

# **The Error Correction Model in Elucidating the Association of Exchange Rate and FDI Inflows in India**

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*The current study determined long term association between exchange rate and FDI inflows in India ranging from 1991 to 2015. Exchange rate was taken as an exogenous variable while FDI was considered as an endogenous variable. To examine whether there was a long term association between the two considered variables or not, Engel-Granger Approach of co-integration was used and further, co-integration vector was built. The variables were found to be integrated of order one  $I(1)$ . The empirical results of co-integration revealed that there existed a co-integration between FDI Inflows and exchange rate which was further followed by error correction mechanism.*

## **INTRODUCTION**

The paper is aimed to analyse long-term casual relations between foreign direct investment (FDI) and exchange rate. It is assumed that there might be a long-term link between these variables. Foreign direct investment and exchange rate are considered to be the determinant of economic growth. As stated in the theory, it is the exchange rate that entices foreign direct investment in a country (Szkorpova, 2014). FDI gained a substantial amount of significance globally as an instrument of international economic integration. Foreign direct investment (FDI) was of immense importance to developing countries in their endeavours to develop their economies (Heshmati and Davis, 2007; Hooda, 2011). Foreign direct investment (FDI) was enunciated as a form of long term international capital movement, done with the motive of productive activity and accompanied with managerial control or participation in the management of foreign firms (Chopra and Sachdeva, 2014). Foreign direct investment was the sum of equity capital, reinvestment of earnings and other long or short term capital as shown within the balance of payments. It usually involved participation in management, joint venture, transfer of technology and expertise (Malankar, 2013).

FDI was distinguished from portfolio investment as the former was a more stable form of investment and provided an opportunity to the investor to have an effective voice in the management. However, the latter was concerned with maximising short term returns and a passive investment in the securities of another country, for instance, stocks and bonds (Thuhid, N et.al, 2016).

FDI usually proved conducive to the host country as it brought along ample benefits which the recipient country could avail from FDI Inflows i.e. use of advanced technology, expertise, better infrastructural developments (Koojaroenprasit, 2012), widened product basket, raising standard of living, uplifting the brand quality, fostering competitiveness, improved foreign relations, boosting exports, and providing India with a global platform (Rahul S, 2011; Chopra and Sachdeva, 2014). At the very outset, to examine whether there was a long term association between the two variables or not, Engel-Granger Approach (or Bi-variate Approach) of Co-Integration was used and further, Co-Integration Vector was built. The empirical results of co-integration revealed that there existed a co-integration between FDI Inflows and Exchange rate which was further followed by Error Correction Mechanism.

The paper is divided into six chapters. The first chapter is the introduction. The second chapter is aimed at the relevant bibliography overview. A model used and data are specified in the third chapter. The fourth chapter deals with the long-term links model between exchange rate and foreign direct investment. The fifth chapter is about the Engel Granger approach of Co-integration. The last chapter includes casual relation model results between selected variables.

## LITERATURE OVERVIEW

There is a series of empirical studies examining the influence of exchange rate on FDI. Such effects are examined by enormous approaches. The results of individual studies vary, which depends on the period selected, data processed, other variables included in the model or it depends on the econometric methods. Regression analysis, Johansen Co integration and Granger causality test, Auto-regressive Distributed lag model (ARDL) as well VAR autoregressive model are used to examine relationships among the given variables. The results of selected relevant studies are cited in this chapter.

Linear regression analysis using ordinary least square equation was used to examine the relationship between exchange rate, economic growth and FDI by Kamath, 2009. The study exhibited least impact of exchange rate and economic growth on foreign direct investment in an Indian economy. Azam and Lukman, 2010 examined the numerous factors effect on foreign direct investment (FDI) inflows into Pakistan, India and Indonesia. For this purpose, Log linear regression model and the method of least squares were applied. The empirical analysis was carried out with annual data for period 1971-2005. The results of research disclosed that market size, external debt, domestic investment, trade openness and physical infrastructure were the important economic determinants of FDI. Further, the study revealed that the empirical results of the economic determinants of India matched with the empirical results of Pakistan excluding two determinants (i.e. trade openness and government consumption) while the results of Indonesia did not match with the results of the economic determinants of FDI for Pakistan and India. Meerza, 2012 researched the causal relationship between trade, foreign direct investment (FDI) and economic growth by means of Johansen Co integration test and Granger causality test. The research was performed by Bangladesh by means of annual data during 1973-2008. The co -integration analysis suggested that there was a long run equilibrium relationship among the variables. The results of the study identified that there was a causal relationship among the considered variables of the study. Further, the study revealed that economic growth of Bangladesh led both FDI and export growth and it was observed in the study that there was a unidirectional causal relationship between FDI and export with direction from export to FDI. Cobb–Douglas production function and ARDL method was used to analyze the effects of foreign direct investment (FDI) on the gross domestic production (GDP) growth in Indian economy by Gaikwad, 2013. The research was performed during the period 1990-2008. The empirical results of the study articulated that in the long run there was a long-run relationship among the growth of gross domestic production and its major determinants of the labor force, the real capital and the real foreign direct investment. The findings of the study indicated that foreign direct investment though had a positive effect but small significant effect on Gross domestic production, while the labor force and capital had the most effect on gross domestic production.

Co integration test followed by Vector auto-regression (restricted/unrestricted) model and Granger causality test was applied to explore the short run and long run causal relationship between GDP, exchange

rate, inflation rate and FDI inflows by Khan and Mitra, 2014. The research was implemented in Indian context. Further, with the help of simple regression model, the exponential growth rate of FDI inflows was computed. Eventually, Chow test was employed to detect the presence of significant structural break in the data series of FDI inflows. The results of the study revealed that long run equilibrium existed among the concerned variables of the study. Granger-causality test concluded that exchange rate and GDP statistically had a significance influence on FDI, whereas, inflation rate was a insignificant variable to predict FDI inflows. Further, the growth analysis result claimed that the total FDI inflows grew exponentially at a rate of 23% per annum. However, the results of Chow test exhibited that 1991-92 was a statistically significant structural break year in the context of FDI inflows in India. Bandekar and Sankaranarayanan (2014) analysed the trends of FDI inflows in India and identified the factors that influenced the FDI inflows to India for the period 1991-2012 for the Indian economy. The study made use of various statistical tools like Correlation, ANOVA and Regression analysis (Ordinary Least Square) and time series analysis to analyse the data. The results of the study disclosed that the relationship between FDI inflows and factors such as GDP, trade openness, total reserves and electric power consumption was positive as expected, but the relationship between FDI inflows and exchange rate, external debt was inverse and positive and the relationship between FDI inflows and employment growth was inverse and negative. Engle Granger Co-integration analysis was used to establish an empirical relationship between foreign direct investment (FDI) and economic growth in the study by Olatunji and Shahid, 2015. The research was performed for Nigeria during 1970-2010. The results of the study pointed out that there was no long-run relationship between FDI and economic growth in the study. However, there was a short-run dynamic relationship between FDI and economic growth.

## **DATA AND SPECIFICATION OF THE MODEL**

The variables considered for the study were FDI Inflows and exchange rate for the period 1991 to 2015. FDI was taken as a dependent variable and Exchange rate was taken as an independent variable. For the purposes of the study, FDI was expressed in terms of US million \$ and Exchange rate was calculated as an annual average and expressed in US \$.

### **Foreign Direct Investment**

FDI is considered as a long term commitment to the host country and significantly contributes to gross fixed capital formation in developing countries. FDI has numerous advantages over other types of capital flows, for instance, its' greater stability and the fact that it does not create obligations for the host country. It not only provides financial resources for investment in a host country, but also augments domestic saving efforts. FDI serves as an engine of economic growth, assists technological development, enhances foreign exchange reserves, and improves management and organizational competencies.

### **Exchange Rate**

An exchange rate also known as a foreign-exchange rate, forex rate, FX rate between two currencies is the rate at which one currency is exchanged for another. It is also regarded as the value of one country's currency in terms of another currency. Exchange rates are determined in the foreign exchange market, which is open to a wide range of different types of buyers and sellers where there is a perpetual trading of currency.

The empirical analysis employed annual data on Exchange rate and FDI in India for the period of 1991-2015. For the purposes of the study, secondary data were used. The secondary sources included World Development Indicators published by the World Bank, FDI Fact Sheet published by the Department of Industrial Policy & Promotion, Ministry of Finance, Handbook of Statistics on Indian Economy, Reserve Bank of India Bulletin, Economic Survey, International Financial statistics yearbook etc.

### Unit Root Test

Before proceeding with the Engel Granger approach of Co-Integration test on time series data, the statistical properties of the time series data with regard to stationarity of the data were observed using Augmented Dickey-Fuller (ADF) Unit root test. Furthermore, to apply Co-Integration test, the basic assumption of Co-Integration was seen whether the data was integrated in the same order or not. The variables considered in the model were displayed in natural logarithms. Thereafter, in order to examine the impact of Exchange rate on FDI Inflows in the context of Indian Economy, the below mentioned linear regression equation for the model was used:

$$FDI_t = \alpha_t + \beta_t EXCH_t + U_t$$

Where; FDI and EXCH represented Foreign Direct Investment and Exchange rate at a particular time, respectively while  $U_t$  represented the “noise” or error term;  $\alpha_t$  and  $\beta_t$  represented the slope and coefficient of regression respectively. The coefficient of regression,  $\beta_t$  demonstrated elasticities, i.e., how a unit change in the independent variable (Exchange rate) affected the dependent variable (FDI). The error term was incorporated into the equation to cater for numerous other factors that may stimulate FDI Inflows (Egbo, 2011).

### LONG TERM RELATIONSHIP TEST BETWEEN FDI AND EXCH

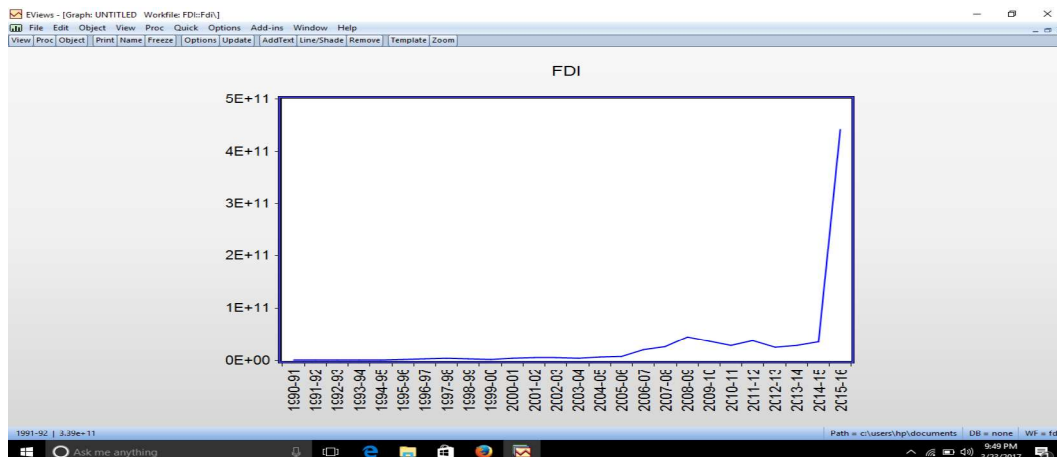
Thereafter, to examine Co-integration between Exchange rate and FDI inflows, Engel-Granger Approach of Co-Integration was used. If both the variables were Co integrated, there existed a long-run association between them. On the other hand, if the variables were not Co integrated, there was no long-run association between the chosen variables. It was only after Co-Integration between the two selected variables that error correction mechanism was built (Louzi & Abadi, 2011).

### ENGEL-GRANGER APPROACH OF CO-INTEGRATION

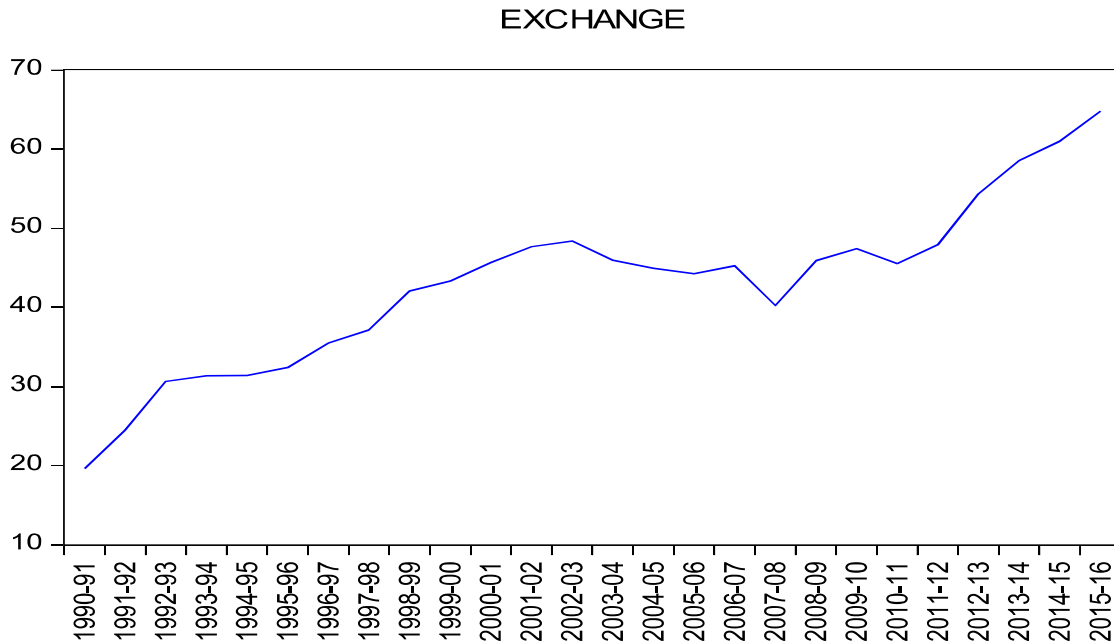
#### Augmented Dickey-Fuller Test Statistic for Unit Roots

The application of Augmented Dickey Fuller Unit root test on the current data disclosed that data was stationary in order of Integration one due to the existence of Difference Stationary Process and thus, facilitated the application of Co-Integration test. With the help of a Graph, it was observed that the data had a Difference stationary process (Phillips, et al 1988).

**FIGURE 1**  
**FDI IN DIFFERENCE STATIONARY PROCESS**



**FIGURE 2**  
**EXCHANGE RATE IN DIFFERENCE STATIONARY PROCESS**



**RESULTS OF CO-INTEGRATION**

The plots indicated an upward trend, indicating that the mean, variance and covariance of the series was not static over a period of time, which further, suggested that the series had a unit-root and was non-stationary in nature. (Shumway, et. al, 2011)

***Ho:*** - There was a Unit Root in the series. (Data was Non-Stationary)

***Ha:***-There was no Unit Root in the series. (Data was Stationary)

Thus, for applying Co-Integration test, the basic assumption was that data ought to be stationary in the same order of Integration. Thus, the first step was that through Augmented Dickey Fuller Unit Root test, the stationarity of the data was checked and both the variables came out to be stationary in order of Integration 1 with none model i.e. without trend and drift model.

$$\begin{aligned} & \text{FDI} \sim I(1) \\ & \text{EXCH} \sim I(1) \end{aligned}$$

**TABLE 1**  
**ADF TEST RESULTS**

| <i>Variables</i> | <i>Level</i>            | <i>F<sup>t</sup><br/>Difference</i> | <i>Null<br/>Hypothesis</i>                | <i>Results</i>  |
|------------------|-------------------------|-------------------------------------|---|---|
| FDI              | 2.149643<br>(0.9902)*** | -3.081856<br>(.0036)***             | Rejected at 1 <sup>st</sup><br>Difference | Variable was<br>stationary at 1 <sup>st</sup><br>difference |
| Exchange         | .2.847159<br>(.9981)*** | -3.646757<br>(.0008)***             | Rejected at 1 <sup>st</sup><br>Difference | Variable was<br>stationary at 1 <sup>st</sup><br>difference |

*Notes: denote significant at 5% using t-stat approach*

*Source: Author's own work*

*Null Hypothesis (H<sub>0</sub>): Selected variable was not stationary*

*Alternative Hypothesis (H<sub>1</sub>): Selected variable was stationary*

The second step before examining co-integration between the variables was to estimate the equation using OLS Regression which exhibited the following results:

**TABLE 2**  
**OLS REGRESSION TEST RESULTS**

Dependent Variable: FDI  
Method: Least Squares  
Date: 03/23/17 Time: 21:19  
Sample: 1 26  
Included observations: 26

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| C                  | 1.45E+11    | 6.19E+10              | 2.342472    | 0.0278   |
| EXCHANGE           | 4.06E+09    | 1.40E+09              | 2.897600    | 0.0079   |
| R-squared          | 0.259170    | Mean dependent var    |             | 2.93E+10 |
| Adjusted R-squared | 0.228302    | S.D. dependent var    |             | 8.49E+10 |
| S.E. of regression | 7.46E+10    | Akaike info criterion |             | 52.98270 |
| Sum squared resid  | 1.34E+23    | Schwarz criterion     |             | 53.07948 |
| Log likelihood     | 686.7751    | Hannan-Quinn          |             | 53.01057 |
| F-statistic        | 8.396088    | Durbin-Watson stat    |             | 1.172765 |
| Prob(F-statistic)  | 0.007905    |                       |             |          |

*Source: Author's own work*

## THE VECTOR ERROR CORRECTION MODEL (VECM)

Thus, Co-Integration Vector was: -  $\begin{bmatrix} C & -1.45E+11 \\ EXCH & 4.06E+09 \end{bmatrix}$

The third step in the Engle Granger procedure was to examine the stationarity of residuals at none model through the ADF Unit root test. Engel-Granger Approach of Co-Integration exhibited that residuals were stationary at none model (i.e. without drift and intercept), thereby, disclosing the existence of a long run association between Exchange rate and FDI inflows in an Indian Economy.

**TABLE 3**  
**CO-INTEGRATION TEST RESULTS**

| <i>Variables</i> | <i>Level</i>           | <i>Results</i>  |
|------------------|------------------------|---|
| Resi_fdi(-1)     | -0.955779<br>(.0258)** | Stationary at none thus, co-integration exists between the variables. |

\*\*significance at .05 level

Source: Author's own work

Residuals in Matrix Form were presented as

$$I_t = FDI_t - \alpha - \beta EXCH_t$$

$$= [1 - \alpha - \beta] [FDI_t \quad 1 \quad EXCH_t]$$

Thus, Co-Integration existed between EXCH and FDI inflows during the post-liberalized period. As per Engle Granger Approach (1987), if the variables were co integrated, then there must prevail vector error correction mechanism (VECM) (Egbo, 2011). Thus, the Error Correction term was calculated as:

| Variable      | Coefficient | Std. Error | t-Statistic | Prob.  |
|---------------|-------------|------------|-------------|--------|
| D(EXCHANGE)   | 6.11E+09    | 4.56E+09   | 1.340372    | 0.1932 |
| RESID_FDI(-1) | -0.957678   | 0.430697   | -2.223554   | 0.0363 |

Source: Author's own work

## RESULTS AND INTERPRETATIONS

The aforementioned table illustrated that growth in exchange rate would positively contribute in FDI growth. Thus, 1% increase in exchange rate would accelerate FDI by 6.11 percent. It was an instantaneous impact. In addition to, the results further revealed that exchange rate was found to be complementary with FDI. As residual was negative and statistically significant (as p value was less than .05), thus, the model was considered to be a stable one. Thus, the error correction term was -0.957678 which indicated rapid speed of convergence to long term equilibrium (Gaikwad, 2013).

## CONCLUSION

This paper examines the long term association between foreign direct investment and exchange rate in India. The research used annual time series data of the years 1991-2015. Initially, the data were adjusted for the calculations. Subsequently, they were used for testing for stationarity. Before applying any statistical test on the data series, it was significant to find out the order of integration of the variables through ADF test of stationarity. The test results exhibited that the time series are stationary up to first difference. However, it was found that Exchange rate and FDI were integrated of order one [1]. The empirical analysis of the data suggested that the variables had a difference stationary process. This result enabled a continuance with further research. Further, the study employed Engel Granger approach of Co-Integration to determine long run association between the variables which demonstrated that there existed Co-integration between the variables and supported the generally accepted argument. As a last step of research, error correction term was built which articulated that increase in exchange rate was found to be complementary with growth in FDI inflows. The error correction coefficient, estimated at -0.95 was statistically significant and suggested a rapid speed of convergence to equilibrium.

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