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A statistical analysis on causality test in India's foreign market

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Abstract

The gargantuan current account deficit was a much discussed issue in Indian economy during 2012-13. It was USD 87.8 billion, 4.8% of GDP in the financial year 2013. Accordingly the price of Rupees against Dollar has been continuously falling in the recent past. Foreign trade market has been characterized by some common scenarios. Firstly, there is a change in the composition of trade. Whereas the combined share of import of Petroleum, Electronic goods and Gold is rising, the same for Machinery, Iron and Steel is falling and Gold is rising. Secondly, major changes have been observed in the trading partners for the exportable and importable items in the past two decades. Thirdly, GDP trend has been heavily dependent on the foreign investment and external assistance.

This paper examines the trend of export and import and some other parameters related with India's foreign trade with the help of usual statistical tools. There is also an effort to find out the dependency of the India's GDP on these parameters using causality test and multiple regression analysis.

Keywords

Causality test, GDP, Export, Import, Trade.

AMS Subject Classification

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Contents

1. Introduction

India has been experiencing ballooning Current Account Deficit (CAD) since the first five year plan. CAD touched a record high of USD 87.8 billion in Financial Year 2013 which is 4.2% of GDP. During the period of first plan it was only Rs. 42 Crores.

India's trade policy is characterized by both import restrictions and import liberalization (after 1991) along with export promotion. The policies recommended by Mudaliar Committee (1962), Alexander Committee (1978), Abid Hussain Committee (1985) are among the major ones. Trade policy 1991 was in favour of free flow of export and import. Petroleum has been always considered a major importable item in India. The situation was worsened in August 1990 because of the Iraq's invasion of Kuwait. India experienced a double digit inflation resulting from the mammoth price rise of Petroleum. In the post reform era import of mineral oil is augmented at an average growth rate 7.8% despite of International price rise at an average rate 12.1%. At present about 70% of total import is for oil and non-essential items and the rest 30% includes Gold (12%), Capital Goods (6%), Chemical (5%) and Electronics (7%). In the last decade at different points of time India has experienced Current Account surpluses due to buoyant invisible inflows through private transfers (remittances) and software service exports. So it is clearly understandable foreign trade parameters and their trends mean a lot for the growth of any economy. Here is the reason enough for which the main theme of this paper can claim a great attention from us. For more details see [3–6, 8].

2. Objective of the Study

No country in this era of globalisation can exist without the influence of foreign countries. The direction of growth of domestic economy can be changed at any moment under the guidance of foreign trade market. FDI has a direct impact on the income and employment perspectives through its multiplier effect. The trends of export, import, external assistance also have serious links with the trends of GDP of any economy. Under these circumstances the main objective of this paper is to find out the extent of dependency of GDP on the foreign trade parameters so that the domestic economy can be modified accordingly for the growth and welfare of domestic people.

3. Methodology

Apart from the analysis of different dimensions of India's foreign trade market in brief, the following methodologies have been used in this paper

(a) Testing of hypothesis of simple linear type of trend equation i.e. $Y = A + Bt$ of different foreign trade parameters. In this case the null hypothesis (H_0) is there is no change of respective parameter over time.

(b) Multiple regression analysis to find out the impacts of FDI, External assistance and Export on the India's GDP. In this case the equation will be

$$GDP = \text{constant} + a\ (\text{Export}) + b\ (\text{External Assistance}) + c(FDI)$$

(c) Correlation Matrix which gives the strengths of relationships among the different foreign trade parameters.

(d) **Causality Test:** Let us consider in a bivariate framework we are trying to forecast for any particular variable. Under Granger test if that forecast is improved after taking lagged values of another variable then second variable has a Granger cause to the first variable. More generally "if variable X (Granger) cause variable Y then changes in X should precede changes in Y. Therefore, in a regression of Y on other variables (including its own past values) if we include past or lagged values of X and it significantly improves the prediction of Y, then we can say that X (Granger) cause Y".

Relationship and causality between two variables are not the same things. There may be relationship between two variables. It does not necessarily mean causation. Let us consider that we are trying to have prediction on the time series data of a variable Y. If the error of current Y is reduced after taking into consideration the past values of another variable X along with the past values of Y, then time series X is said to be Granger cause to another time series Y. When the linear combination of two non-stationary variables is non-stationary the Granger's causality test can take place.

$$\Delta X_t = \alpha_1 + \sum_{i=1} \beta_{1i} \Delta X_{t-i} + \varepsilon_{1t} \tag{3.1}$$

$$\Delta X_t = \alpha_2 + \sum_{i=1}^{n_1} \beta_{1i} \Delta X_{t-i} + \sum_{j=1}^{n_2} \beta_{2j} \Delta X_{t-j} + \varepsilon_{2t} \tag{3.2}$$

Equations (3.1) and (3.2) are useful to examine whether the coefficients of past lags of Y are zero or not. If in equation (3.2) the above-said co-efficient is not zero (i.e. computed F statistic is significant) then Y Granger causes X. By the same way, we can examine whether X Granger causes Y or not [2]. To test the hypothesis the relevant F statistic is given by

$$(RSS_R - RSS_{UR})/m \div RSS_{UR}/n - k$$

where m denote the number of lagged terms. To test the stationarity, graphical analysis on autocorrelation function (ACF) may be given. The ACF at lag k is given by,

$$N_k = S/a_0 = (\text{Covariance at lag}k)/\text{variance}$$

We have also taken help at first of unit root test to find out order of integration of the variables. Let us assume

$$Y_t = \rho Y_{t-1} + u_t, \quad -1 \le \rho \le 1,$$

where, u_t is a white noise error term, also

$$\Delta Y_t = \delta Y_{t-1} + u_t$$
$$\Delta Y_t = Y_t - Y_{t-1}, \quad \rho - 1.$$

Thus in case of unit root test null hypothesis becomes $\delta = 0$. If it is zero or if the null hypothesis is not rejected we conclude that Y_t is non-stationary.
Cointegration test can be applied if the variables are of same order of integration. Dicky-Fuller (DF) and Augmented Dicky Fuller (ADF) are two popular tests which are useful to examine the unit roots and stationary property of the variables. The rule of thumb is, to run standard Granger causality test in a bivariate framework the linear combination of two series has to be non-stationary. If it is stationary then simple regression analysis is acceptable.
To get optimal lag length of independent variable we have followed Akike's final prediction error (FPE) criterion as suggested by Hsiao [9].
Following this approach any optimum lag length will minimise the Final Prediction Error (FPE). Let us consider that m and n are the optimum

$$FPE(m,0) = [(R+m+1)/(R\text{–}m\text{–}1)] \times [RSS(m,0)/R] \tag{3.3}$$

$$FPE(m,n) = [(R+m+n+1)/(R\text{–}m\text{–}n-1)] \times [RSS(m,n)/R] \tag{3.4}$$

Lag Lengths of the independent variables estimated from the equations (3.1) and (3.2). In the equation (3.3) FPE $(m,0)$

will be obtained from equation (3.1) and in the equation (3.4) above FPE (m,n) will be obtained from equation (3.2) where, RSS $(m,0)$ is the residual sum of square and R denotes the number of observation. If the FPE value in equation (3.4) is smaller than the FPE value in equation (3.3) then we can conclude Y Granger cause X.

4. Hypotheses of the Study

Regarding testing of hypotheses, the analysis in this paper has taken place against following null hypotheses (H_0)

(a) GDP is not dependent on FDI

(b) GDP is not dependent on External Assistance

(c) GDP is not dependent on Export

(d) There is no Causality between the trends of GDP and FDI

5. Brief Review of Literature

Shawa and Shen [14] have studied the existence of causality among FDI, G DP and export in Tanzania during 1980-2012 considering time series annual data over 33 years. The study found no causation between FDI and GDP. As per study of Miankhel, Thangvelu and Kaliranjan [13] economic growth is responsible for the growth o1 FDI in India whereas, in Thailand there is bilateral causality between two. The study of Dritsaki M, Dritsakic and A. Adamopolous [7] shows the causality among the variables FDI, export and economic growth in Greece during 1960-2002. In his study they found the dependency of FDI on economic growth and unilateral causality from economic growth towards FDI in Bangladesh during 1973-2008. Athukorala [1] also received the same result in Srilanka. For more details see [10–12, 15].

Statistical Results and their Interpretations

(A) Simple Linear Trend Results

The results we received subject to the time series data

Table 1

Parameters	R-square	t values	Sig.
Forex.(Gold+SDR +Foreign Currency)	0.382	5.936	0.002
Export	0.464	7.027	0.001
Import	0.404	6.215	0.001
External Assistance (Loan+Grants)	0.857	12.46	0.001
Oil Import	0.472	5.764	0.001

(see appendix) of Foreign exchange (1950-2010), Export (1950-2010) and Import (1950-2010). External assistance data covers the period 1979-2010. The trends of all the parameters are statistically significant at the 5% level of significance.

(B) Multiple Regression Results

From the results of multiple regression analysis we get the following equation

$$GDP = 317670.3 + 20.334(FDI) - 1.435(\text{External Assistance}) + 7.652(\text{Export})$$

The value of R^2 is quite high and satisfactory. The constant term, FDI and Export have shown statistically significant results at the 5% level of significance. The values of Variance Inflation Factor for all the parameters are less than 5. So we can rule out the possibility of multi-collinearity among the variables.

Table 2. Multiple Regression Results

	Coeff.	t Value	Sig.	VIF	R Square
Constant	317670.3	4.224	0.002		0.990
FDI	20.334	3.749	0.005	3.600	
External Assistance	-1.435	-0.212	0.837	2.296	
Export	7.652	10.988	0.001	4.790	

[C] Correlation Results

The table given below presents the values of correlation coefficients among GDP, FDI, External Assistance and Export over the period 1990-2010. All the values are statistically significant either at 5% level of significance or at the 10% level of significance.

Table 3. Correlation Matrix

	GDP	FDI	External Assistance	Export
GDP	1.000	0.904*	0.739**	0.987*
FDI		1.000	0.648**	0.850*
Assistance				0.751*
Export				1.000

*5% level of significance; **10% level of significance.

Below the histograms and normal probability plots of residuals are presented. Histogram Dependent Variable: GDP

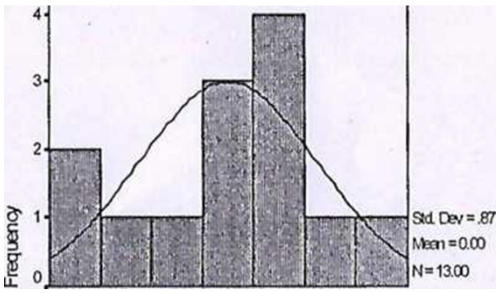

Figure 1

[D] Causality Test

Here we try to get the results on Granger Causality between GDP and FDI over the period 1990-2011. The basic methodology has been mentioned before.

Correlogram of FDI

Table 4. Sample: 121; Included observations: 21

Autocor -relation	Partial Cor -relation		AC	PAC	Q-Stat	Prob
.|***** |	.|***** |	1	0.648	0.648	10.139	0.001
.|**** |	.|*. |	2	0.526	0.183	17.168	0.000
.|*** |	.|*. |	3	0.452	0.099	22.653	0.000
.|**. |	.**| . |	4	0.215	-0.269	23.962	0.000
.|*. |	.*| . |	5	0.080	-0.117	24.155	0.000
.| . |	.| . |	6	0.034	0.041	24.192	0.000
.| . |	.| . |	7	-0.038	0.037	24.242	0.001
.*| . |	.*| . |	8	-0.101	-0.061	24.621	0.002
.*| . |	.*| . |	9	-0.130	-0.086	25.298	0.003
.*| . |	.| . |	10	-0.151	-0.039	26.297	0.003
.*| . |	.| . |	11	-0.186	-0.042	27.968	0.003
.**| . |	.| . |	12	-0.204	-0.045	30.194	0.003

Correlogram of GDP

Table 5. Included observations: 21

Autocor -relation	Partial Cor -relation		AC	PAC	Q-Stat	Prob
.|****** |	.|****** |	1	0.797	0.797	15.338	0.000
.|***** |	.| . |	2	0.629	-0.018	25.383	0.000
.|**** |	.| . |	3	0.478	-0.049	31.513	0.000
.|***. |	.*| . |	4	0.338	-0.067	34.754	0.000
.|**. |	.| . |	5	0.217	-0.045	36.182	0.000
.|*. |	.| . |	6	0.117	-0.038	36.623	0.000
.| . |	.| . |	7	0.031	-0.046	36.656	0.000
.| . |	.| . |	8	-0.042	-0.046	36.720	0.000
.*| . |	.| . |	9	-0.102	-0.047	37.141	0.000
.*| . |	.*| . |	10	-0.159	-0.064	38.244	0.000
.**| . |	.*| . |	11	-0.211	-0.072	40.403	0.000
.**| . |	.*| . |	12	-0.262	-0.080	44.081	0.000

To test the stationarity graphical analysis on autocorrelation function (ACF) may be presented. The ACF at lag k is given by

$$N_k = S/a_0 = (\text{Covariance at lag } k)/\text{variance}$$

The Correlograms of GDP and FDI indicate that the values of autocorrelation coefficients decline towards zero with the rising number of lag length. Here we run the causality test considering lag length one and get the following results. There is unilateral Granger causality from GDP to FDI.

Table 6. Unit Root Tests without Trend

Variable	Level		First Difference	
	DF	ADF(1)	DF	ADF(1)
GDP	-2.036	-2.258	-5.168	-3.654
FDI	-1.568	-0.425	-5.712	-3.487

Table 7. Unit root Test with Time Trend

Variable	Level		First Difference	
	DF	ADF(1)	DF	ADF(1)
GDP	-2.236	-2.548	-5.148	-4.314
FDI	-4.170	-2.295	-5.025	-2.236

Table 8. Cointegration Tests

Regression Equation	DF	ADF
(c) Regress GDP on FDI	-3.131	-2.570
(d) Regress FDI on GDP	-1.282	-1.259

Note: No DF and ADF values are significant subject to Critical values at 5% level of significance.

Table 9. Granger Causality Test between GDP & FDI

Regression	FPE†
(a) GDP as a dependent variable	
i. Regress GDP on GDP $(m = 1)$	0.01495
ii. Regress GDP on GDP $(m = 1)$ and FDI $(n = 1)$	0.01407
(b) FDI as a dependent variable	
i. Regress FDI on FDI $(m = 1)$	0.00468
ii. Regress FDI on FDI $(m = 1)$ and GDP $(n = 1)$	0.00530

Note: † FPE represents Akaike's final prediction error.

Table 10

Null hypothesis	F Statistic	Probability
GDP does not cause FDI	0.1884	8E-05
FDI does not cause GDP	0.3551	0.14327

6. Conclusion

There are ample proofs of sector-wise and region-wise concentrations in FDI inflow in India. The main Vantage points of India are cheap and skilled workforce and size of the market, whereas the foreign firms must have zeal in their own firm specific factors creating domestic monopoly. Thus we must apply social cost benefit approach in the long run utilizing domestic resources what Korea did in the semi-conductor and telecom equipment manufacturing sector. Needless to say Indian economy or its trend of GDP is heavily dependent on FDI inflow, Exports and External Assistance. The causality test apparently shows unilateral causality from GDP to FDI.

Appendix

Table 11

Year	Export	Import	GDP	Other Internal Assistance	FDI
1950-51	606	608	10401		
51-52	716	890	11054		
52-53	578	702	10850		
53-54	531	610	11810		
54-55	593	700	11170		
55-56	609	774	11371		
56-57	605	841	13547		
57-58	561	1035	13951		
58-59	581	906	15551		
59-60	640	961	16384		
60-61	642	1122	17942		
61-62	660	1090	19010		
62-63	685	1131	20429		
63-64	793	1223	23462		
64-65	816	1349	27367		
65-66	810	1409	28857		
66-67	1157	2078	32669		
67-68	1199	2008	38261		
68-69	1358	1909	40512		
69-70	1413	1582	44605		
70-71	1535	1634	47638		
71-72	1608	1825	50999		
72-73	1971	1867	56214		
73-74	2523	2955	68420		
74-75	3329	4519	80770		
75-76	4036	5265	86707		
76-77	5142	5074	93422		
77-78	5408	6020	105848		
78-79	5726	6811	114647		
79-80	6418	9143	125729	1859.5	
80-81	6711	12549	149642	3847	
81-82	7806	13608	175805	2973.9	
82-83	8803	14293	196644	2972.7	
83-84	9771	15831	229021	2087.7	
84-85	11744	17134	256611	4880	
85-86	10895	19658	289524	5650.4	
86-87	12452	20096	323949	6159.5	
87-88	15674	22244	368211	9265.3	
88-89	20232	28235	436893	13069.8	
89-90	27658	35328	501928	10826	
90-91	32553	43198	586212	8123	351
91-92	44041	47851	673875	12707.6	675
92-93	53688	63375	774545	14093.8	1787
93-94	69751	73101	891355	14033.9	3289
94-95	82674	89971	1045590	13460.1	6820
95-96	106353	122678	1226725	12163.2	10389
96-97	118817	138920	1419277	17141.4	16425
97-98	130100	154176	1572394	16966	13340
98-99	139752	178332	1803378	8530.6	16868
99-2000	159561	215236	2012198	20319	19342
2000-01	203571	230873	2168652	18124.7	19265
2001-02	209018	245200	2348330	25095	21286
2002-03	255137	297206	2530663	21171.8	14301
2003-04	293367	359108	2837900	17105.1	12871
2004-05	375340	501065	3242209	25817.2	14653
2005-06	456418	660409	3693369	18937.9	24584
2006-07	571779	840506	4294706	31789.9	56390
2007-08	655864	1012312	4987090	33282.8	98642
2008-09	840755	1374436	5630063	29525.9	142829
2009-10	845534	1363736	6108903	15359.6	123120
2010-11	1142922	1683467	7248860	22596.1	97320

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