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A Study on Cointegration between Indian & Brazilian Stock Markets

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Abstratct – The objective of this study is to analyze the relationship between the Indian & the Brazilian Stock Markets. To find out the relationship Cointegration analysis of Indian and the Brazilian stock markets has been made over 12 years time period using Johansen test of Cointegration. The findings of the study suggested that there exists no long run causality and short run causality amongst the two stock markets. For an investor, the study has provided useful information for diversifying the investment between the two stock markets since the two markets do not have long run relationship.

Keywords: Cointergation; Vector Autoregression; Unrestricted VAR, Granger Causality

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INTRODUCTION

The present study attempts to analyze the connections that exist amongst the Indian & the Brazilian Stock Markets. To find the presence & the extent of co-movement, cointegration analysis of Indian stock markets and the Brazilian stock market has been made over 12 years time periods. The results of the study will aid us to gain insight on the benefits of diversifying the portfolio between Indian and Brazilian stock markets and will also help in knowing the status of the Indian capital market in the current scenario.

With globalization & liberalization of restrictions on international flow of capital and trade, an Indian market is expected to be more integrated with other stock markets of the world. Liberalization & Globalization has paved the way for more inflow of foreign capital into India. These changes would definitely have a profound impact on behavior of stock markets. The present study aims to examine the extent to which Indian and Brazilian stock market is integrated This study by testing if there is any co-moment of Indian and Brazilian stock markets, will provide an insight as to whether the investor could benefit by diversifying his portfolio between the two markets or not.

Diversification is a strategy which helps in minimizing risks because diversification minimizes the risk by allocating the investment in the different funds and markets. The stock markets of different nations are affected by various macroeconomic variables & other factors so it may need not have the same level of risk. Globalization has also reduced the risk through international portfolio management. A depression or crisis in another market can affect the Indian stock market in a more and more globally integrated environment. Hence, the long term relationship with other stock markets would not only give an idea of the possible profits out of international diversification but also will also gives impact of international stock market volatility on the Indian stock market.

As the level of international stock market degree of relationship increases, the benefit of diversification falls. Furthermore, Markowitz portfolio theory explaines that risk is minimized when we increase the low correlated securities in the portfolio.

A lot of studied have been made to study Cointegration between various stock markets. Many of the studies relating to the cointegration of emerging markets to the larger established markets have found possible diversification benefits while other studies have found a high degree of cointegration, indicating that long-term diversification is not likely to be beneficial. All of the studies we have examined do agree that cointegration is a good parameter to determine possible co-movements between equity markets, with the most popular process undoubtedly being Johansen's methods. (Maggiora and Spring, 2009).

OBJECTIVE OF THE STUDY:

The main objective of the study is to find out the long run and short run relationship between Indian and Brazilian stock markets using the Johansen Test of Cointegration.

REVIEW OF PAST STUDIES:

Few of the research articles reviewed for the study are listed below:

Golaka C. Nath & G. P. Samanta (2003) examine the relationship between the foreign exchange and stock markets for India. The study finds that the returns in these two markets are not inter-related in the recent years, the return in stock market have influenced on return in exchange rate.

Hen Chen et al (2006), studied the cointegration between India-US, India- China, US-China Stock Markets. They found that the stocks markets are fractionally cointegrated. The US stock market have influenced on both stock markets while there is no causal relationship between the India & Chinese stock markets.

M.V. Subha & S. Thirupparkadal Nambi (2010), Tested the extent of cointegration between the major Indian stock exchanges with the leading stock markets of America like NYSE, S&P500 and the NASDAQ using the Engle Grangler test of Cointegration. The data has been collected for the time span of 8 years starting from Jan 1st 2000 to 31st Dec 2008. The study found that the Indian Stock Market has no dependence with the NASDAQ and the S&P 500 confirming the absence of cointegration between the Indian and American Stock markets

Prashant Joshi (2013), explained the relationship between the stock markets of USA ,Brazil, Mexico, China and India using the daily sample from January, 1996 to July, 2007. The researcher analyzed the sample using the Johansen and Juselius multivariate cointegration & VECM model. The study finds that there is long run relationship among the markets demonstrating that stock prices in the countries studied here share a common trend. The finding of the study suggested that the speed of adjustment in the Indian stock market is greater than the stock markets of other nations.

RESEARCH METHODOLOGY:

Cointegration is the statistical equivalence of the economic theoretic notion of stable long run relationship. It is based on the properties of the residuals from the regression analysis when the individual series are non-stationary. The studies examined agree that Cointegration is a good parameter to determine possible co-movements between equity markets, with the most popular process undoubtedly being Johansen's methods. (Della Maggiora and Skerman, Spring 2009). Two variables are said to be cointegrated when a linear combination of the two variables is stationary.

DATA:

We include the Brazil: Sao Paulo Stock Exchange: BOVESPA index to proxy Brazilian stock market & SENSEX to proxy Indian stock market. The sample data on monthly closing prices has been retrieved from ceic database. The data ranges for a period of 12 years starting from April 2005 to February 2017. Alexander (2001) strongly advocates cointegration analysis between markets should be completed in each indices local currency. Not converting to a common currency will eliminate any possible exchange rate volatility.

ANALYTICAL TOOLS:

For the purpose of studying Cointegration, a stepwise procedure needs to be followed. The following analytical tools have been used for the purpose:

1. Unit Root Tests (ADF)
2. Johansen's cointegration testing
3. Trace test
4. Max Eigenvalue test
6. Unrestricted VAR
7. VAR Granger Causality Test

The Johansen Cointegration process is a maximum likelihood method that determines the number of cointegrating vectors in a non-stationary time series Vector Autoregression (VAR) with restrictions imposed, known as a vector error correction model (VECM). Johansen's estimation model is as follows:

$$\Delta X_t = \mu + \sum_{i=1}^{p} \Gamma_i \Delta X_{t-i} + \alpha\beta' X_{t-i} + \varepsilon_t$$

Where :

X_t = (nx1) vector of all the non stationary indices in the study

r_i = (nxn) matrix of coefficients

α= (nxr) matrix of error correction coeffecients where r is the number of cointegrating relationshios in the variables so that 0<r<n. it measures the

speed at which the variables adjust to their equilibrium.

β= (nxr) matrix of r cointegrating vectors, so that 0<r<n. this is what represents the long-run cointegrating relationship between variables.

RESULTS:

Table 1: Result of unit root test

Variables At Level	ADF Test			Philips Perron Test		
	Intercept	Intercept and Trend	No Intercept and No Trend	Intercept	Intercept and Trend	No Intercept and No Trend
SENSEX	0.6163	0.2671	0.9495	0.5907	0.1470	0.9375
BOVESPA	0.1058	0.3373	0.8197	0.0718	0.2352	0.7815
First Difference						
SENSEX	.0000	.0000	.0000	.0000	.0000	.0000
BOVESPA	.0000	.0000	.0000	.0000	.0000	.0000

Table 2: Result of unit root test

Variables At Level	ADF Test			Philips Perron Test		
	Intercept	Intercept and Trend	No Intercept and No Trend	Intercept	Intercept and Trend	No Intercept and No Trend
SENSEX	-1.3262	-2.6315	1.2875	-1.3797	-2.9609	1.1710
BOVESPA	-2.5511	-2.4806	0.4891	-2.7280	-2.7076	0.3377
First Difference						
SENSEX	-11.7165	-11.6758	-11.5104	-11.7268	--11.6873	-11.5668
BOVESPA	-10.2716	-10.2578	-10.2414	-10.2931	-10.2755	-10.2703

This results from the tests mentioned above have been discussed here:

An essential perquisite for applying Johansen's test of Cointegration is that time the series should be non stationary and should become stationary after integrating of the same order. The result of Augmented Dickey-Fuller (ADF) and Philips Perron test in table 1& 2 shows that the closing price data for both the series have been non stationary but becomes stationary after first differencing. So, our data is integrated of order one, I (1) which is a requirement for Johansen's cointegration test.

Table 3: Result of co-integration test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	'p' Value
Unrestricted Cointegration Rank Test (Trace)				
None *	0.071033	10.54673	15.49471	0.241
At most 1	0.002739	0.378534	3.841466	0.5384
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
None *	0.071033	10.16819	14.2646	0.2011
At most 1	0.002739	0.378534	3.841466	0.5384

Both the Trace test & Max-Eigenvalue test indicates there are no Cointegrating equation at the 0.05 level which indicates that there is long run causal relationship between the two markets which means that they would cause each other in short run only.

Table 4: Result of lag length criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2776.72	NA	2.59E+15	41.16616	41.2092	41.18365
1	-2391.89	752.5515*	9.18e+12*	35.52427*	35.65339*	35.57674*
2	-2389.56	4.485351	9.42E+12	35.54903	35.76423	35.63648
3	-2386.06	6.636047	9.49E+12	35.55644	35.85773	35.67888
4	-2383.11	5.499435	9.64E+12	35.57205	35.95942	35.72947

Table 5: VAR Results

Dependent Variable: INDIA

Method: Least Squares (Gauss-Newton / Marquardt steps)

Date: 02/07/19 Time: 10:43

Sample (adjusted): 2005M05 2017M02

Included observations: 142 after adjustments

INDIA = C(1)*INDIA(-1) + C(2)*BRAZIL(-1) + C(3)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.991064	0.016690	59.38219	0.0000
C(2)	-0.012878	0.008959	-1.437435	0.1528
C(3)	1002.430	440.3301	2.276543	0.0243

Table 6: Result of Granger Causality Test

R-squared	0.968984	Mean dependent var	18412.68
Adjusted R-squared	0.968538	S.D. dependent var	5928.750
S.E. of regression	1051.619	Akaike info criterion	16.77495
Sum squared resid	1.54E+08	Schwarz criterion	16.83740
Log likelihood	-1188.021	Hannan-Quinn criter.	16.80033
F-statistic	2171.278	Durbin-Watson stat	1.974997
Prob(F-statistic)	0.000000		

For testing the short run causality, unrestricted VAR has been used. The appropriate lag length has been determined using AIC, SC and HQ which suggests 1 lag to be incorporated. The results of the lag length criteria are presented in the table 4. The VAR results show that there is no relationship between the BOVESPA on SENSEX while the previous values (lag) has impact on the Sensex. After that to determine the direction of short run causality, VAR Granger Causality Test has been used testing the null hypothesis:

1) H_0: BOVESPA (Brazil) does not granger cause SENSEX (India)

2) H_0: SENSEX (India) does not Granger cause BOVESPA (Brazil)

The result of the granger causality test exhibits that there is no short term causality running from either side.

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