CHAPTER IV

Foreign Direct Investment and Exports in India: Cointegration and Causality Analysis

Abstract:

This Chapter is an attempt to investigate the relationship between FDI and exports. For the study annual data of exports and FDI inflows are collected for 46 years and the data are divided into pre and post liberalization period. Using Engle-Granger cointegration methodology and error correction mechanism, the study finds that there is no cointegrating relationship between exports and FDI in the pre and post liberalization period taken separately. But when the full sample is considered, we find a cointegrating relationship and causality between exports and FDI in the long run and in the short run.

4.1. Introduction:

In this Chapter, we investigate whether exports and FDI inflows have any long-term relationship or whether exports and FDI move together in the long run in the context of India. The relationship is tried to be examined by collecting annual data for exports and FDI and using time series analysis. The analysis is carried out in three parts. The first part represents the pre-liberalization period (sub-sample I), the second part represents the post-liberalization period (sub-sample II) and the third part of the study represents both the pre and post liberalisation period (1970-2015).
The findings suggest that there is no long run relationship in the two sub samples, but we find both long and short run relationship and causality in the full sample.

The Chapter is organized as follows: the Introduction of the Chapter in first section is followed by data source and methodology in the second section. The results and discussion of the chapter is presented in the third section and ends up with the findings of the chapter in the fourth section.

4.2. Data Source and Methodology:

4.2.1. Data:

Annual data from 1970 to 2015 for aggregate exports and total FDI inflows to India are used for the study. These data are collected from United Nations Conference on Trade and Development (UNCTAD) that are used for international best practices. The values of the variables in current prices are converted into constant prices taking 2005 as the base year. This is done to avoid the effects of prices and biases. Moreover, the data are transformed into the logarithmic (natural logarithm) values so that changes in the variables represent the relative changes or percentage changes after multiplication by 100 (Gujarati, 2011).

4.2.2. Methodology:

To analyse these data time series techniques have been used. The first step in multivariate time series is to determine if the series under consideration are stationary or non-stationary. To check the stationarity of the time series, two popular unit root tests viz., Augmented Dickey Fuller (ADF) and Phillip-Perron (PP) tests have been used. Since we have found the two time series under consideration are non-stationary at level but stationary at first difference, we applied Engle-Granger
(1987) residual based cointegration test to examine long run relationship. Then to examine the short run relationship and Granger causality between the two time series, Error Correction Mechanism (ECM) is used.

We have two time series, one is exports and the other is FDI:

\[ X_t = \alpha_1 + \beta_1 T + \rho_1 X_{t-1} + u_{1t} \]  
\[ F_t = \alpha_2 + \beta_2 T + \rho_2 F_{t-1} + u_{2t} \]  

Where, \( X \) is exports and \( F \) stands for FDI. The constant and trend terms are shown through \( \alpha \) and \( T \) respectively and \( u_{1t} \) and \( u_{2t} \) represents the random disturbance terms for the two time series. For ADF test, the following regressions are estimated:

\[ \Delta X_t = \alpha_1 + \beta_1 T + \delta_1 X_{t-1} + \Theta_1 i \sum \Delta X_{t-i} + \epsilon_{1t} \]  
\[ \Delta F_t = \alpha_2 + \beta_2 T + \delta_2 F_{t-1} + \Theta_2 i \sum \Delta F_{t-i} + \epsilon_{2t} \]  

In equation (3) and (4), \( \Delta \) represents one-time differenced term; \( \epsilon \) represents white noise error term. The null hypothesis is that \( \delta_1 = \delta_2 = 0, i.e., \) both the series have unit root. ADF test is a better test than the DF test because it takes into account the presence of the correlation between the error terms by adjusting one time differenced terms of the dependent variable (Ali, 2013).

The lag length of ADF is selected on the basis of Akaike Information Criteria (AIC) taking maximum lags equal to the cube root of the number of observations. AIC provides a superior lag length in case of small sample in the manners that it minimizes the chance of under estimation while maximizing the chance of true lag length (Khim and Liew, 2004). Further, we followed a step by step procedure to include whether both trend and intercept or only intercept or no
trend and no intercept in the concerned time series. First, we check both trend and intercept, if the trend is insignificant, then we check it with only intercept. If again intercept is found insignificant, then we check the unit root test without intercept and trend.

ADF test suffers from certain limitations. First, the power of ADF is low when the series is stationary but with a root close to non-stationary boundary (Brooks, 2008). Second, the error terms in ADF are not independently and identically distributed (IID) (Maddala and Kim, 1998; Enders 1995). A generalization of the Dickey-Fuller procedure was developed by Phillips and Perron (1988) that allows the errors to be weakly dependent and heterogeneously distributed ((Enders, 1995). The Phillips-Perron (PP) procedure considers the following regression equation:

\[
\Delta X_t = \alpha_1 + \beta_1 T + \pi_1 X_{t-1} + u_{1t}
\]

\[
\Delta F_t = \alpha_2 + \beta_2 T + \pi_2 F_{t-1} + u_{2t}
\]

Where \(u\) is the error term and may be heteroskedastic. ‘T’ is the trend term. Under the null hypothesis that \(\pi_1 = \pi_2 = 0\), the PP statistics gives the same asymptotic distribution as ADF statistics. The advantages of PP over ADF are, it is robust to general forms of heteroskedasticity in the error term and the user does not have to specify the lag length to test the regression (Zivot, 2006).

Given these two non-stationary time series and stationary at first difference as suggested by the ADF and PP unit root tests, we applied cointegration test to examine the long run relationship between these two time series. That is, in the long run, whether these two time series move together or not. According to Engle-Granger procedure, if the linear combination of these two non-stationary time series
gives us a stationary series then there will be a long run relationship between them.

The basic equation for the cointegration test is

\[ X_t = \alpha_1 + \alpha_2 F_t + u_t \] (7)

\[ i.e., u_t = X_t - \alpha_1 - \alpha_2 F_t. \] (8)

Where \( X \) and \( F \) imply exports and FDI respectively; \( \alpha \) is the intercept term and \( u \) is the random disturbance term; \( t \) implies the time period. According to the Engle-Granger approach, \( u_t \) in equation (8) should be stationary at level if there is cointegration relationship between \( X \) and \( F \).

After examining cointegration, the next step is to examine the short run relationship and causality between the variables. To examine the short run relationship and causality, ECM is used. Taking into account the Exports-FDI series, the following basic equation is estimated to examine the long run equilibrium relationship and short run causality together:

\[ \Delta X_t = \beta_1 + \beta_2 \Delta F_t + \beta_3 u_{t-1} + \varepsilon_t \] (9)

Where \( \Delta \) is the first difference operator, \( \varepsilon \) is the random error term and \( u_{t-1} \) is the one period lagged value represents the cointegrating equation (i.e., \( u_{t-1} = X_{t-1} - \alpha_1 - \alpha_2 F_{t-1} \)). Change in exports (\( \Delta X \)) depends on change in FDI (\( \Delta F \)) and equilibrium error term. According to EG approach, \( \beta_3 \) in equation (9) should be negative and significant if there is causal relationship between the two in the long run.
4.3. Results and Discussion:

4.3.1. Unit Root Test:

To check the stationarity of the series, two unit root test methods have been used—Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) Test. The null hypothesis for both the variables is that the series has a unit root for both the unit root test method. If the series has unit root then the series is non-stationary, and if the series has no unit root then the series is stationary. The guidelines for rejection of the null hypotheses are that if the estimated value of the variable is greater than the critical value or if the ‘p’ value is less than 5 per cent (i.e. 0.05), we can reject the null hypothesis. Here, for ADF test MacKinnon one sided ‘p’-values and for PP test MacKinnon (1996) one-sided ‘p’-values are used for the rejection of null hypothesis.

The sample has been divided into three parts—one part named as sub-sample I (which represents pre-liberalization period, i.e. 1970-1991), second part named as sub-sample II (which represents post-liberalization period, i.e., 1992-2015) and the last part named as full-sample covering the period 1970-2015.
From Table 4.1, it is obvious that the ‘p’ values for both the series in all samples are greater than 5 per cent at level and the estimated values are also less than the critical values (Appendix-A:4.3.1.A.1. to 4.3.1.C.8.). This implies that we cannot reject the series at level. Therefore all the series have unit root at level i.e., non-stationary at level. When we take first difference of all the series, then the results show that the ‘p’ values are less than 5 per cent and the estimated values are also greater than the critical values indicating rejection of null hypothesis. The results are same for the ADF and PP unit root tests. Thus, we can declare that all the

Table 4.1: Unit Root Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF</th>
<th>Phillips-Perron</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>1st Diff.</td>
<td>Level</td>
</tr>
<tr>
<td>Exports</td>
<td>-1.65 (0.44)</td>
<td>-3.32 (0.03*)</td>
<td>-1.55 (0.49)</td>
</tr>
<tr>
<td>FDI</td>
<td>-3.50 (0.07)</td>
<td>-3.95 (0.03*)</td>
<td>-2.94 (0.17)</td>
</tr>
<tr>
<td>Sub-sample II (1992-2015)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exports</td>
<td>-0.81 (0.80)</td>
<td>-3.56 (0.02*)</td>
<td>-0.81 (0.80)</td>
</tr>
<tr>
<td>FDI</td>
<td>-2.38 (0.15)</td>
<td>-3.94 (0.01*)</td>
<td>-2.31 (0.18)</td>
</tr>
<tr>
<td>Full Sample (1970-2015)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exports</td>
<td>-2.87 (0.18)</td>
<td>-5.14 (0.00*)</td>
<td>-2.00 (0.58)</td>
</tr>
<tr>
<td>FDI</td>
<td>-3.29 (0.08)</td>
<td>-5.62 (0.00*)</td>
<td>-3.13 (0.11)</td>
</tr>
</tbody>
</table>

Note:
1. Figures in the brackets ( ) indicates (in ADF Test) the Mackinnon one sided ‘p’-values for rejection of null hypothesis.
3. * represents rejection of null hypothesis at 0.05 per cent or less level of significance.
time series are non-stationary at level but stationary at first difference, thus all the
time series are integrated of order one \( i.e., I(1) \).

### 4.3.2. Cointegration:

To examine the long run relationship under Engle-Granger (1987) residual
based cointegration procedure; we derive residuals by regressing FDI inflows on
exports and then check the stationarity of the derived residuals. We applied ADF
unit root test to check the stationarity of the derived residuals and the ADF test
statistics is compared with the critical values given by Engle and Granger (1987) as
cited by Mamun and Nath (2005). Because residuals are generated from a regression
equation, we can not use the standard ADF critical values. Moreover, the lag length
is chosen on the basis of AIC’s automatic lag selection procedure taking maximum
lags equal to the cube root of the number of observations (Mamun and Nath, 2005).
The cointegration results are presented in Table 4.2.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Long Run Equation</th>
<th>ADF test statistics for the Residuals (ECT)</th>
<th>Lag Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-sample I (1970-1991)</td>
<td>( X_t = 6.44 + 0.31F + u_t ) (0.00) (0.05)</td>
<td>-1.64</td>
<td>1</td>
</tr>
<tr>
<td>Sub-sample II (1992-2015)</td>
<td>( X_t = 5.66 + 0.62F + u_t ) (0.00) (0.00)</td>
<td>-2.49</td>
<td>1</td>
</tr>
<tr>
<td>Full Sample (1970-2015)</td>
<td>( X_t = 6.57 + 0.52F + u_t ) (0.00) (0.00)</td>
<td>-3.64*</td>
<td>1</td>
</tr>
</tbody>
</table>

**Note:**
1. * indicates significant levels at 5 per cent.
2. Figures within the brackets show the probability values.
3. The Engle-Granger Critical value at 5 per cent level of significance is (– 3.37).
4. Lag length has been chosen on the basis of AIC’s automatic lag selection
   procedure taking maximum lags equal to the cube root of the number of observations.
From Table 4.2 it is seen that there is no cointegration relationship between exports and FDI when we checked it separately for pre and post liberalization period (Appendix-A: 4.3.2.I. and II). Because the ADF test statistics residuals of the two sub-samples are smaller than the critical values given by Engle and Granger at 5 per cent level of significance. While the ADF test statistics of the residuals for the full sample is greater than the Engle-Granger critical values at 5 per cent level of significance. Therefore, we found a cointegrating relationship between the two for the full sample (Appendix-A: 4.3.2.III). Therefore, there is long run relationship between exports and FDI in India during 1970 to 2015.

4.3.3. Error Correction Mechanism (ECM):

*ECM for Full Sample (1970-2015):*

Since we found a long run relationship between exports and FDI for the period 1970-2015, we can examine the short run relationship and Granger causality using error correction mechanism (ECM)\(^4\). Before presenting the ECM results, the residual diagnostics results have been shown in Table 4.3 which shows the validity of the regression equation.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Test</th>
<th>H(_0)</th>
<th>P value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normality</td>
<td>Normally Distributed</td>
<td>0.37</td>
<td>Cannot reject the H(_0)</td>
</tr>
<tr>
<td>2</td>
<td>Serial Correlation</td>
<td>No Serial Correlation</td>
<td>0.83</td>
<td>Cannot reject the H(_0)</td>
</tr>
<tr>
<td>3</td>
<td>Heteroskedasticity</td>
<td>No Heteroskedasticity</td>
<td>0.95</td>
<td>Cannot reject the H(_0)</td>
</tr>
</tbody>
</table>

The ‘p’ values in Table 4.3 for all the least square assumptions are greater than 5 per cent which indicates that our model satisfies all the least square assumptions.

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\(^4\) We have not applied ECM for pre and post liberalization period since there is no cointegration relationship between exports and FDI in the same periods.
assumptions. We have applied the Jarque-Berra probability values, Breusch-Godfrey serial correlation LM test and Breusch-Pagan-Godfrey test for Normality, serial correlation and heteroskedasticity test respectively. The ECM results are presented in Table 4.4.

Before applying the ECM, it is necessary to choose the optimum lag length. From VAR lag length criteria we find that all the lag length selection criteria viz., LR, FPE, AIC, SIC, HQ suggests lag 1 (Appendix-A:4.3.2.III.1.) as the optimum lag for ECM. Therefore, we estimate the ECM result taking lag 1.

**Table 4.4. ECM Results**

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Coefficient</th>
<th>Coefficient Values</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant</td>
<td>0.19</td>
<td>0.00***</td>
</tr>
<tr>
<td>2</td>
<td>D(lnX(-1))</td>
<td>0.12</td>
<td>0.42</td>
</tr>
<tr>
<td>3</td>
<td>D(lnF)</td>
<td>0.06</td>
<td>0.02**</td>
</tr>
<tr>
<td>4</td>
<td>D(lnF(-1))</td>
<td>0.05</td>
<td>0.06*</td>
</tr>
<tr>
<td>5</td>
<td>ECT(-1)</td>
<td>-0.13</td>
<td>0.00***</td>
</tr>
<tr>
<td>6</td>
<td>$R^2$</td>
<td>0.28</td>
<td>NA</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>3.80</td>
<td>0.01***</td>
</tr>
</tbody>
</table>

Note:***, ** and * denotes significant at 1 per cent, 5 per cent and 10 per cent respectively.

Table 4.4 represents the ECM results. Since the series are non-stationary at level, we take the differenced form of the variables to apply least square. If there is causality from FDI to exports the Error Correction Term (ECT) should be negative and significant. When it so, it means that the change in dependent variable is Granger caused by the change in independent variable. From Table 4.4, it is observed that the ECT is negative and significant at 1 per cent significant level. Thus, there is long run causality from FDI to exports. The coefficient value of ECT

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$^5$LR= sequential modified LR test statistic, FPE=Final prediction error, AIC= Akaike information criterion, SC= Schwarz information criterion, and HQ= Hannan-Quinn information criterion
is -0.13 which indicates that it corrects the previous year’s disequilibrium by only 13 per cent. Moreover, the change in lag exports corrects disequilibrium in current exports by 12 per cent but it is not statistically significant. Furthermore, the short run relationship between exports and FDI shows that change in FDI corrects change in exports by 6 per cent and change in lag FDI corrects by 5 per cent which are significant at 5 per cent and 10 per cent significant level respectively. The smaller value of the coefficients indicates weak relationship between the two in the short run.

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>Value</th>
<th>Df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistics</td>
<td>4.56</td>
<td>(2, 39)</td>
<td>0.02</td>
</tr>
<tr>
<td>Chi Square</td>
<td>9.11</td>
<td>2</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Table 4.5 shows the results of short run Granger causality from FDI to exports. Here the null hypothesis is that the coefficient of $\Delta(\ln FDI)$ and $\Delta(\ln F(-1))$ is zero. It means, current year FDI and one year lagged FDI together do not Granger cause exports. The probability value of F-statistics is less than 5 per cent. We can reject the null hypothesis at 5 per cent level of significance. Hence, FDI granger causes exports at 5 per cent level of significance (Appendix-A:5.3.2.III.5.).
4.4. Findings:

Having non-stationary series at level and stationary at same order \((i.e. I(1))\), there is long run relationship between aggregate exports and FDI in India during the period from 1970 to 2015. But we find no long run relationship between the two when we divided the data into pre and post liberalization period. Moreover, the ECM for the full sample suggests the presence of causal relationship from FDI to exports, although the relationship is weak. The Wald test for short run causality shows that there is short run causality from FDI to exports.

The relationship between exports and FDI is not straightforward. There are many other determinants of exports besides FDI. Granger himself had warned that studies conducted through strictly bivariate framework and omitting relevant variables could result in spurious causality (Maddala and Kim 1998). Therefore, to address these issues, the next Chapter is an effort to investigate the exports-FDI relationship by taking into account some of these relevant determinants so that we can have a clearer picture of the export behaviour in response to FDI inflow.
Reference:

Books:


Journals:


