Chapter: 6
Causal relationship between FDI & exogenous macroeconomic variables

6.1 Introduction

This chapter focused to measure causal relationship of exogenous macroeconomic variables with FDI inflow in India. Exogenous macroeconomic variables and their relationship with inflow of FDI used in the present study has discussed in the part of methodology. In the present study following variables has been used in time series with the addition of some more exogenous variables which has been not used earlier in Indian context i.e.,Foreign reserve, annual exchange rate and sources of foreign capital inflow are the components of capital account also used to check the causal relationship between inflows of FDI as exogenous macroeconomic variables. Component of capital account i.e., net external assistance, net commercial borrowing, rupee debt service and net NRI deposit which are also influenced on inflow of FDI. The objectives of this chapter mentioned in introduction are: to estimate the short run and long run relationship between FDI inflow and exogenous macroeconomic variables in India; and to analyse the causal relationship between FDI inflow and exogenous macroeconomic variables. Null hypothesis of this chapter are: FDI inflow does not cause exchange rate, foreign reserve and trade; FDI inflow does not cause the parameters of capital account.

To achieve above mentioned objectives, econometrics methods has been used which has been discussed in the part of methodology.

6.1.0 FDI Inflow, Foreign Reserve, Exchange Rate and Trade

Relationship of exogenous macro variables with FDIINFL is focused in this chapter with the help of different econometrics tools. There are number of definitions about the

relationship among the variable i.e.(FDIINFL) Inflow of Foreign Direct Investment, Foreign Reserve (FR), Average Exchange Rate(AER) and Openness in a economy for trade(OPEN). This chapter investigates the relationship among these variable in Indian context.Real exchange rate recorded negative association with inflow of FDI (Goldberg and Klein, 1998).Foreign Reserve are maintained by countries for meeting their international payment obligations in short and long terms, including sovereign and commercial debts, financing of imports, for intervention in the foreign currency markets during periods of volatility. Besides helping to boost the confidence of the market in the ability of a country. Calvo Guillermo A. et al.1996, found that the substantial portion of the surge in capital inflows has channeled to accumulation of foreign exchange reserve. Reserve accumulation can be an instrument to interfere with the exchange rate. A currency will tend to become more valuable whenever demand for it is greater than the available supply. Openness is also necessary part to investigate the relationship with Foreign Direct Investment. Muhammad Shahzad Iqbal, et al. 2010 found bidirectional relationship between FDI inflow and import and export.So, openness to trade for economic prosperity is necessity part. Does the Foreign Direct Investment cause to increase the foreign reserve, and to control the exchange rate?

6.1.1 ADF Unit Root Test of stationarity

Table 6.2.1 shows the results AER and OPEN series are stationary on intercept and Trend & Intercept respectively at 5% level of significance on 1st difference.

Again the computed ADF test-statistics is significance at 1% level of significant for the series AER and OPEN, thus it means the series does not havean unit root problem and AER and OPEN are a stationary at 1% significant level on 2nd difference. That means the 2nd difference of series become stationary. Therefore all the series are stationary integrated order of two, I(2) for ADF test-statistics in Table 6.1.1.

Table 6.1.1: Augmented Dickey-Fuller Unit Root Test

Variables	Model	Level	1st Diff	2nd Diff
FR	Intercept	0.790	-3.138**	-6.850*
	Trend & Intercept	-1.641	-4.771*	-6.655*
AER	Intercept	-1.582	-3.651**	-5.174*
	Trend & Intercept	-2.210	-3.107	-5.440*
OPEN	Intercept	3.332	-1.968	-7.170*
	Trend & Intercept	0.929	-4.438**	-7.298*
FDIINFL	Intercept	0.480	-2.074	-3.519**
	Trend & Intercept	-1.283	-2.307	-3.423***

*Significant at 1%, ** Significant at 5%, *** Significant at 10%

Critical values of 'tau' are given in appendix

6.1.2 PP Unit Root Test of stationarity

Phillips Parron test-statistics is also useful to check the stationary and non-stationary without augmented term in the model of Intercept and Trend & Intercept.

The computed PP test-statistics is smaller than the critical value of 'tau' (1%, 5% and 10% level of significant) for FR, AER, OPEN and FDIINFL on 1st Difference. FR, AER, OPEN and FDIINFL series are stationary to accept the Null Hypothesis for no unit root. All the series are stationary on 2nd difference on 1% level of significance. The series are stationary, I(1) and I(2).

FDIINFL and GNPDIFL become stationary at 1% level of significant on 2nd difference and FDIINFL is already significant on 1st difference at Intercept and Trend & Intercept.

Once variable have been classified as integrated of order I(0), I(1) and I(2) etc is possible to setup models that lead to stationary relation among the variables and where standard inference is possible. The necessary criteria for stationary among non-stationary variable is called co-integration.

Table 6.1.2: Phillips-Parron Unit Root Test

Variables	Model	Level	1st Diff	2nd Diff
FR	Intercept	1.639	-2.969***	-7.344*
	Trend & Intercept	-1.362	-3.533***	-7.325*
AER	Intercept	-2.541	-3.891*	-8.032*
	Trend & Intercept	-2.804	-3.529***	-15.544*
OPEN	Intercept	9.033	-3.842*	-14.655*
	Trend & Intercept	3.136	-6.279*	-17.410*
FDIINFL	Intercept	0.239	-4.431*	-8.095*
	Trend & Intercept	-1.592	-4.708*	-7.887*

*Significant at 1%, ** Significant at 5%, *** Significant at 10%

Critical values of 'tau' are given in appendix

6.1.3 Johanson Co-integration Test

For the **e**xistence of unit roots for all time series, we employ co-integration technique. The None indicate the Null Hypothesis for no co-integrated equation. At most 1 indicates that there is one co-integrated equation or error term. At most 2 mean that there are two co-integrated equation.

Trace statistics (141.34) is greater than critical value at 1% level of significance which rejects the null hypothesis. Its mean there are co-integrated equation. P-value also shows the significance of co-integrated equations. The value of at most 1 is also significant by the p-value and trace statistics (71.36) is greater than critical value. It means that the null hypothesis can not accept again to confirm the co-integrated equations. The values of at most 2 and 3 are also significant by the p-value and trace statistics (32.20 and 12.51 respectively) is greater than critical value. It means that the null hypothesis can not accept again to confirm the co-integrated equations.Trace Statistic indicates four co-integrated equation at 99% level of confidence. It means that there is error term or all the variables are co-integrated and variables have long run association.

Maximum eigenvalue test under the Johanson Co-integration test in table 6.2.3.shows the four cointegrating equations at 1% level of significance and shows 99% level of confidence. On the none hypothesis mean there is no co-integrated equation or error term. The max-Eigen statistics value (69.97) is greater than the critical value at 1% level of significance. P value shows the higher confidence level. It means that the null hypothesis can not accept. At most 1, 2 and 3 also shows the significant result to reject the null hypothesis at 1% significant level. Max-Eigen statistics indicates 4 significant cointegrating equations.

Johanson Co-integration test of Trace and Max confirms the long run association among FDIINFL, FR,AER and OPEN. Now it is necessary to check the VECM model.

Table 6.1.3: Johanson Conintegration Test

Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.969	141.343	47.856	0.000
At most 1 *	0.858	71.365	29.797	0.000
At most 2 *	0.626	32.209	15.494	0.000
At most 3 *	0.465	12.516	3.841	0.000

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.969	69.978	27.584	0.000
At most 1 *	0.858	39.156	21.131	0.000
At most 2 *	0.626	19.692	14.264	0.006
At most 3 *	0.465	12.516	3.841	0.000

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

6.1.4 NoramalizedCo-integration Equation

Table 6.1.4 the estimates of the normalized cointegrating has shown the long run associations or relationship among the FDIINFL, FR, AER and OPEN. If sign is positive it means that variables move together in long run. Coefficient of FR and AER has significant positive sign meaning that FR and AER have positive association in long run with FDIINFL. When the FR and AER go up the FDIINFL also goes up. FDIINFL and OPEN has significantnegative association.

Co-integrationequation ,

FDIINFL = 2.77(FR) + 140.92 (AER) – 50161.08(OPEN) ….6.1

Table 6.1.4: Noramalized Co-integration Equation

Normalized cointegrating coefficients (standard error in parentheses)				
FDIINFL		FR	AER	OPEN
1.000	=	+2.772	+140.927	-50161.080
		(-0.205)	(-20.022)	(-4475.130)

6.1.5 Vector Error Correction Model

The results revealed that the targeted model D(FDIINFL) has shown the error correction coefficient (-1.8378) for co-integration equations. All the dependent variables are converted in 1st difference by system during the estimation. There are requirements to check the significance of independent variables on lag one and lag two to explain the dependent variable. D(FDIINFL), D(FR),D(AER) and D(OPEN) are dependent variables. D(FDIINFL(-1)), D(FDIINFL(-2)), D(FR(-1)), D(FR(-2)),D(AER(-1)), D(AER(-2)),D(OPEN(-1)) and D(OPEN(-2)) are independent variables on lag one and lag two respectively.

The error correction coefficient should be significant and negative Speed. Speed of adjustment towards equilibrium is 183%. Speed of adjustment in any disequilibrium towards long run equilibrium state 183% meaning that it is adjusting very fast toward long run equilibrium. The coefficient value of cointegrating equation is also significant for the long run adjustment towards equilibrium. Short run coefficient is also significant as shows in table 6.1.5 with the superscript (*).

Table 6.1.5: Vector Error Correction Estimates

Error Correction:	D(FDIINFL)	D(FR)	D(AER)	D(OPEN)
CointEq1	-1.837*	-3.924**	0.000	-0.000***
	-0.283	-1.839	-0.004	-5.900
	[-6.477]	[-2.133]	[0.125]	[-1.710]
CointEq2	0.062	1.418**	-0.008*	4.207
	-0.091	-0.595	-0.001	-1.905
	[0.682]	[2.380]	[-6.170]	[0.022]
CointEq3	-12.680	65.653	-0.663*	-0.004**
	-9.580	-62.110	-0.146	-0.001
	[-1.323]	[1.057]	[-4.518]	[-2.120]
D(FDIINFL(-1))	1.378*	4.661**	-0.005	-0.000***
	-0.350	-2.271	-0.005	-7.305
	[3.934]	[2.051]	[-1.077]	[-1.760]
D(FDIINFL(-2))	1.477*	2.690	-0.005	-4.125
	-0.398	-2.580	-0.006	-8.205
	[3.712]	[1.042]	[-0.899]	[-0.498]
D(FR(-1))	-0.273*	-0.978	0.005*	5.425**
	-0.098	-0.635	-0.001	-2.005
	[-2.786]	[-1.540]	[3.958]	[2.668]
D(FR(-2))	-0.059	-1.763**	0.008*	-2.935
	-0.132	-0.857	-0.002	-2.705
	[-0.448]	[-2.056]	[3.977]	[-1.068]
D(AER(-1))	-29.599	64.825	-0.408	-0.001
	-19.512	-126.503	-0.299	-0.004
	[-1.516]	[0.512]	[-1.364]	[-0.295]
D(AER(-2))	15.972	-20.620	0.195	9.125
	-15.139	-98.149	-0.232	-0.003
	[1.055]	[-0.210]	[0.843]	[0.029]
D(OPEN(-1))	-2095.244	19667.91	-165.989*	-0.648
	-3059.53	-19835.5	-46.906	-0.633
	[-0.684]	[0.991]	[-3.538]	[-1.022]

D(OPEN(-2))	-4230.934**	5714.055	-68.366**	-0.103
	-1752.74	-11363.3	-26.871	-0.363
	[-2.413]	[0.502]	[-2.544]	[-0.285]
C	338.782*	732.499	3.400***	0.088*
	-116.683	-756.477	-1.788	-0.024
	[2.903]	[0.968]	[1.900]	[3.666]

Standard errors in ( ) & t-statistics in [ ]. * significant at 1%, ** significant at 5%,
*** significant at 10%

6.1.6 ECM Statistically viability

In table 6.1.6, targeted model equation 1 shows the value of R-square and DW statistics. R-square value is 0.92 which means that the independent variables can explain the dependent variable 92% from this model. From the deduction of the R-square value one can explain the exogenous factor also affecting the dependent variable which is 8%. It means that there is good R-square value which is desirable. The value of DW test statistics is 3.1822, which is between dL and dU.

Targeted model equation 2 shows the value of R-square and DW statistics. R-square value is 0.79 meaning that the independent variables can explain the dependent variable 79% from this model. From the deduction of the R-square value one can explain the exogenous factor is also affecting the dependent variable which is 21%. It means that there is good R-square value which is desirable. The value of DW test statistics is 2.1257, which is also between the dL and dU.

In table 6.2.6, targeted model equation 3 also shows the value of R-square and DW statistics. R-square value is 0.87 meaning that the independent variables can explain the dependent variable 87% from this model. From the deduction of the R-square value one can explain the exogenous factor is also affecting the dependent variable which is 13%. It means that there is

good R-square value which is desirable. The value of DW test statistics is 2.2966, which is between the dL and dU.

Again targeted model equation 4 shows the value of R-square and DW statistics. R-square value is 0.96 meaning that the independent variables can explain the dependent variable 96% from this model. From the deduction of the R-square value one can explain the exogenous factor is also affecting the dependent variable which is 4%. It means that there is good R-square value which is desirable. The value of DW test statistics is 2.4490, which is also between the dL and dU.

It means we cannot reject null hypothesis. It means that the variables are not autocorrelated.

Table 6.1.6: ECM Statistically Viability

Targeted Model Equation1: D(FDIINFL) = C(1)*(FDIINFL(-1) - 2070.9815*OPEN(-1) + 266.067) + C(2)*(FR(-1) - 14463.125*OPEN(-1) + 517.611) + C(3)*(AER(-1) - 86.112*OPEN(-1) - 6.224) + C(4)*D(FDIINFL(-1)) + C(5)*D(FDIINFL(-2)) + C(6) *D(FR(-1)) + C(7)*D(FR(-2)) + C(8)*D(AER(-1)) + C(9)*D(AER(-2)) +C(10)*D(OPEN(-1)) + C(11)*D(OPEN(-2)) + C(12)

R-square	0.926	Mean dependent var	92.781
Adjusted R-square	0.824	S.D. dependent var	226.713
S.E. of regression	94.882	Sum squared resid	72021.490
Durbin-Watson stat	3.182		

Targeted Model Equation2: D(FR) = C(13)*(FDIINFL(-1) - 2070.981*OPEN(-1) + 266.067) + C(14)*(FR(-1) - 14463.125*OPEN(-1) + 517.611) + C(15)*(AER(-1) - 86.112*OPEN(-1) - 6.224) + C(16)*D(FDIINFL(-1)) + C(17)*D(FDIINFL(-2)) + C(18)*D(FR(-1)) + C(19)*D(FR(-2)) + C(20)*D(AER(-1)) + C(21)*D(AER(-2)) + C(22)*D(OPEN(-1)) + C(23)*D(OPEN(-2)) + C(24)

R-square	0.795	Mean dependent var	778.838
Adjusted R-square	0.513	S.D. dependent var	882.016
S.E. of regression	615.140	Sum squared resid	3027182.000
Durbin-Watson stat	2.125		

Targeted Model Equation3: D(AER) = C(25)*(FDIINFL(-1) - 2070.981*OPEN(-1) + 266.067) + C(26)*(FR(-1) - 14463.125*OPEN(-1) + 517.611) + C(27)*(AER(-1) - 86.112*OPEN(-1) - 6.224) + C(28)*D(FDIINFL(-1)) + C(29)*D(FDIINFL(-2)) + C(30)*D(FR(-1)) + C(31)*D(FR(-2)) + C(32)*D(AER(-1)) + C(33)*D(AER(-2)) + C(34)*D(OPEN(-1)) + C(35)*D(OPEN(-2)) + C(36)

R-square	0.877	Mean dependent var	1.188
Adjusted R-square	0.709	S.D. dependent var	2.700
S.E. of regression	1.454	Sum squared resid	16.928
Durbin-Watson stat	2.296		

Targeted Model Equation4: D(OPEN) = C(37)*(FDIINFL(-1) - 2070.981*OPEN(-1) + 266.067) + C(38)*(FR(-1) - 14463.125*OPEN(-1) + 517.611) + C(39)*(AER(-1) - 86.1127945711*OPEN(-1) - 6.22401735724) + C(40)*D(FDIINFL(-1)) + C(41)*D(FDIINFL(-2)) + C(42)*D(FR(-1)) + C(43)*D(FR(-2)) + C(44)*D(AER(-1)) + C(45)*D(AER(-2)) + C(46)*D(OPEN(-1)) + C(47)*D(OPEN(-2)) + C(48)

R-square	0.964	Mean dependent var	0.054
Adjusted R-square	0.916	S.D. dependent var	0.068
S.E. of regression	0.019	Sum squared resid	0.003
Durbin-Watson stat	2.449		

[(dL=0.102, dU=3.227) on 1% level of significance]

[(dL=0.160, dU=3.335) on 1% level of significance]

6.1.7 Granger Causality Test

The first row of below table 6.1.7 revealed that the null hypothesis, FR does not Granger Cause FDIINFL, cannot be accepted, the level of significance is desirable. FR cause FDIINFL. In the second row the null hypothesis, FDIINFL does not Granger Cause FR, can not accept at 9.8 percent level of significance and therefore, FDIINFL Granger Cause FR. So, there is a bidirectional causal relationship between FDIINFL and FR.

Third row shows that the null hypothesis, AER does not Granger Cause FDIINFL, is accepted, the level of significance is not desirable. AER does not cause FDIINFL. In the fourth row the null hypothesis, FDIINFL does not Granger Cause AER, is accepted. AER and FDIINFL does not cause to each other.

As shows in table the null hypothesis, OPEN does not Granger Cause FDIINFL, cannot be rejected and vice versa for the FDIINFL does not Granger Cause OPEN. So, there is not a unidirectional or bidirectional relationship.

Table 6.1.7: Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.	Relationship Uni / Bidirectional
FR does not Granger Cause FDIINFL	21	5.570	0.014	↔ Bidirectional
FDIINFL does not Granger Cause FR		2.691	0.098	
AER does not Granger Cause FDIINFL	21	1.441	0.265	No Relation
FDIINFL does not Granger Cause AER		1.450	0.263	
OPEN does not Granger Cause FDIINFL	21	2.280	0.134	Unidirectional at 86% level of confidence
FDIINFL does not Granger Cause OPEN		0.999	0.389	

6.1.8 Result summery of FDI inflow, foreign reserve, exchange rate and trade openness

The main theme of this is to investigate relationship among exogenous variables in long run. The exogenous variables which are used in this chapter are FDIINFL, FR, AER and

OPEN. In this chapter some econometrics tools are used to investigate the long run association and relation of FR, AER and OPEN with FDIINFL.

Time series variables are non stationary on level and become stationary on 1st difference and 2nd difference. If the variables become stationary on 2nd difference then it is necessary to check the long run relationship with the help of co-integration. Co-integration test confirms the long run association among (FDIINFL) Inflow of foreign direct investment, (FR) foreign reserve, (AER) average exchange rate and (OPEN) openness in an economy for trade. Before co-integration test, it is necessary to check the stationary of time series variables.

Inflow of the foreign direct investment has been influenced by the foreign reserve and average exchange rate in long run. Econometrics analysis shows the normalized equation which is verified the positive long run relationship between foreign direct investment and foreign reserve and average exchange rate. Rise in exchange rate induces the FDI inflow.Calvo Guillermo A. et al. 1996, found that the substantial portion of the surge in capital inflows has channeled to accumulation of foreign exchange reserve Devaluation of currency helps to increase the inflow of foreign direct investment. Opennesshas significantly negative relationship with inflow of foreign direct investment.

Speed of adjustment is 183 percent towards equilibrium in long run. The coefficient of speed is significant at 1% level which is desirable result for error correction method. Some other coefficients are also significant to adjust the speed in short run those are verified by the help of t-statistics and p value.

Granger causality results have confirmed the bidirectional relationship between inflow of foreign direct investment and foreign reserve. This is the desirable objective of this study. Average exchange rate and openness for trade has not caused the inflow of foreign direct investment. The relationship among the variable are also verified by the help of correlation

coefficient. All the variables are positively correlated with each other. Inflow of foreign direct investment and openness in trade highly correlated. Inflow of foreign direct investment and foreign reserve is also highly correlated. Only average exchange rate has average positive relation with the inflow of foreign direct investment.