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Co-integration of Indian stock market with the markets of developed European countries

Dr. Abhay Kumar Assistant Professor at NMIMS University, Mumbai.

ABSTRACT

Liberalization, privatization and globalization (LPG) has removed the barriers of capital flow from one country to another country. This free flow of capital among countries has brought co-movement in financial markets. The paper investigates long term relationship of Indian stock market with the markets of two developed European countries UK, & Germany. For the research and analysis, Daily closing data of UKX, DAX and Nifty for 11 years from 01 January 2004 to 30 December 2014 were collected. After cleaning, 2416 cleaned and synchronized data set were used for the research. Unit root test of the level series data and log difference data was conducted to test stationarity. The test accepts null hypothesis that it has a unit root. DF, ADF & PP test confirms the indices are 1 (I) process. To test co-integration among the markets, Johansen co-integration test was employed. Both Eigen value test and Trace test confirms no co-integration of Indian market with the markets of UK, & Germany. It was further found by causality test that markets do not Granger cause each other. Unrestricted VAR test calculated by taking lag 2 reflects that some of the markets can be auto regressed against the lag value of its own and some with the lag value of others and with the lag value of both.

KEYWORDS Correlation, Co-movements, Co-integration, Stationarity, Causality

1. Introduction:

Co-integration analysis helps portfolio manager to identify the international portfolio for diversification. If the markets are cointegrated they will move in the same direction and therefore, diversification will not fetch any benefits in terms of risk reduction or profit maximization. Correlation analysis is also useful tool to establish the relationship between variables, but many a times correlation can be spurious also. So only it is said that "correlation does not imply causation". Co-integration analysis helps in establishing genuine co-movement where the cause and effect of variables is clearly visible. The paper is consist of four sections. First section deals with the introduction, second section covers literature review, third covers data and methodology of the research. Last section presents brief analysis of results and conclusion.

2. Literature review

So many studies have been conducted on stock market integration of Asian stock markets with US and other developed stock market for different periods. The researchers have found mixed result. Some of them found co-movement some did not. Further the literature shows that the markets of developed economy and open economy show strong long term relationship. Sadhan Kumar Chattopadhyay & Samir Ranjan Behera "Financial Integration for Indian Stock Market" In their paper, they found that Indian stock market is not at all integrated with the world markets. Shegorika Rajwani, Jaydeep Mukherjee, (2013) "Is the Indian stock market cointegrated with other Asian markets?" Management Research Review, Vol. 36 Iss: 9, pp.899 – 918. The results suggest that the Indian stock markets are not integrated with any of the Asian markets either individually or collectively, and conclude that Indian markets are not sensitive to these markets in the long run. Verma, Rajneesh Prakash; Rani, Poonam. IUP Journal of Financial Risk Management (Sep 2015) in the article "Transmission of Stock Price Movement: An Empirical Analysis of BRIC Nations for the Post-2008 Financial Crisis Period" Concluded that the market return of BRIC countries do not move together in the long run after the 2008 crisis. This finding supports the findings of Chittedi (2010) but contradicts the findings of the pre-crisis period (Mobarek, 2012). Dr. Amalendu Bhunia &, Soumya Ganguly " Does Indian Stock Market Rely on other Asian Stock Markets" American Research Journal of Humanities and Social Sciences Original Article ISSN 2378-7031 Volume 1, Issue1, Feb-2015. In the their paper, Johansen multivariate co-integration test indicates that Indian stock market is associated with selected emerging stock market over a period of twenty years. Granger causality test in the paper shows bi-directional causality exists between the selected variables in 30 cases out of 72 cases. Wing-Keung Wong, Jun Du & Aman Agarwal "Financial Integration for India Stock Market, a Fractional Cointegration Approach" Department of Economics Working Paper No. 501, NUS have investigated long run equilibrium relationship and short run dynamic inter linkages between the Indian stock market and world major developed stock market. For their research they used weekly closing data of BSE 200 (India), S&P 500 (US), FTSE 100 (UK) and Nikkei 225 (Japan) from January 1991 to December 2003. They found that OLS estimation indicate that Indian stock market is statistically significantly cointegrated with stock markets in United States, United Kingdom and Japan. The research shows unidirectional granger causality running to the Indian stock market from the US, UK and Japanese stock markets. And there is only one set of cointegrating vector for the four-variable system as per Johansen ML estimation method.

3. Data and Methodology:

To varify Cointegration of Indian stock market with developed European countries, daily closing price data of Nifty (India), DAX (Germany), UKX (UK) is obtained from 01 Jan 2004 to 30 dec 2014 (11 years) from Bloomberg database. The data set includes 2416 daily observations of closing price. Though cointegration test can be carried out on level series but to find the causality we require unit root test. Unit root tests such as: DF, ADF & PP test of level series has accepted the null hypothesis that it contains unit root. Therefore log difference series (LN (Yt) – LN(Yt-$_1$) is tested for unit root. DF, ADF & PP test. Test on log difference series has rejected the null hypothesis. The test suggest the indices are I (1) process. Log difference series stabilizes the behavior of level series by reducing the scales without changing the character. Therefore Log difference series is preferred over log return series. The result of ADF test are shown in table 2 and 3.

Co-integration Analysis: Co-integration among the markets was examined using Johansen Co-integration test

Johansen test is a procedure for testing cointegration of several I(1) time series. This test permits more than one cointegrating relationship. This is the reason why this test more preferable than the —EngleGranger test. Engle Granger test is based on the —DickeyFuller test for unit roots in the residuals from a estimated single cointegrating relationship.

There are two methods of Johansen test i.e. trace test and Eigen value test. Inferences are bit different in both the test which is explained below. Cointegration assumes the presence of common non-stationary (i.e. $\mathbf{I}(1)$) processes underlying the input time series variables.

$$X_{1,t} = \alpha_1 + \gamma_1 Z_{1,t} + \gamma_2 Z_{2,t} + \cdots + \gamma_p Z_{p,t} + \epsilon_{1,t}$$
$$X_{2,t} = \alpha_2 + \phi_1 Z_{1,t} + \phi_2 Z_{2,t} + \cdots + \phi_p Z_{p,t} + \epsilon_{2,t}$$

$$X_{m,t} = \alpha_m + \psi_1 Z_{1,t} + \psi_2 Z_{2,t} + \cdots + \psi_p Z_{p,t} + \epsilon_{m,t}$$

The number of independent linear combinations (k) is related to the assumed number of common non-stationary underlying processes (p) as follows:

$$p = m - k$$

So, let's consider three plausible outcomes:

1. $k=0, p=m$ In this case, time series variables are not cointegrated
2. $0 < k < m$, $0 < p < m$. In this case, the time series variables are cointegrated.
3. $k=m, p=0$ All time-series variables are stationary ($I(0)$) to start with. Cointegration is not relevant here.

By examining the number of independent combinations, we are indirectly examining the cointegration existence hypothesis.

The Johansen test has two forms: the trace test and the maximum eigenvalue test. Both forms/tests address the Cointegration presence hypothesis, but each asks very different questions.

Trace Test

The trace test examines the number of linear combinations (i.e K) to be equal to a given value (k_0) , and the alternative hypothesis for k to be greater than k_0

$$H_o : K = K_o$$
$$H_o : K > K_o$$

To test for the existence of Cointegration using the trace test, we set $k_0 = 0$ (no cointegration), and examine whether the null hypothesis can be rejected. If this the case, then we conclude there is at least one cointegration relationship.

In this case, we need to reject the null hypothesis to establish the presence of Cointegration between the variables.

Maximum Eigenvalue Test

With the maximum eigenvalue test, we ask the same central question as the Johansen test. The difference, however, is an alternate hypothesis:

$$H_o : K = K_o$$
$$H_o : K = K_o + 1$$

So, starting with $k_0 = 0$ and rejecting the null hypothesis implies that there is only one possible combination of the non-stationary variables to yield a stationary process. What if we have more than one? The test may be less powerful than the trace test for the same k_0 values.

A special case for using the maximum eigenvalue test is when $K_0 = m-1$, where rejecting the null hypothesis implies the existence of m possible linear combinations. This is impossible, unless all input time series variables are stationary (i(0)) to start with.

Co-integration does not reveal anything about direction of causality. So granger causality test is applied to predict direction of causality. A variable x is said to Granger cause another variable y if past values of x helps in predicting the current level of y given all other appropriate information. The simplest test of Granger causality requires estimating the following two regression equations:

$$y_t = \beta_{1,0} + \sum_{i=1}^{p} \beta_{1,i} y_{t-i} + \sum_{j=1}^{p} \beta_{1,p+j} x_{t-i} + e_{1t} \quad (1)$$

$$x_t = \beta_{2,0} + \sum_{i=1}^{p} \beta_{2,i} y_{t-i} + \sum_{j=1}^{p} \beta_{2,p+j} x_{t-i} + e_{2t} \quad (2)$$

In the equation, p is the number of lags that adequately models the dynamic structure so that the coefficients of further lags of variables are not statistically significant and the error terms e are white noise. The error terms may, however, be correlated across equations. If the p parameters are jointly significant then the null that x does not Granger cause y can be rejected. Similarly, if the p parameters are jointly significant then the null that y does not Granger cause x can be rejected. This test is usually referred to as the Granger causality test.

4. Empirical Analysis

Table1: Summary Statistics of log difference series

	LDAX	LNIFTY	LUKX
Mean	0.037	0.060	0.016
Maximum	13.463	16.226	11.112
Minimum	-7.739	-21.247	-9.266
Std. Dev.	1.474	1.746	1.260
Skewness	0.178	-0.933	0.077
Kurtosis	10.958	20.454	13.431
Jarque-Bera	6393.123	31044.660	10964.530
Probability	0.000	0.000	0.000

Table 2: Unit root test result of level series

Variables	Without Trend					
	DF		ADF		PP	
	1% level	t-Statistic	1% level	t-Statistic	1% level	t-Statistic
DAX	-2.565919	0.550259	-3.432860	-0.965617	-3.432860	-0.905315
NIFTY	-2.565919	1.185910	-3.432860	-0.549767	-3.432860	-0.546037
UKX	-2.565919	-0.680691	-3.432860	-2.187639	-3.432860	-2.010116

Table 4: Unit root test result of log difference series

Variables	Without Trend					
	DF		ADF		PP	
	1% level	t-Statistic	1% level	t-Statistic	1% level	t-Statistic
LDAX	-2.565924	-5.394970	-3.432861***	-49.42183	-3.432861	-49.52517
LNIFTY	-2.565924	-7.257182	-3.432861	-49.84929	-3.432861	-49.84521
LUKX	-2.565919	-39.90897	-3.432861	-51.73437	-3.432861	-52.09007

When value of t statistics is less than the value at 1%, we cannot reject null hypothesis means we accept null hypothesis that it has a unit root and series are not stationary.

Result: Level series has unit root and are not stationary whereas log difference series are stationary.

Table 3 (A): Correlation Matrix: Level series

	DAX	NIFTY	UKX
DAX	1	0.882745	0.90494
NIFTY	0.882745	1	0.704076
UKX	0.90494	0.704076	1

3(B):Correlation Matrix: Log difference series

	LDAX	LNIFTY	LUKX
LDAX	1	0.373058	0.864083
LNIFTY	0.373058	1	0.377008
LUKX	0.864083	0.377008	1

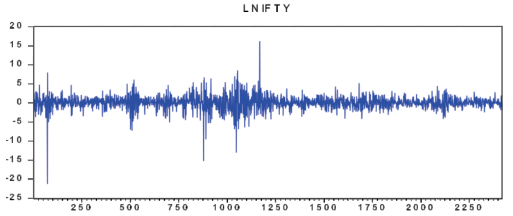
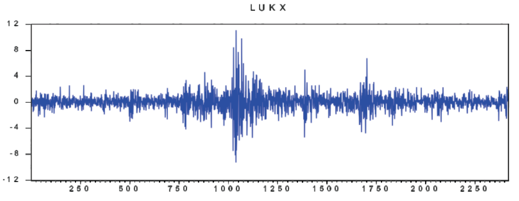
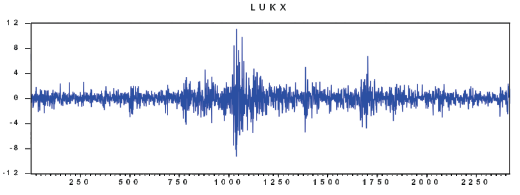


Figure 1: Graphical presentation of Log difference series





It is clear from graphical presentation also that log difference series are stationary.

Unrestricted Cointegration Rank Test (Trace)
NIFTY with DAX

Sample (adjusted): 6 2419
Included observations: 2414 after adjustments
Linear deterministic trend
Lags interval (in first differences): 1 to 4

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.002274	5.763691	15.49471	0.7232
At most 1	0.000111	0.268600	3.841466	0.6043
NIFTY with UKX				
None	0.002839	7.110248	15.49471	0.5648
At most 1	0.000103	0.247553	3.841466	0.6188
Unrestricted Cointegration Rank Test (Maximum Eigenvalue) NIFTY with DAX				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.002274	5.495092	14.26460	0.6785
At most 1	0.000111	0.268600	3.841466	0.6043
NIFTY with UKX				
None	0.002839	6.862695	14.26460	0.5055
At most 1	0.000103	0.247553	3.841466	0.6188

Result: Both Trace and Max-eigenvalue test indicates no cointegration at the 0.05 level
 * denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Johanssen cointegration test outcome: Both trace test and Eigen value test indicates no cointegration of NIFTY either with DAX or UKX at the 0.05 level. Therefore Null hypothesis cannot be rejected. Means there is no long run association of NIFTY with either UKX or DAX.

Vector Auto regression: Vector auto regression captures the linear interdependencies among various time series variables. Each variable has an equation explaining its evolution based on its own lags and the lags of the other variables in the model. When serious are not co-integrated unrestricted VAR gives better result. For testing auto regression, unrestricted VAR test is applied with a lag of 2.

VAR Estimates (observations: 2417)		
	NIFTY	DAX
NIFTY(-1)	0.966169	0.019430
	(0.02137)	(0.02640)
	[45.2017]	[0.73608]
NIFTY(-2)	0.029748	-0.017419
	(0.02135)	(0.02636)
	[1.39357]	[-0.66075]
DAX(-1)	0.108200	0.999750
	(0.01743)	(0.02153)
	[6.20633]	[46.4342]
DAX(-2)	-0.104065	-0.002682
	(0.01746)	(0.02156)
	[-5.96117]	[-0.12442]
C	-5.676836	12.10746
	(6.48820)	(8.01280)
	[-0.87495]	[1.51101]

	NIFTY	UKX
NIFTY(-1)	0.965702	0.014293
	(0.02162)	(0.01961)
	[44.6763]	[0.72900]
NIFTY(-2)	0.032703	-0.013657
	(0.02160)	(0.01960)
	[1.51372]	[-0.69690]
UKX(-1)	0.140886	0.950351
	(0.02396)	(0.02174)
	[5.87936]	[43.7225]
UKX(-2)	-0.137272	0.044917
	(0.02396)	(0.02174)
	[-5.72840]	[2.06643]
C	-10.58417	24.70942
	(12.1379)	(11.0099)
	[-0.87200]	[2.24429]

VAR Model: When P >5% then the particular Independent Variable is no significant to influence the dependent variable. When P value < 5%, Independent Variable is significant to explain dependent Variable.

VAR Result: NIFTY (-2) is significant to influence NIFTY.
NIFTY (-1), NIFTY (-2) and DAX (-2) is significant to influence DAX.
NIFTY (-1), NIFTY (-2) and UKX (-2) is significant to influence UKX.

Pairwise Granger Causality Tests (Sample: 1 2419, Lags:2)			
Null Hypothesis:	Obs	F-Statistic	Prob.
DAX does not Granger Cause NIFTY	2417	21.0012	9.E-10
NIFTY does not Granger Cause DAX		0.60117	0.5483
UKX does not Granger Cause NIFTY	2417	17.7779	2.E-08
NIFTY does not Granger Cause UKX		0.40545	0.6667

5. Conclusion

When world economy is doing well, most of the markets move up, that does not mean that they have long term relationship. Though the market moves in the same direction but the movement may not be causing each other to move. To find the long term relationship and causality among markets cointegration test and causality test is employed. Portfolio managers across the world use these tools for better results from global diversification. If the indices of two countries are co-integrated, then diversification may not fetch desired result in risk minimization and return maximization. The study found no co-integration of Indian market with the markets of UK, & Germany. Causality test revealed that Indian market do not granger cause these markets neither caused by them. Though VAR test confirms that markets can be auto regressed against the lag value (-2) of its own. And both DAX and UKX can be auto regressed with both the lag value of Nifty.

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