

Country	Mean	Std.dev	Kurtosis	Skewness	Mini	Max
INDIA	0.056	1.581	5.364	0.724	-3.05	7.97
SINGAPORE	0.017	1.173	6.056	-0.706	-9.22	5.94
JAPAN	-0.024	1.425	1.669	-0.213	7.23	7.22
USA	0.039	2.138	5.029	-0.346	-10.24	17.20

Table - 2 : Cross-correlations on Daily Returns (2000 – 2008)

Lags	NIFTY ON STI	NIFTY ON NIKKEI	NIFTY ON NASDAQ
-5	-0.306*	0.017	-0.012
-4	0.584*	0.015	-0.088*
-3	-0.254*	0.040	0.259*
-2	0.013	0.076*	-0.048
-1	0.022	0.041	0.069*
0	0.122*	0.244*	0.032
1	0.022	0.091*	0.025
2	0.020	0.021	0.019
3	0.030	0.024	-0.013
4	0.001	0.006	-0.007
5	-0.010	-0.004	-0.020

* Significant at 1% level

Table 3 : Unit Root Tests (ADF Test) (2000-2008)

Variable	Test Based on Logs of Prices	Test Based on First Differences of Logs of Prices
	τ	τ
INDIA	-2.79	-32.077*
SINGAPORE	-2.310	-31.281*
JAPAN	-2.884	-31.977*
USA	-2.654	-35.335*

The critical values for ADF test are -.3.96 and -3.41 at 1 per cent and 5 per cent respectively.
* Significant at 1% level.

Table 4

Engle-Granger ADF Test of Co -integration (2000 – 2008)

Name of the Indices	τ	d
INDIA ON Singapore	-3.36*	0.0437
INDIA ON Japan	-1.65	0.0040
INDIA ON USA	-0.547	0.0026

* significant at 5% level.
The critical value for EG -ADF tests at 5% level of significance is –3.17 .
The critical value for d at 5% level of significance is 0.386

Table 5

Higher Order Engle-Granger ADF Test of Co- integration

Name of the Indices	β	τ	No of countries	5% level
India, Singapore, Japan and USA	-0.022	-3.99*	4	-3.85
India, Singapore and Japan	-0.020	-3.89*	3	-3.56
India, Japan and USA	-0.004	-1.60	3	-3.56
India, Singapore and Nasdaq	-0.022	-3.96*	3	-3.56